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Environmental Geochemistry and Human Health
Radon and lung cancer: the need for national action plans
Fernando P. Carvalho

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Abstract:

The radioactive gas radon has been recognized as a carcinogenic agent and prolonged exposure to radon ranks second, after tobacco smoke, as a cause of lung cancer. Radon has a natural origin, and the isotope $^{222}$Rn of the uranium family and with the longest half-life (T1/2=3.8 d) among radon isotopes, may accumulate in dwellings, caves, and mines and originate high radiation doses to residents and workers. The World Health Organization (WHO) in order to abate the incidence of lung cancer in the population, proposed new limits to radon concentrations indoors. Generally, radon concentrations indoors are related with the geology of the regions, and granite regions often display the highest radon concentrations. In Portugal and in Europe in general, the mapping of radon indoors was made and the regions with occurrence of elevated radon concentrations are identified. Many other countries may have in their territory areas with high radon levels albeit not identified yet. Worldwide it is needed to deal with radon through mitigation and preventive measures to achieve a significant reduction of the existing exposures to radon in the existing buildings and to prevent radon exposures in new constructions. Nevertheless, in spite of the WHO recommendations there is a significant inertia in adopting measures to abate radon exposure. While some countries have delineated action plans to deal with exposure to radon, others did not act on this issue yet. The need to approve measures and suitable national action plans to cope with radon exposure is discussed.

Key words: radon, radon daughters, radiation doses, lung cancer, mitigation, prevention.
Biogeochemical assessment of the impact of Ciscarpathian landscape on population health

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Abstract:
The chemical composition of soils and natural waters affects the biochemical processes in phyto-and zoocenosis of certain area. Regularities of disease spread among the population of Ciscarpathia are consistent with three landscape groups – mountain, foothill and plain.

Carpathian flysch rocks are the main source of dispersed elements that enter the environment. According to research, the sediments of Cretaceous, Paleogene and Neogene period contain concentrations of Ti, Cr, Cu, Ni, Ga, Zr and Ba that are equal to bulk earth values, but Be, Mg, V and Sr compose less than bulk earth value. Abrupt changes of dispersed elements content are observed during the gradation from mudstones of Stryiska suite to siltstones and sandstones of Yamnenska suite, namely, the concentration of Mn decreases by a factor of 42, Cu – 21, Ba, Mg – 16, Ni – 3 and Ti – by a factor of 2. Along with the transition to the Quaternary sediments, concentration of trace elements in rocks significantly reduces and is not exposed to sudden changes in the entire their vertical section.

Liveliness of dispersed elements is increased in the weathering crust. In mountainous landscapes Sr is extensively washed from rocks, Mn and Cu are less washed; Ti, Cr and Va are poorly included into water migration. The intensity of elements removal decreases along with transition to plains. The intensity of trace elements involvement into migration is associated with rocks weathering. In mountainous landscapes the weathering crust coincides with the soil. Sr has the highest migration ability in Carpathians, then Mn, Cu, Ba, V and Pb follow in descending order. According to the research, along with absolute landmarks increasing, water migration factors of micronutrients are increased. After passing to the soluble state trace elements reach the groundwater. Groundwater mineralization significantly increases along with the changes in mountain landscapes on foothills and plains. In the direction from mountains to plains the content of Sr, V and Ba in groundwater decreases and the content of Ni, Pb and Mn increases. The highest concentrations of Cu, Cr and Mo are typical for groundwater of mountain landscapes.
conditions and mountainous relief of Ciscarpathia contribute to the rocks weathering and transition of trace elements into moving (mobile) form. In mountainous landscapes plant species composition is determined by mineralogical and chemical composition of soil formation rocks and intensity of their destruction. Soil depth in this area is shallow, granulometric composition is insignificant. This led to the formation of high mountain Phytocenoses, which are characterized by a high content of V, Sr, Mn and Cu. In lowland landscapes of Ciscarpathia the conditions of phytocenoses are associated with increased concentrations of Mn, Ba, Cr and Pb in soils and groundwater. Groundwater mineralization in this area increases almost threefold in comparison with the mountainous area. The processes of dispersed elements migration are slowing down. Areas with high concentration and dispersion of trace elements are typical for lowland landscapes. Concentrations of V, Sr and Cu are smaller in plain area phytocenoses in comparison with highland phytocoenoses. Mountain people are often affected by the thromboobliterating diseases; they rarely suffer from leukemia, lymphomatoid granulomatosis, malignant myopia, acute attacks of glaucoma, malignant neoplasms, brain and spinal cord tumors and nephritis. Population of foothill area often suffers from leukemia and malignant myopia, population of plains suffers from acute attacks of glaucoma, gastric and lung cancer, tumors of brain and spinal cord and nephritis, rarer – from thromboobliterating diseases. The results of medical and geographical studies give reason to believe that the prevention of blood system diseases, ophthalmology and dental diseases among the population via selection of diet with optimal micronutrient content could be quite promising.
As spatial distribution characters in Mexico, revealed by Low Density Geochemical Baseline Results

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Abstract:
Arsenic occurs naturally in the earth’s crust and is widely distributed in the environment. Natural mineralization and activities of micro-organisms enhance arsenic mobilization in the environment but human intervention has exacerbated arsenic contamination. Although arsenic is useful for industrial, agricultural, medicinal and other purposes, it exerts a toxic effect in a variety of organisms, including humans. International Cancer Research has classified arsenic as the first type of carcinogen. Peripheral vascular diseases, hypertension as well as cerebrovascular disease (i.e., cerebral ingestion) are observed to link to long-term arsenic ingestion (Chen et al., 1995). Arsenic exposure may not only affect and disable organs of the body, especially the skin, but may also interfere with the proper functioning of the immune system (Duker et al., 2005). Nowadays, millions of individuals in the world are suffering from by arsenic toxicities and the arsenic contamination has been reported worldwide.

In Mexico, arsenic is one of important elements for perspective of the medical geology. Most of the health impacts have been resulted from the drinking of the naturally contaminated groundwater (Armienta et al., 2013). The polluted water body precipitates some heavy metals after a series of self-cleaning processes. The sediment is a buffer zone of water pollutants, and is also a sink of pollutants, which can become a source of pollutants under certain conditions.

In 2017 and 2018, China Geological Survey (CGS) and Servicio Geológico Mexicano (SGM) cooperation implemented the low density geochemical baselines project in Mexico with the sample density of 80km by 80km in 0-5cm, A and C horizon level. The contour map of arsenic in 0-5cm, A and C horizon level have been achieved. As positively anomaly map in Mexico could correspond to the distribution of the metal mineral such as in Chihuahua and Sinaloa, and some human activities area, such as in Mexico City. The characters of arsenic distribution in Mexico could prove that As pollution in the environment are rang from geological background to human activity and a combination of the two.

Keywords: Arsenic pollution, distribution characters, Low Density Geochemical Baselines, Mexico.

References:
Changes of serum NTX and TRACP-5b in adults of coal-burning fluorosis areas in Guizhou Province

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Abstract:

[Objective] To study the changes of serum NTX and TRACP-5b levels in adults aged from 20 to 90 years in coal-burning fluoride areas, and the relationship among serum NTX, TRACP-5b levels and age and dental fluorosis, so as to provide data of related indicators for the pathogenesis of skeletal fluorosis.

[Methods] The multi-stage sampling method was adopted. First, a number of natural villages were randomly selected from doujing township, and then 90 subjects from the natural villages were randomly selected to form the case group. After excluding the interference of other harmful environmental factors, following the principle of similar geographical environment, economic level and educational level, a simple random sampling was carried out in yunmu village of huaga township, and 40 observation subjects were selected as the control group. The subjects were diagnosed with dental fluorosis, at the same time, serum concentrations of NTX and tracp-5b were detected to analyze the relationship among concentrations of NTX and tracp-5b, age and degree of fluorosis.

[Results] The detection rate of dental fluorosis in fluorosis area was 95.0%, higher than that in control area (P<0.0001). The concentration of NTX in adults in fluorosis area was higher than that in control area (P<0.0001), while the concentration of tracp-5b was lower than that in control area (P=0.005). The concentration of NTX in the youth group was higher than that in the control group (P<0.0001), and the concentration of tracp-5b in the middle-aged group was lower than that in the control group (P=0.011). There were no significant differences in the concentrations of NTX and tracp-5b among adults in fluorosis area, and there was no correlation with age (P>0.05).

[Conclusion] The increase of fluoride intake will affect the concentrations of serum NTX and TRACP-5b in adults who live in the fluorosis areas, but the specific mechanism remains to be further studied.

Key words: coal-burning fluorosis area; adult; NTX; TRACP-5b
Study on Relationship between Fluorine in Geological Environment and Endemic Fluorosis in Huai River Basin

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Abstract:

Fluorosis arises in many places in Huai river basin, and in local area, the incidence of fluorosis disease is serious, which is worth to people’s health and development of the local economy. In the past decades, some scientists and institutes had done some works for the fluorosis, China geological survey had implement a certain projects about environmental geological research including fluorosis for many years in Huai river basin. Based the past works, this paper shows that endemic fluorosis distributing status in Huai river basin, fluorid content in groundwater in different depths, and indicate that four factors of fluorid and two factors of fluorosis disease. Finally, the author points out a certain water apply measures for prevention and cure from fluorosis disease.

Key Words: Huai River Basin; ground water; endemic fluorosis; prevention and cure
Contamination and Health Risk Assessment of Heavy Metals and Polycyclic Aromatic Hydrocarbons (PAHs) in street dusts from Kaifeng, China

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Abstract:

The components and concentrations of pollutants (heavy metals and polycyclic aromatic hydrocarbons (PAHs)) in street dust are indicators of environmental pollution. To explore the pollution levels of eight metals (V, Cr, Co, Ni, Cu, Zn, Cd, Pb) and 16 PAHs in street dust, 90 dust samples were collected from street dust in Kaifeng. The concentrations of V, Cr, Co, Ni, Cu, Zn, Cd, and Pb in street dust samples from Kaifeng City, China were measured by inductively coupled plasma mass spectrometry (ICP-MS), and that of Al using by ICP-OES. The results showed that the concentrations of heavy metals in street dust of Kaifeng were 62.33, 59.78, 5.80, 19.28, 36.61, 206.85, 0.96, 49.26, 53383.13 mg·kg⁻¹, respectively. When compared with the surrounding background dust values, the samples generally displayed elevated trace element concentrations (Cu, Zn, Cd, Pb). The results of the geo-accumulation index (Igeo) of the metals revealed the following orders: Cd > Zn > Pb > Cu > Cr > Al > Ni > V > Co. There were no non-carcinogenic risks (HI) and carcinogenic risks (CR) for adults and children. The exposure to Cr in dust could exhibit potential health risks for children. Cadmium posed the greatest carcinogenic risk in Kaifeng’s dust. It was found that the concentrations of 16 PAHs species in surface dusts of Kaifeng City varied from 624.83 to 23418.27 μg·kg⁻¹ dry weight, with an average of 4202.89 μg·kg⁻¹. The four-ring PAHs were the dominant components of PAHs in Kaifeng citystreet dust. The incremental life time cancer risk (ILCRs) indicated that the risk of exposure to dust PAHs was pervasive for local residents in Kaifeng.

Key words: street dust, heavy metal, PAHs, ILCRs, Kaifeng
Fluoride levels in soil and vegetables in the vicinity of a phosphating plant

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Abstract:

This study assessed the levels of fluoride (F) in soil and vegetables in the vicinity of a phosphating plant in Guizhou province, southwest China. Field samples, including soil and vegetable were collected to determine the total and water soluble F concentrations in an extensive survey. Results showed that total and water soluble F contents in agricultural soils ranged from 529.36 to 1496.02 mg·kg⁻¹ and 2.23 to 37.27 mg·kg⁻¹, with the mean value of 819.45 mg·kg⁻¹ and 13.33 mg·kg⁻¹, respectively. Total F concentrations in vegetables ranged from 0.02 to 25.89 mg·kg⁻¹, with the mean value of 1.32 mg·kg⁻¹. Compared with the Chinese maximum permissible concentration in vegetables for total F, 55.30% of vegetable samples in the present study area are contaminated with F. The total and water soluble F in soil exhibited no significant correlations with total F in vegetables, which is inferred that F in vegetables may be derived mainly from the atmosphere instead of soil. The risk index of F via vegetable consumption for both population groups was less than 1, indicating the risks associated with the consumption of locally grown vegetables near the phosphating plant may not be a potential health concern.

Key words: Fluoride, Soil, Vegetables, Health risk, Phosphating plant
Arsenic levels in drinking water and dietary components and its health effects on the rural residents of west Tibet, China

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Abstract:

Arsenic (As), one of the ubiquitous metalloids, is ranked as class one human carcinogen due to its hypertoxic nature and its main exposure pathways are drinking water and foods. Elevated As concentration in the soils, lakes water, streams water and sediments in Singe Tsangpo drainages in Ngari area, western Tibet has been found (Li et al., 2013). However, the health effects on the local residents of the high arsenic background is still unclear. The investigation of As exposure sources and health effects on the local residents of Ngari rural area was carried out since 2016. Samples of drinking water (n=45), food (n=86) and biomarker including nail (n=284) and hair (n=230) were collected from 12 villages in this region. The average As concentration of drinking water (including stream water, well water, lake water, snow water and hot spring water) was 173.9±783.5 μg·L⁻¹ (n=45, range from 0.4 μg·L⁻¹ to 5346.8 μg·L⁻¹). This value for the samples of dug well water which is the main drinking water for the residents was 59.4±74.2 μg·L⁻¹ (n=36, range from 0.4 μg·L⁻¹ to 372.7 μg·L⁻¹). As concentration in the highland barley as the staple food for the local people ranged from 0.01 mg·kg⁻¹ to 4.17 mg·kg⁻¹ and its mean value was 0.30±0.64 mg·kg⁻¹. The percentage of drinking water and highland barley contributing to the average daily dose (ADD) exceeded 80% compared with other sources. Therefore, the drinking water and highland barley were the main sources of As exposure for the local residents. A significant positive correlation between total ADD and water As concentration (rs=0.819, p<0.01) were observed too. In addition, hazard quotient (HQ) for non-carcinogenic exposure risk and cancer risk (R) were both extremely high via water (HQ: 0.03-872.9; R: 1.4×10⁻⁵ -0.70) or highland barely (HQ: 0.15-20.8; R: 6.8×10⁻⁵ -0.03) showing a significant health threat to the local residents. Arsenic concentrations of hair and nail samples ranged from 0.02 mg·kg⁻¹ to 103.01 mg·kg⁻¹ and from below detection limit (BDL) to 118.80 mg·kg⁻¹ with average values of 1.74±7.00 mg·kg⁻¹ and 2.63±8.45 mg·kg⁻¹ respectively, which
were higher than the accepted level (1.0 mg·kg⁻¹ for hair (Hindmarsh et al., 2002) and 1.5 mg·kg⁻¹ for nail (Hinwood et al., 2002)). Arsenic in nails was a linear relationship of 1.5 times arsenic in hair. Nail and hair As concentrations showed significant positive correlations with drinking water concentration (rs=0.492, p<0.01 and rs=0.742, p<0.01, respectively) and ADD, but higher correlations of the nail than hair indicated that the nail was more valid than hair as biomarker for a long-time As exposure in this area. Moreover, the result that male had higher As in hair than female was corresponding with previous studies (Vahter et al., 2007).

The preliminary epidemiological investigation revealed that endemic arsenism existed in Tibet for the symptoms of chronic arsenic poisoning such as keratosis in palms or depigmentation in the back of some local residents appeared. More detailed and widely epidemiological investigation on endemic arsenism and risk assessment of arsenic in the residents of Tibet need to do.

**Key words:** endemic arsenism, Tibet, drinking water, dietary, risk assessment
Effects of Bisphenol A on Human Health and Related Toxicity Mechanisms
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Abstract:
Bisphenol A (BPA) is an industrial component that commonly used in synthesis of polycarbonate plastics, epoxy resin and other polymer materials. The presence of BPA is ubiquitous in surrounding environment for its mass productions and widespread applications. The environmental BPA can enter body via different ways such as inhalation, digestion and derma. Numerous studies have showed BPA has an estrogen-like and anti-androgen effect as an endocrine disruptor. Meanwhile, BPA can cause damage to different tissues and organs, including reproductive system, immune system and neuroendocrine system, etc. Recently, evidences have shown that BPA could induce carcinogenesis and mutagenesis in animal models. The aim of this review was to compile the available current research data regarding BPA and provide an overview of the current status of BPA exposure. It would contribute to clarify the relationship between BPA exposure and adverse effects on health. At the same time, the underlying mechanisms of BPA-induced multi-organs toxicity were well summarized. This review provides systematic evidences of BPA toxicity on human health and related mechanisms. These mechanisms are involved in the receptor pathways, the disruption of neuroendocrine system, the dysregulation of enzymes and other biomolecules, the immune and inflammatory responses, as well as genotoxic and epigenetic mechanisms. Further researches focused on low dose effects of BPA and its potential molecular mechanisms are still needed to be conducted. As the supervision of BPA has been strengthened in recent years, the substitutes of BPA need to be considered.

Keywords: Bisphenol A, Toxicity, Mechanisms, Endocrine Disruptors, Review
The toxic effects and possible mechanisms of bisphenols
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Abstract:
Increasing concern over bisphenol A (BPA) as an endocrine-disrupting chemical and its possible effects on human health have prompted the removal of BPA from consumer products, often labeled “BPA-free.” Some of the chemical substitutes may have similar physiological effects in organisms. (BPS) as a substitute chemical of (BPA), has raised concerns on its presence in the environment, which may pose considerable risks to the eco-system and human health. This review was carried out to evaluate the physiological effects and endocrine activities of BPS. The review included 93 articles published and indexed from 2010 to 2019. Electronic search was performed in Web of Science and PubMed. For inclusion, the studies had to be primary literature assessing any physiological effects of BPS exposure. The majority of these studies examined the hormonal activities of BPS and found the potency to be in the same order of magnitude and of similar action as BPA (estrogenic, anti-estrogenic, androgenic, and anti androgenic) in vitro and in vivo. Despite hopes for a safer alternative to BPA based on the current literature, BPS is hormonally active as BPA, and has endocrine-disrupting effects. Further investigations are needed to understand the clinical consequences of BPS exposure and the mechanisms by which BPS acts as an endocrine disruptor.

Keywords: Endocrine disruptor, Estrogenicity, Neurotoxicity, BPS, Hormonal activity.
Quantification of human exposure and public health risks from groundwater arsenic in India: new models and old challenges

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Abstract:

Arsenic in groundwaters utilized as drinking, cooking and irrigation waters represents a substantial risk to human health in many countries of the world (Polya and Middleton, 2017; UNICEF/WHO, 2018). Although India has, since the discovery of widespread groundwater arsenic hazard in West Bengal in the early 1980s, been identified as one of the countries most severely impacted, to date there has been little published detailed quantitative assessment of the likely country-wide extent of public health risks arising from that hazard. The aim of this study was to derive such an assessment.

The distribution of groundwater arsenic hazard was obtained from a review of published scientific papers (e.g. Chakraborti et al., 2017) and from public domain Indian and state government sources (e.g. Sinha et al., 2011) with interpolations made assuming log-normal distribution of arsenic concentrations at state, district and block as appropriate following the method of Polya et al. (2018). These were combined with population distributions from the Indian census and estimates of groundwater usage for drinking to determine human exposures through this route. Lastly, dose-response relationships based on Smith et al (2000) and Argos et al (2010) were used as the basis to calculate cancer and overall public health risks.

Considerable differences were found in estimates of populations exposed to over 50 ppb As in drinking water (As-DW) from different sources. Notable the estimates in or derived from Chakraborti et al (2017) and Sinha et al (2011) for Uttar Pradesh were substantially different, reflecting in part different sampling frames (e.g. private wells vs public wells; high arsenic impacted villages vs more representative sampling basis). Notwithstanding this, our more conservative models suggests arsenic-attributable excess mortality in India on the order of 10,000 per annum, whilst models assuming a log-normal distribution of As-DW suggests much higher country-wide excess mortality on the order of several 10,000s per annum, which reflect deviation from log-normal behaviour particularly with respect to higher As-DW. There is a requirement for more public domain transparently representative data in order to derive more accurate health risk estimates.

**Key words:** groundwater, arsenic, India, exposure, public health risks
Effects of prenatal exposure to thallium on cord blood leukocyte mitochondrial DNA copy number

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Abstract:

Background: The cord blood leukocyte mitochondrial DNA copy number (mtDNAcn) could be subjected to external environmental stressors. However, little is known about its correlation with thallium exposure, a heavy toxic metal.

Objective: To investigate the trimester-specific relationship between maternal exposure to thallium and cord blood leukocyte mtDNAcn.

Methods: A total of 762 mother-newborn pairs were recruited from Wuhan Children Hospital from Nov 2013 to Mar 2015 in Wuhan City, China. Each participant was required to provide their spot urine sample at the first (the periods of the first prenatal care visit), second (the periods of the oral glucose tolerance test) and the third (the periods of fetal heart rate monitoring) trimester, respectively. Umbilical cord blood was collected immediately after delivery. The concentration of thallium in maternal urine was quantified using inductively coupled plasma mass spectrometry (ICP-MS). Cord blood leukocyte mtDNAcn was measured by real-time quantitative polymerase chain reaction (qPCR). The associations of specific gravity (SG) adjusted urinary thallium concentrations detected in each trimester with mtDNAcn measured in cord blood leukocyte were estimated using general linear regression model.

Results: The median value of maternal urinary thallium concentration were 0.34 μg/L, 0.36 μg/L and 0.33 μg/L for the first, second and third trimester, respectively. After adjusted for maternal age, pre-pregnancy body mass, gestational age, infant’s sex, parity, maternal education, passive cigarette smoking, pregnancy induced hypertension and gestational diabetes mellitus, the linear regression model showed a 10.4% lower cord blood mtDNAcn with each doubling increase of thallium levels of the first trimester (percentage change: -10.4%; 95% CI: -17.7%, -2.4%; P=0.012).
While the second trimester and the third trimester did not show a significant correlation between thallium exposure and cord blood mtDNACn [the second trimester: -6.7% (-15.0%, 2.4%); the third trimester: -1.7% (-10.0%, 7.3%)]. In the stratified analysis models, the observed significant association of thallium exposure during the first trimester with cord blood mtDNACn was profound among those women with giving birth to a female infant [-12.2% (95% CI: -22.5%, -0.4%)].

Conclusions: Our study revealed a significant negative association between maternal thallium exposure during early pregnancy and cord blood leukocyte mtDNACn in Chinese pregnant women, pointing towards the important role of mitochondria as a target of thallium toxicity in early pregnancy.

**Keywords:** Thallium; Mitochondrial DNA copy number; Early pregnancy; Cohort study.
The Relationship of RUNX2 Methylation and Bone Mineral Density in Adults: An Epidemiological Survey from Endemic Fluorosis Areas in China

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Abstract:

Background: Excessive fluoride exposure can lead to abnormal bone metabolism, and osteoblasts actively play a leading role in the early stages of skeletal fluorosis. However, the mechanism about how fluoride activates osteoblasts and further affects bone metabolism has not been fully elucidated, especially the role of epigenetic modifications in the process.

Objectives: We aimed to investigate the relationship between bone mineral density (BMD) of adults and the methylation level of the RUNX2 gene promoter region in endemic fluorosis areas.

Methods: We conducted a cross-sectional study in Tongxu County, Henan Province. Four villages with different fluoride exposure concentrations in drinking water were selected using random sampling method. A total of 1,240 subjects aged 19 to 61 years from the four villages were recruited by cluster sampling. Among them, questionnaires, biological samples (blood and urine) and BMD measurements were collected. The fluoride levels in urine (UF) were determined using the ion-selective electrode method. Then the participants were divided into control group (CG, n=900) and high urinary fluoride group (HUFG, n=297) based on a cutoff value of UF concentration 1.6 mg/L (Chinese Sanitary Standard for Population normal urinary fluoride, WS/T 256-2005) (43 missed data were excluded). The concentrations of calcium (Ca²⁺), magnesium (Mg²⁺) and alkaline phosphatase (ALP) in serum were detected respectively. In addition, the methylation levels of RUNX2 gene promoter region were determined using Quantitative Real-time PCR and the proportion of various types of white blood cells was measured by routine blood test to adjust the methylation level. Independent sample t-test, chi-square test, one-way ANOVA and multiple linear regression analysis were used for statistical analysis by SPSS 22.0 software.
Results: Both in total and female population (n=758), the content of ALP in HUFG was higher than CG (P<0.05), whereas no differences in Ca2+, Mg2+ and BMD between CG and HUFG were observed (P>0.05, respectively). In the male population, the differences of methylation rate between CG (71.42±10.21) % and HUFG (74.37±10.22) % were statistically significant (P<0.05). However, we did not find that BMD was associated with RUNX2 gene methylation when fluoride exposure levels were similar (P>0.05). Multiple linear regression analysis suggested significant effects of BMI, Mg2+ and ALP on T-score after adjustment for age and gender (P<0.05, respectively). Furthermore, BMI and alcohol consumption were influencing factors of RUNX2 methylation after adjustment for age, sex and measured white blood cell proportions (P<0.05).

Conclusions: Our findings indicate that fluoride may affect the methylation status of the RUNX2 gene promoter region, however, we did not find the effect of RUNX2 methylation on BMD.

Keywords: Fluoride, Bone mineral density, RUNX2 gene, Methylation
Fluoride exposure, Calcitonin gene methylation and osteoporosis among female farmers in China

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Background: A number of epidemiological studies have reported that long-term excessive fluoride exposure can impair skeletal system. It has reported that the Calca gene plays an important role in the regulation of bone formation. However, the relationship between fluoride exposure, calcitonin gene methylation and osteoporosis in female living in a rural area remains unclear.

Objectives: We aimed to explore the relationship between Calca gene methylation and osteoporosis in female farmers with fluoride exposure.

Methods: We conducted a cross-sectional study including 747 female farmers with different fluoride exposure levels in drinking water in the Henan province of China. All study participants knew well about our research and signed the informed consent. General demographic characteristics were collected by face-to-face interview questionnaires. Body mass index (BMI) was calculated based on the measured height and weight. Total cholesterol, triglyceride, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol and alkaline phosphatase (ALP) levels were determined, respectively. Bone status was categorized into three groups according to the definition of World Health Organization, normal bone mineral density, osteopenia and osteoporosis based on the T-value measured by ultrasound bone densitometer. Methylation status was determined by methylation-specific PCR. SPSS statistical software package, version 21.0 was used for all statistical analyses.

Results: The prevalence of osteoporosis in menopausal women (58.9%) was higher than non-menopausal women (41.1%) (P<0.001). Significant differences were not observed between female in normal fluoride area and high fluoride area in T-value or Calca methylation level (P>0.05). We found Calca methylation were significant differences among normal bone mineral density (25.9%), osteopenia (26.3%) and osteoporosis (30.1%) (P<0.05). logistic regression results showed that higher Calca methylation level [OR=1.019, 95%CI: 1.001-1.022] and ALP [OR=1.009, 95% CI:
1.001-1.016] were risk factors for osteoporosis. Besides, we found BMI [OR=0.887 (95% CI: 0.848-0.928)], no menopause [OR=0.598 (95% CI: 0.377-0.947)], serum calcium [OR=0.575 (95% CI: 0.364-0.907)] were protective factors for osteoporosis. However, no significant correlation was observed between fluoride exposure and osteoporosis, as well as fluoride exposure and Calca gene methylation.

**Conclusions:** Calca gene methylation, ALP, menopause were risk factors for osteoporosis in Chinese female living in fluorosis area, while BMI and serum calcium were protective factors.

**Key word:** fluoride exposure, osteoporosis, Calca gene, DNA methylation
IQ Alterations in Children at 7-13 Years Old: The Roles of Prenatal and Childhood Fluoride Exposure

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Background: Chronic exposure to excessive fluoride will cause multiple pathological changes for humans. However, the effects of prenatal and childhood fluoride exposure on children's intelligence quotient (IQ) are rarely reported.

Objective: A cross-sectional study was performed to evaluate the roles of prenatal and childhood high fluoride exposure in alterations of children's IQ at age 7-13.

Methods: A total of 678 children in one fluoride exposure school and three control schools were selected in Henan province of China. Urinary fluoride level was measured by fluoride ion-selective electrode assay. Children's IQ level was assessed by the third revision of Chinese children's norm for Combined Raven Test (rural children's version).

Results: Children in prenatal fluoride exposure group (BG) had lower IQ scores than childhood fluoride exposure group (AG), both prenatal and childhood exposure group (DG), and control group (CG) (P<0.05, respectively). Ratio deficits of excellent and extremely excellent grades were observed in children from BG compared with those from the other three groups (P<0.05, respectively). When urinary fluoride level does not exceed 0.9 mg L⁻¹, children's IQ increases with the increase of urinary fluoride level (P<0.05). For every 0.1 mg L⁻¹ increase in urinary fluoride, children's IQ score increased by 0.12 in multiple adjustment regression analysis.

Conclusions: Prenatal fluoride exposure in drinking water could cause loss of children's IQ, especially in the proportion of children with excellent and extremely excellent IQ grades. Particularly, appropriate concentration of fluoride exposure in childhood may improve intellectual development of children in some degree.

Keywords: Fluoride, Pregnancy, Childhood, Children, Intelligence development
Fluoride Exposure and Behavioral Outcomes in Children at 7-13 Years of Age: A pilot study in China

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Abstract:

Background: Previous studies have revealed that fluoride exposure could have adverse effects on neurodevelopment-related outcomes, manifesting as a lower IQ, however little is known about the effects of fluoride exposure on children's behavioral outcomes. Objective: We aimed to examine the potential relationship between fluoride exposure and children's behavioral outcomes in rural areas in China.

Methods: A total of 325 resident children aged 7 to 13 years, who lived in endemic fluorosis villages in Tongxu County of Henan Province were eligible for the present study. Participants were divided into high fluoride exposed group (HG) and control group (CG) according to the urinary fluoride concentration. Urinary fluoride (UF) levels were measured by the ion selective electrode method. Children's behavioral outcomes were assessed by the Conners’ Parent Rating Scale-Revised (CPRS-48). We evaluated the potential relationship between fluoride exposure and children's behavioral outcomes using multivariate regression models and logistic regression models.

Results: Urinary fluoride in HG children was 2.26±0.96 mg/L, and was 0.81±0.36 mg/L in CG. After adjusting for height, weight, IQ scores, passive smoking history, and mother migrant worker, we found that per 1.0 mg/L increase in UF was corresponded with a 4.01 (95%CI: 2.87, 5.15) higher scores on the psychosomatic problems in multivariate regression models. In logistic regression models, children exposed to fluoride had significantly higher psychosomatic problems subscale scores than control group, and were 5.29 (95%CI: 1.15, 24.27) times more likely to have psychosomatic problems. However, no significant associations were found among other outcomes and fluoride exposure.

Conclusion: In this study, a potential adverse association between higher levels of fluoride exposure and children’s behavioral problems was found, especially the psychosomatic problems measured by CPRS-48 in children aged 7 to 13 years.

Keywords: fluoride, neurotoxicity, behavior, children
Hot spring bath therapy can improve bone metabolism and bone mineral density in sub-healthy people
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Abstract:
Osteoporosis is becoming an urgent health problem that need to solve all over the world, characterized by abnormal bone metabolism caused by an imbalance in bone remodeling, which reduces bone mineral density and increases the incidence of fractures. The side effects of drugs to treat osteoporosis will negatively affect the health of people. This study aimed to investigate the relieving effects of hot spring bath therapy on the bone metabolism and bone mineral density in sub-healthy people. We recruited 87 volunteers in Xifeng, and 60 volunteers completed the project. All the participants underwent hot spring bath therapy for 1 months, at least 40 min per day, five times a week, in Xifeng hot spring which is one of the famous eight hot springs in China. The proposal for this intervention study was reviewed and approved by the Ethics Committee of Guizhou Medical University. Written informed consent was obtained from all participants. All volunteers were required to be sub-healthy residents of the local area (hot spring village), age 35 to 65 years. Exclusion criteria include bone trauma, metabolic bone disease, bone tumors, autoimmune diseases, and food and/or drugs history that can interfere with bone metabolism. In addition, some chronic non-communicable diseases (including hypertension, diabetes, cardiovascular disease, stroke, cerebral insufficiency, chronic obstructive pulmonary disease, bronchial asthma, chronic bronchitis, chronic pneumonia, infectious skin diseases, and so on) that are not suitable for hot spring bath therapy are also the exclusion criteria we consider. After giving informed consent, fasting venous blood were collected, and the serums were separated. Chemiluminescence is used to determine the hormones parathyroid hormone (PTH) and calcitonin (CT), which regulate calcium and phosphorus metabolism, and osteocalcin (OST) and bone alkaline phosphatase (BALP), which reflect bone synthesis. We used ultrasonic bone densitometry to measure bone mineral density (including bone quality index, T value and Z value) before and after intervention of volunteers. Compared with the before intervention, the concentration of PTH, CT and BALP were significantly increased in the after intervention (P all <0.05). No significant difference was seen among the concentration of OST during self-comparison before and after intervention (P>0.05). For bone mineral density, the bone quality index, T value and Z value in the after intervention were slightly higher than in the before intervention, but these changes did not show statistical differences (P all >0.05). Overall, our results suggested that hot spring bath therapy can improve bone metabolism and bone mineral density in sub-healthy people. The study can provide a scientific basis for a further understanding of the intervention effects on bone metabolism and bone mineral density in Xifeng hot spring.

Key words: hot spring; bone metabolism; bone mineral density; sub-healthy.
MiR-191 is involved in renal dysfunction in exposed populations by regulating inflammatory response caused by arsenic

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Abstract:
Chronic exposure to arsenic may result in the manifestation of damage in multiple organs or systems of the body. Arsenic-induced renal dysfunction has been determined, but their pathogenesis have not been fully examined. In this study, we measured the expression levels of miR-191 in plasma, the contents of pro-inflammatory (IL-6, TNF-α) and anti-inflammatory (IL-2, TGF-β) cytokines and renal dysfunction indicators (UREA, CREA, UA and CYSC) in serum from control and arsenic poisoning populations, and analyzed the relationship between the miR-191, cytokines and renal dysfunction indicators. The aim was to study the mechanism of miR-191 in arsenic induced renal dysfunction. The results clearly show that the miR-191, CYSC in the arsenic exposure group were significantly higher than the control group ($P$ all $<$0.05). Compared with the control and suspicious groups, the miR-191, CYSC in the mild, moderate and severe arsenic poisoning groups were significantly increased ($P$ all $<$0.05). No significant differences were seen among the renal dysfunction indicators in the other groups ($P$ all $>$0.05). Further studies have found that the alteration of miR-191 expression were significantly associated with arsenic-induced renal dysfunction ($P$<0.05). Moreover, the content of IL-2 in the arsenic exposure group was decreased compare with control group ($P$<0.05). In contrast, the content of IL-6 and TGF-β in the arsenic exposure group were higher than the control group ($P$ all $<$0.05). Subsequently, compared with the control group, the content of IL-2 in the moderate and severe arsenic poisoning groups were significantly decreased ($P$ all $<$0.05). The content of IL-6 in the severe arsenic poisoning group was higher than the control and suspicious groups ($P$ all $<$0.05). However, there is significant difference among the contents of TGF-β only in the control and severe arsenic poisoning groups ($P$<0.01). No significant differences were seen among the pro-inflammatory and anti-inflammatory cytokines in the other groups ($P$ all $>$0.05). Further studies have found that the inflammatory response (pro-inflammatory and anti-inflammatory imbalance) caused by arsenic exposure is closely related to miR-191-mediated arsenic-induced renal dysfunction ($P$ all $<$0.05). Overall, the association of miR-191, inflammatory response and renal dysfunction, is clearly supported by the current findings. That is, miR-191 is involved in renal dysfunction in exposed populations by regulating inflammatory response caused by coal burning arsenic. The study can provide a scientific basis for a further understanding of the causes of the arsenic-induced renal dysfunction, the improvement of miR-191 biological function and targeted prevention strategies.

\textbf{Key words:} arsenic; miR-191; renal dysfunction; immune inflammation.
Effect of different geological background on metal concentrations in tea leaves in eastern Guizhou, China: distribution and health risk assessment

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Abstract:

Mineralization of strata and geochemical background affect metal concentration in soil and crop and metal accumulation in tea presents health risk to tea consumers. The objectives of this work were to investigate the effect of different geological background on metal concentrations in tea leaves and estimate its health risk. 22 tea leaves and associated soils from four regions (Longtang (LT), Tangshan (TS), Wude (WD), and Pingshan (PS)) which belong to three different geological background areas (the Cambrian Qingxudong and Gaotai Formations, the Silurian Hanjiadian and Shiniulan Formations, and the Permian Wujiaping and Changxing Formations) were collected from eastern Guizhou, China. Total metal concentrations including Al, Cd, Cr, Mn, Pb, and Tl were analyzed using acid digestion method and inductively coupled plasma-mass spectrometry (ICP-MS). Accordingly, 41% and 14% of the soil samples had higher Cd and Pb concentrations than their screening values for agricultural soils in China (pH<5.5). The high concentrations of Pb (72.9 mg/kg) and Tl (0.669 mg/kg) in soil from PS may be influenced by the mineralization of the strata which is the Cambrian Qinxudong and Gaotai Formations. The high concentration of Cd (0.598 mg/kg) in soil from LT planting area may be related to the high geochemical background of Cd in the regional strata (the Permian Wujiaping and Changxing Formations). Soil mineralization and background metals affected soil metal concentrations. The soil pH was negatively correlated with Mn and Tl concentrations in tea leaves. Therefore, controlling the soil pH in tea plantations and preventing soil acidification are necessary. Compared with the China and World Health Organization (WHO) limits, the concentrations of Pb, Cd, and Cr in tea leaves were lower. Besides, Mn accumulation ability of tea leaves was the strongest (average BCF=6.1). Exposure to Al, Cd, Cr, Mn, Pb, and Tl via tea infusion intakes did not
cause a health concern. Taking the negative impacts of Mn, Al, and Tl on human health for heavy drinkers and the higher rates of their target hazard quotients (THQs) to hazard index (HI) into consideration, establishing the regulation of Mn, Al, and Tl concentrations in tea products is imperative. Furthermore, the HI values showed that Longtan (LT) and Pingshan (PS) were higher than Tangshan (TS) and Wude (WD), indicating that Silurian sand and mudstone distribution area in TS and WD is more suitable than the Cambrian and Permian carbonate distribution area in PS and LT for planting tea trees in view of heavy metals.

**Key words:** Heavy metals, *Camellia sinensis*, Surface soils, Bioconcentration factor, Health risk assessment
Importance and Urgency of Safe Disposal of Rare Earth Mine Associated Radioactive Waste

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Abstract:

Rare earth is an extremely important strategic mineral resource. China is the largest producer and exporter of rare earth in the world. However, the development and utilization of rare earth is a "double-edged sword". While benefiting mankind, the accompanying problems of resources and environment are constantly highlighted. Inner Mongolia is the largest light rare earth production base in China, while the seven southern provinces are mainly heavy ion rare earth. Because of the advantages of easy mining and extraction of heavy ion rare earth ores, it has become the most important heavy rare earth production base in China. Ionic rare earth elements in Guangdong are mainly distributed in eastern Guangdong (accounting for 63% of total rare earth elements in Guangdong Province, Dongjiang River Basin) and Northern Guangdong (25% in Beijiang River Basin). The mining and extraction of rare earth in the upper reaches of the Dongjiang River and Beijiang River have caused serious pollution of water and soil, which has seriously threatened the environmental safety and human health of the Guangdong-Hong Kong-Macao Greater Bay Area.

Because uranium (U4+), thorium (Th4+) and rare earth (REE3+) have similar ionic radius and chemical properties, U and Th are usually associated in ionic rare earth ores by isomorphic substitution. A large number of radioactive waste residues containing U, Th and Ra are produced in the process of rare earth mining and extraction. Among them, 232Th and 226Ra are mainly concentrated in acid-soluble slag in the form of ThO2, Th3(PO4)4 and RaSO4, while 238U is concentrated in the form of heavy uranate and U(OH)4. Th(IV) is the stable state of thorium. Th(OH)4 exists in colloidal form in natural environment. The complexes with SO42- and PO43- are extremely stable. Uranium often exists in the form of U(IV) and U(VI). U(VI) is the most stable valence state in nature. It is prone to hydrolysis reaction to produce uranyl ion (UO22+). It has large ionic potential and electronegativity, and is a strong complex formation with high polarity and low polarization. UO22+ not only
has radioactivity, but also has high biological toxicity and chemical migration. At the same time, U decay will produce alpha, beta, gamma rays and radon gas, resulting in radioactive pollution in the workplace and the surrounding environment. Therefore, uranium is an important object of concern for the safe disposal of radioactive waste.

Since the 1960s, Guangdong rare earth smelters have spread all over the province. Each smelter can only build a reservoir for temporary storage of radioactive waste, but there are also many problems of simple stacking of rare earth tailings and waste residues, which are facing greater security risks and environmental risks. With the social development and urban expansion, some enterprises (such as rare earth smelters in Guangzhou, Yangjiang and Dianbai) are facing retirement or relocation, and a large number of associated radioactive wastes are in urgent need of safe treatment and disposal. A large number of investigations and studies on the types and activities of radionuclides in rare earth associated radioactive waste have been carried out in China. The types and activities of radionuclides in the extraction and application of rare earth ores in different regions and different types are also different. The problem of radioactive contamination associated with rare earth ores is particularly prominent in China, but the research on the types of nuclides, the intensity of radioactivity and the migration law of radioactive substances in the production process of ion-adsorbed rare earth is not comprehensive. Scientific research on safe disposal of rare earth associated radioactive waste is urgently needed.

**Key words:** Radioactive pollution; Rare earth mine waste; Safe disposal; Guangdong
Correlation between hot spring bathing and sleep disorders among residents aged 30-65 years living and working in typical hot spring areas of Guizhou Province

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Abstract:
Objectives Guizhou is a province rich in geothermal water resources, but there is little information of the health impact of its geothermal water. Sleep disorder is a common health problem among adults. Therefore, we aimed to evaluate the association of hot spring bath with sleep disorders in Guizhou province. Methods A cross-sectional survey employing a self-designed questionnaire was conducted on the health status, hot spring bath and other health behaviors of adults aged 30-65 living and working in the surrounding areas of five hot springs in Guizhou Province, including Xifeng (Xifeng County, Guiyang), Guiyu (Wudang District, Guiyang), Fodingshan (Shiqian County, Tongren), Jianhe (Jianhe County, Qiandongnan) and Shuijing (Suiyang County, Zunyi). The sleep status during the past month was evaluated via Pittsburgh Sleep Quality Index (PSQI). The frequency of bathing in hot springs was divided into four categories: non-bathers (never bathing in hot springs), past bathers (not bathing in the past year), occasional bathers (occasionally bathing in hot springs, but less than once per month), and regular bathers (frequently bathing in hot springs, >1/month in the past year). Results The prevalence of sleep disorders was 29.4% among the whole survey population. Significant difference (χ²=66.874, P<0.001) was detected in the prevalence of sleep disorders among non-bathers (37.4%), past bathers (31.4%), occasional bathers (23.8%), regular bathers (21.7%), respectively. Logistic regression analysis showed that, after excluding the confounding effects of investigation sites, age, sex, marriage status, smoking, alcohol
drinking, recreational mobile phone time, regular eating, history of chronic diseases, mental (depression) and physical unfitness in the past two weeks, compared than non-bathers, the proportion of sleep disorders was lower among past bathers (OR=0.758, 95%CI=0.622-0.923), occasional bathers (OR=0.648, 95%CI=0.528-0.795) and frequent bathers (OR=0.554, 95%CI=0.427-0.719). Subgroup analysis with Binary Logistic regression model showed that a significant lower proportion of sleep disorders was found in regular bathers compared with non-bathers among both genders (OR=0.526 and 0.619 for male and female, respectively), while female occasional bathers (OR=0.600) reported less sleep disorders than non-bathers.

Conclusions The frequency of hot spring bathing may be negatively correlated with sleep disorders. Sleep disorders is relatively less among hot spring bathers, especially those frequent bathers.

Key words: Hot Spring Bathing; Sleep Disorders; Guizhou.
Association between quality of life and frequency of using hot spring among residents aged 30-65 years living in typical hot spring areas of Guizhou Province

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Abstract:
Objectives Residents living in typical hot spring areas of Guizhou have a long history and habit of using hot spring, but it was unclear whether using hot spring could improve their quality of life (QOL). The aim of our study was to explore the association between frequency of using hot spring and the quality of life. Methods A cross-sectional survey was designed to conduct by investigating participants’ QOL, frequency of using hot spring and other health information, who aged 30-65 living in the surrounding areas of typical hot springs, included Xifeng (Xifeng County, Guiyang), Guiyu (Wudang District, Guiyang), Fodingshan (Shiqian County, Tongren), Jianhe (Jianhe County, Qiandongnan), Shuijing (Suiyang County, Zunyi) hot spring in Guizhou. The quality of life was assessed via WHOQOL-BREF. The frequency of using hot springs was divided into four grades: never spring bathers, past spring bathers, occasional spring bathers, and regular spring bathers. Results A total of 3708 residents were investigated, and the score of QOL was increasing with frequency grades of using hot spring bath, which was significantly different (P all <0.05), included physiological (14.69±2.30, 14.95±2.24, 15.58±1.91, 15.74±2.03, P for trend<0.05), psychological (13.49±1.67, 13.71±1.75, 14.21±1.74, 13.31±1.92, P for trend<0.05), social relative (14.98±1.96, 15.08±1.93, 15.26±1.81, 15.29±1.89, P for trend<0.05) and environment domain (12.15±1.63, 12.45±1.79, 12.99±1.733, 13.05±1.84, P for trend<0.05). Multiple linear regression analysis of QOL shown that partial regression coefficients of the frequency of using hot spring were 0.183, 0.162, 0.091 and 0.195 (P all <0.05) for physiological, psychological, social relative and environment domain, respectively. Conclusions The frequency of using hot spring was positively associated QOL, which suggest using hot spring more could improve QOL.

Key words: Hot Spring; Quality of Life (QOL); Association; Guizhou
The Influence of Hot Spring Bath on Quality of Life of Patients with Chronic Disease in Hot Spring Area of Guizhou Province

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Abstract:

Objective: To analyze the influence of hot spring bath on quality of life of patients with chronic disease in hot spring area of Guizhou, and to provide a reference for the health promotion of chronic disease patients. Methods: The self-compiled questionnaire and World Health Organization Quality of Life Scale (WHOQL-BREF) were used to investigate the 30-65 year-old population in five typical of hot springs in Guizhou Province, including Xifeng (Xifeng County, Guiyang), Guiyu (Wudang District, Guiyang), Fodingshan (Shiqian County, Tongren), Jianhe (Jianhe County, Qiandongnan) and Shuijing (Suiyang County, Zunyi). Two independent samples t-test and multiple linear regression was used to analyze the relation between hot spring and quality of life. Results: A total of 3708 residents in hot spring area were investigated, of whom 1941 had chronic diseases. Among patients with chronic disease, there were 590 has habits of hot spring bath, 1351 has not bathing. Univariate analysis shown that patients who had habit of spring bath have higher score of quality of life than patients without habit in the physiological domain of quality of life (14.64±2.25 Vs. 13.91±2.37; t = 6.266, P < 0.001), psychological domain (13.73±1.78 Vs. 13.20±1.64; t = 6.189, P < 0.001), and environment domain (12.60±1.74 Vs. 11.89±1.56; t=8.910, P < 0.001). The results of multivariate analysis shown that after controlling the possible confounding factors (sex, age, marriage smoking, drinking, diet, exercise), the chronic patients with hot spring bath were higher in the domain of physiology and environment than those without hot spring bath. Conclusion: Hot spring bath could promote the quality of life of patients with chronic disease in the physiological and environmental domains. Patients with chronic disease may be benefit from taking hot spring bath.

Key words: Chronic Disease, Hot Spring Bath, Quality of Life
Using Data Analytics to Improve Disease Management for Geological Contamination Disease in Southwest China

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Abstract:

With the advent of Health Information Technology and fast adoption of Electronic Medical Records (EMR) software, much of healthcare data, from individual to population, is stored and immediately accessible for further use to improve health outcomes with lower costs and better care. The continuous growth of health data becomes “Big Data” that holds values remained to be leveraged for the enhancement of disease management. Indeed, the arrival of huge health data does offer emerging opportunities that may be fulfilled until necessary classification and purification processes are conducted on a variety of data sources including structured, unstructured, numeric, and non-numeric. This process, in fact, is not easy for dealing with disease data since it includes not only traditional disease records, but also related data about environments and social economics (e.g., climates, living conditions, incomes, etc.). In this presentation, we will highlight the process of how “Big Data” can be used to support data analytics to predict the potential incidences of Geological contamination diseases that have occurred in Asia, including China and U.S. A framework is proposed to show the process of how “Big Data” are cleansed for health analytics by using popular tools such as R and Python, by which some analytical methods are used to produce Geological contamination diseases prediction in support of disease prevention and thus disease management. In addition, an example is given to illustrate the prediction of rate by using a predictive model for people in Southwest China for the coming years. Through data analytics and predictive modeling, the public health administration of Southwest China will be able to improve disease management with better prediction for disease prevention. The goal of this presentation is to seek public awareness of how Big Data could be used to improve people health and healthcare outcomes in order to assure the well-being of each individual and the wellness of the community, by and large.

Key words: Big data, Data analytical, Geological Contamination Disease
Tracking iron mineralogical changes during in situ experiments in a high arsenic reducing aquifer in Yinchuan Plain

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Abstract:
Groundwater arsenic contamination is a major public health concern. Cost-effective and long-lasting methods for groundwater arsenic (As) in situ treatment has long been sought for, with one of the challenges being dissolution and/or transformation of unstable iron (Fe) oxide minerals in reducing aquifers. Recent laboratory experiments have opened the possibility for the in situ formation of more stable minerals including magnetite, a mixed Fe(II)-Fe(III) oxide, to immobilize dissolved As. Here we present new Fe mineralogical data obtained using wet-chemical and spectroscopic methods during two push-pull experiments conducted in Yinchuan Plain that was aimed at forming magnetite in situ for groundwater As remediation. The mineralogy of sediment cores collected prior to, and following injection of local groundwater amended with Fe(II) and nitrate were compared to directly probe changes in mineralogy, and link those changes to groundwater As removal. Paired sediment samples were collected in adjacent (within 1 m) sediment cores from depth intervals where Fe(II) and nitrate were amended into groundwater and re-injected during the push phase. Care was taken to prevent sediment samples from exposure to oxygen prior to analysis. Approximately 0.5 g of each sample was put into a 2-mL vial and coated in glycerol immediately after collection and stored at −20°C for extended X-ray absorption fine structure (EXAFS) analysis. Core sections were also collected in plastic core liners, capped, sealed with parafilm and stored in nitrogen-flushed Mylar bag in the field. Hot HCl extraction for Fe(II) and Fe(total) and slurry test for conductivity were conducted at night after drilling of that day. Samples were freeze dried after shipping to laboratory for a series of mineralogical measurements including magnetic susceptibility (MS), scanning electron microscope (SEM) and X-ray fluorescence (XRF) analyses. Yinchuan sediments had 0.9 – 1.7 g/kg of total Fe abundance, and mainly contained non-reactive Fe-containing silicates, with lesser quantities of Fe(III) oxides and Fe(II) carbonates and sulfides based on EXAFS. Preliminary results of other mineralogical properties all consistently suggested that amount of magnetic minerals increased after experiment, although this increase was heterogenous within the injection depth. This new-formed magnetite appears to be mostly in >100nm diameter nanoparticles based on its magnetic properties. In all, the different analytical methods are highly complementary which provides a parameterized interpretation of Fe mineralogical changes during the in situ experiments.

Key words: in situ arsenic remediation; iron mineralogy; magnetite; magnetic susceptibility; EXAFS.
Effects of MAPK inhibitors on phosphorylation of Smad2/3 in LX-2 cells
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Abstract:

Objective: To investigate the effects of Three mitogen-activated protein kinase (MAPK) inhibitors on the phosphorylated proteins Smad2 and Smad3 in human liver stellate cells (LX-2) activated by sodium arsenite. Methods: LX-2 cells were pre-treated with 10.0 µmol/L ERK, JNK, p38 kinase inhibitors (PD98059, SP600125, SB203580) for 30 min in the 3 inhibition groups, and then 20.0 µmol/L sodium arsenite for 24h. The protein expression levels of pSmad2 and pSmad3 were detected by Western blot. Results: Western blot results showed that the expression of p-Smad2 and p-smad3 in normal group was lower than that in model group. Sodium arsenite exposure significantly increased the expression of p-Smad2 and p-smad3 proteins. The expression of PSmad2 and P Smad3 decreased after the intervention of ERK inhibitor (10µmol/L), JNK inhibitor (10µmol/L) and p38 inhibitor (10µmol/L). Conclusion: Arsenic can promote the high expression of Smad2/3 phosphorylated protein in LX-2 cells by activating ERK, JNK and p38 pathways.

Keywords: LX-2 cells; mitogen-activated protein kinase inhibitors; Smad2; Smad3

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Effects of sodium arsenite on lipid metabolism in L-02

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Abstract:

Long-term exposure to arsenic can cause liver damage, and the liver is a multifunctional organ that plays an important role in lipid metabolism. Sterol regulatory element binding proteins (SREBPs) are important proteins that regulate the synthesis of fatty acids and cholesterol, which are primarily expressed in the liver. PPARα is widely distributed in the liver and can affect the process of lipid metabolism in the body by participating in the oxidation of fatty acids. In this study, sodium arsenite was exposed to L-02 cells to investigate the effects of arsenic on liver lipid metabolism. L-02 cells were exposed to different concentrations (0, 8, 16, 32 mmol / L) of sodium arsenite. The expression levels of SREBP and PPARα protein were detected by Western blot, and L-02 cells were detected by GPO-PAP method. The results showed that the expression of SREBP was increased in the normal group compared with the model group, and the expression of SREBP was decreased with the increase of arsenic concentration. The content of TG in L-02 cells was consistent with the expression of SREBP. Statistical significance (p<0.05) The expression of PPARα in the model group was lower than that in the normal group. The measurement of 16,32 was statistically significant compared with the normal group (p<0.05). Conclusion: Sodium arsenite can cause hepatic steatosis in certain doses in vivo. Arsenic inhibits the synthesis of TG in hepatocytes by inhibiting the expression of SREBP protein. Arsenic inhibits the oxidation of fatty acids by inhibiting the expression of proteins, which may be the reason why arsenic causes fatty liver in the body.

Key words: lipid metabolism; sodium arsenite; liver; L-02
Correlation between hot spring bath and Osteoporosis risk among residents aged 30-65 years living in typical hot spring areas of Guizhou Province

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Abstract:

Objective: To investigate the current risk of Osteoporosis among residents aged 30-65 years living in typical hot spring areas of Guizhou Province, and to explore the correlation between hot spring bath and Osteoporosis risk.

Methods: A cross-sectional survey was conducted with a self-designed hot spring area residents' health questionnaire among residents of 30-65 years old living in the typical five hot spring areas of Guizhou Province, including Xifeng (Xifeng County, Guiyang), Guiyu (Wudang District, Guiyang), Fodingshan (Shiqian County, Tongren), Jianhe (Jianhe County, Qiandongnan) and Shuijing (Suiyang County, Zunyi), and the risk of Osteoporosis was evaluated via the “one-minute test of osteoporosis risk” provided by the International Osteoporosis Foundation (IOF).

Results: The positive rate of Osteoporosis risk screening in 3708 subjects was 65.5%, and the difference was statistically significant between male (87.6%) and female (47.9%), $\chi^2 = 640.708$, $P <0.0001$. Among all participants, 44.6% of the respondents (45.6% male and 43.8% female) had a history of hot spring bath, and univariate analysis showed that those who never took a hot spring bath had a higher risk of Osteoporosis than those with a history of hot spring bathing among both male and female participants. We employed a Logistic regression model to control confounding factors (such as age, education, BMI, smoking, drinking, nighttime sleep duration, and nap duration), and the risk of Osteoporosis in hot spring bathers is lower than that of those who have never taken hot spring bath among males ($OR=0.536, 95\% CI = 0.315~0.913$), but not among females ($OR = 1.079, 95\% CI = 0.805~1.445$).

Conclusion: There was a negative correlation between hot spring bath and Osteoporosis risk among male residents in typical hot spring areas in Guizhou Province, but not in females. Hot spring bath may be a protective factor for osteoporosis risk among males. Keyword: Osteoporosis risk; hot spring bath; correlation
PINK1/Parkin-mediated mitophagy was activated by Sodium arsenite in human hepatic L-02 cells
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Abstract:
Object: Arsenic, a toxic chemical element, widely exists in natural environment, whose compounds can cause damage to multiple organs and systems in the human body. The liver is one of the main target organs of arsenic. Previous studies have demonstrated that mitochondrial dysfunction play a key role in arsenic-induced liver injury. Damaged mitochondria are degraded through a specialized autophagy pathway, called mitophagy, which is driven by PINK1/Parkin signaling. And the mitophagy is a fundamental process critical for mitochondrial quality control. In this study, we aimed to investigated whether PINK1/Parkin-mediated mitophagy is activated in arsenic-treated L-02 cells.

Methods: L-02 cells were cultured to logarithmic growth phase, L-02 cells were treated with different concentrations (0, 5, 10 or 20 μM) of sodium arsenite for 24 h, and L-02 cells were treated with 5 μM sodium arsenite, respectively. A dose-response and aging relationship was obtained at 12, 24, 36 or 48 hours to establish a model of arsenic-induced liver injury. The activity of L-02 cells was measured by CCK-8 assay. Western Blotting was used to detect the expression of autophagy-related proteins PINK1, Parkin, LC3 and p62.

Results: ① Except for 12 h exposure, cell viability decreased significantly in a dose- and time-dependent manner. When the concentration of sodium arsenite was less than 2 μM, the cell viability increased slightly at 12 h. ② Western blotting results showed that the expression levels of mitochondria-associated proteins LC3II, p62 and PINK1 were significantly increased in a dependent manner when cells were exposed to 0, 5, 10, 20 μM sodium arsenite for 24 hours. After exposure to 5 μM sodium arsenite for 0, 12, 24, 36 and 48 hours, the expression levels of LC3 II, p62 and PINK1 proteins gradually increased with time and peaked at 12-24 hours.

Conclusion: This study demonstrates that sodium arsenite activates PINK1 / Parkin-mediated mitochondrial autophagy.

Key words: sodium arsenite, PINK1/Parkin, mitophagy, L-02

Acknowledgements: This work was supported by the Natural Science Foundations of China (81860560) and Postgraduate Innovation Research Project of First-class Discipline Construction of Public Health and Preventive Medicine in Guizhou Province.
Effects of arsenic-induced oxidative stress on Nrf2 pathway and related proteins in L-02 cells

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Abstract:

Inorganic arsenic is a poison and carcinogen widely found in nature. Oxidative stress is considered to be a key mechanism of arsenic toxicity. Nrf2 (NF-E2 related factor 2) is a key factor in cellular oxidative stress. Nrf2 is controlled by Keap1 and interacts closely with ARE to control antioxidant proteins and type II detoxification enzymes. Keap1 and Nrf2 dissociate under oxidative stress, while Nrf2 enters the nucleus and binds to ARE. OBJECTIVE: This study was to investigate the effects of arsenic on the Nrf2 pathway and related proteins induced by oxidative stress in L-02 cells. METHODS: L-02 cells were treated with different concentrations of NaAsO\textsubscript{2} (0, 7.5, 15, 30 μmol/l). The key proteins in the Nrf2 pathway, including Nrf2, NQO1 and SOD1, were detected by Western blotting. The results showed that the expression of Nrf2 and NQO1 in the experimental group was significantly higher than that in the control group at 0, 7.5, 15 and 30 μmol/L. The expression of SOD1 was increased at 0, 7.5 and 15 μmol/L, but decreased at 30 μmol/L. The difference was statistically significant (p < 0.05). In conclusion, arsenic can affect the expression of Nrf2 pathway and NQO1 and SOD1, and the increase of Nrf2 may affect the expression of SOD1 and NQO1.

Key words: oxidative stress, Nrf2, arsenic

Acknowledgements: This work was supported by the Natural Science Foundations of China (81860560) and Postgraduate Innovation Research Project of First-class Discipline Construction of Public Health and Preventive Medicine in Guizhou Province.
Evaluation the physical therapy efficacy of Xifeng and Suiyang Hot Springs on Relieving Joint Pain with Non-osteoarthritis

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Abstract:

Objective: To evaluate the alleviating effect of hot spring physiotherapy on joint pain by comparing the scores of joint pain questionnaires of non-osteoarthritis patients before and after hot spring physiotherapy.

Methods: Taking Xifeng and Suiyang hot spring areas as investigation points, on the basis of epidemiological investigation, through undergoing the healthy, selected 39 cases and 31 cases with joint pain patients (neck shoulder, low back and upper and lower limbs joints) with non-osteoarthritis as the research object from Xifeng and Suiyang hot springs. The participants were given 40 minutes each time, once a day, 5-7 days a week for four weeks of hot spring physiotherapy (hot spring bath). The questionnaire survey was conducted to collect the pain scores of the respondents before and after hot spring physiotherapy, to evaluate the relieving effect of hot spring physiotherapy on joint pain by Student's t test and Mann-Whitney Test.

Results: The total effective rate of Xifeng and Suiyang hot spring physiotherapy for joint pain relief was 98.57%, 44 cases were cured and 25 cases were relieved. The effective rate of Xifeng hot Spring physiotherapy in relieving joint pain was 97.44%, 28 cases were cured and 10 cases were relieved; The effective rate of Suiyang hot spring physiotherapy in relieving joint pain was 100%, 16 cases were cured and 15 cases were relieved. There was no significant difference in remission effect between the two regions according to sex and age.

Conclusion: Xifeng and Suiyang hot spring physiotherapy can effectively alleviate the symptoms of joint pain in patients with non-osteoarthritis, and can be widely used in clinical adjuvant treatment of joint pain.

Key words: Hot spring; Physical therapy; Joint pain
TLR4/MyD88/NF-κB signaling pathway may be involved in arsenic-induced liver injury in rats

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Abstract:
Arsenic exposure causes various hazardous effects in humans and interferes with the functions of several organs, especially the liver and kidneys. However, the detailed mechanisms underlying arsenic toxicity leading to liver injury are not yet thoroughly understood. The main aim of this study was to investigate the role of the TLR4/MyD88/NF-κB signaling pathway in arsenic-induced liver injury in rats. Thirty-two healthy and clean-grade weaned Wistar rats, half of which were male and half of which were female, were divided randomly into four groups (8 animals in each group) according to the body mass of rats after acclimatization under laboratory conditions for 1 week prior to the experiment. The groups included control group (received only deionized water) and low-, middle-, high-arsenic groups, which received arsenic at a dose of 2.5, 5.0, or 10.0 mg/kg via gavage 6 days per week, respectively. The experiment lasted for 4 months. Quantitative real-time PCR and western blotting were used to detect relative mRNA and protein expression of TLR4, MyD88, and NF-κB in liver tissues from rats. Enzyme-linked immunosorbent assays (ELISAs) were applied to detect the level of interleukin-6 (IL-6) in liver tissues from rats. The relative mRNA and protein expression of TLR4, MyD88, NF-κB p65 and NF-κB p50 in liver tissues from rats in the high-arsenic group were higher than those in livers from control group rats. IL-6 expression in liver tissues from rats in the high-arsenic group was increased compared with that in the control group and low-arsenic group. The relative TLR4, MyD88, and NF-κB mRNA and protein expression levels and the IL-6 expression level in liver tissues from rats were positively correlated with total arsenic in the liver. Our results suggest that arsenic-induced hepatotoxicity in rats may be associated with the TLR4/MyD88/ NF-κB signaling pathway.

Key words: Arsenic; Rat; TLR4; MyD88; NF-κB

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Role of H3K18ac-regulated nucleotide excision repair-related genes in DNA damage and repair of HaCaT cells induced by arsenic and TSA intervention

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Abstract:
Objective: To explore the regulatory effect of H3K18ac on NER related genes in the repair of arsenic-induced DNA damage, deepen the molecular toxic mechanism of arsenic from the perspective of epigenetics, and provide new ideas and scientific basis for targeted prevention and targeted treatment of endemic arsenism. Methods: HaCaT cells were cultured routinely. (1) Establishment of DNA damage cell model of arsenic poisoning: HaCaT cells were treated with 0, 2.5, 5, 10 μmol/L NaAsO2 for 24h. (2) Deacetylase inhibitor trichostatin A (TSA) intervention study: divided into blank control group (0 μmol/L), 10 μmol/L NaAsO2 poisoning group, solvent control group (DMSO), 250 nmol/L TSA intervention group, 10 μmol/L NaAsO2 combined with 250 nmol/L TSA treatment group. SCGE method was used to detect DNA damage in each group. RT-qPCR method was used to detect transcription levels of NER related genes (XPA, XPD and XPF). Western-blot method was used to detect the expression levels of H3K18ac and NER related proteins, the enrichment of histone H3K18ac in NER gene promoter region was detected by ChIP-qPCR.

Results: (1) DNA damage cell model of arsenic poisoning: compared with the control group, with the increase of arsenic concentration, the mRNA transcription level and protein expression level of XPA, XPD and XPF genes decreased, the expression level of histone H3K18ac was downregulated, the acetylation enrichment level of H3K18 in the promoter region of NER related genes decreased, and the DNA damage was aggravated, the difference was statistically significant. (2) TSA intervention study: after TSA intervention, compared with the 10 μmol/L NaAsO2 exposure group, the enrichment level of NER related genes XPA, XPD and XPF promoter region H3K18ac in the 10 μmol/L NaAsO2 combined with 250 nmol/L TSA treatment group increased, the transcription level and protein expression level of NER related genes XPA, XPD and XPF increased, and DNA damage decreased, with statistically significant differences. Conclusion: NaAsO2 may inhibit the H3K18ac modification level of HaCaT cells, reduce the mRNA transcription and protein expression of NER related genes, and aggravate the degree of DNA damage. TSA may increase the H3K18ac modification level of cells, promote the up-regulation of mRNA transcription and protein expression of NER related genes, and reduce the degree of DNA damage caused by arsenic.

Keywords: arsenic, DNA damage, NER, H3K18ac, TSA

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Polymorphisms and promoter methylation of hOGG1 increase susceptibility to arsenicosis in population exposed to arsenic from coal-buring

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Abstract:
Arsenicosis caused by burning high arsenic-containing coal is an endemic uniquely in China. Dysfunction of human 8-oxoguanine DNA glycosylase (hOGG1) was considered to be the critical mechanism of arsenicosis. Aberrant methylation and Ser326Cys polymorphism of hOGG1 was confirmed to be significantly associated with the hOGG1 dysfunction in tumors and chemical carcinogenic. To identify the effect of hOGG1 methylation, Ser326Cys polymorphism and their interactions on the risk of arsenicosis, 142 arsenic-exposed subjects were recruited from Jiaole village of Xinren county, Guizhou province, China where the residents were exposed to arsenic from indoor coal burning. Out of 142 exposed subjects, 91 were diagnosed with arsenicosis served as the arsenicosis group, other 31 subjects exhibited no signs of arseniasis were as the control group. The results showed that arsenicosis group exhibited higher prevalence of hOGG1 methylation and variant genotypes (Ser/Cys & Cys/Cys) compared with the control group (methylation: 30.8% vs 3.9%, variant genotypes: 29.7% vs 7.8%). The methylated hOGG1 and variant genotypes (Ser/Cys & Cys/Cys) was associated with significantly higher prevalence of arsenicosis (methylation: OR=10.889, variant genotypes: OR=4.957). Moreover, the results revealed that variant genotype (Ser/Cys & Cys/Cys) might increase the susceptibility to hOGG1 methylation (OR=31.472). Notably, the interaction of variant genotypes (Ser/Cys & Cys/Cys) and methylated hOGG1 was associated with the increased risk of arsenicosis (OR=16.947). Taken together, The interaction of variant genotypes (Ser/Cys & Cys/Cys) and methylated hOGG1 might be a critical pathway driving the arsenicosis, which provide an novel insights into arsenicosis mechanisms underlying genetic-epigenetic interaction.

Key words: arsenic, arsenicosis, hOGG1 methylation, hOGG1 Ser326Cys polymorphis

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investigation of current status of lung function damage in patients with coal-burning type arsenism

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Abstract:

Objective: Lung function indicators can reflect early lung injury, and they have great significance in evaluating the grade of lung injury and labor capacity of the population. Our aim is to investigate the lung function in patients with Coal-burning type arsenism in Guizhou Province by detecting and analyzing the lung function of the respondents.

Methods: The diagnostic standard accorded with Endemic Arsenic poisoning Diagnostic Criteria (WS/T 211-2015), 56 were classified as mild arsenic poisoning group, 81 were classified as moderate arsenic poisoning group and 79 were classified as severe arsenic poisoning Group. 79 healthy people with similar living habits and non-flammable high-arsenic coal history, no occupational pneumoconiosis, no inheritance and family history of cancer were selected, who passed the physical examination were selected as the control group. The measured indicators included forced vital capacity (FVC), forced expiratory volume in the first second (FEV1) was detected by S-980A pulmonary function tester. 92% of the FEV1/FVC lower than the predicted value was used as a sensitive index to reflect obstructive ventilation dysfunction. SPSS 22.0 was used for statistical analysis, including variance analysis, chi-square test and so on.

Result: There was no significant difference in age and sex between these groups. The abnormal rate of pulmonary function in the mild, moderate and severe group was 30.4%, 43.2% and 45.6%, respectively, which were higher than 7.6% in the control group ($P<0.05$). The rates of obstructive pulmonary dysfunction in mild, moderate, and severe groups were 26.8%, 30.9%, 30.9%, and 31.6%, respectively. The rates of restrictive and mixed pulmonary dysfunction in mild, moderate, and severe groups were 3.6%, 12.3% and 14% were higher than the control group, and the difference was statistically significant ($P<0.05$). Multiple comparison among groups, the levels of FVC、FEV1、FVC%、FEV1/ FVC 、MEF75% 、MEF50% 、MEF25% in mild, moderate and severe arsenism groups were all lower than those in the mild group ($P<0.05$). The comparison between the arsenic poisoning groups showed that the FEV1/FVC and MEF75% in the severe poisoning group were lower than that in mild group, the difference was statistically significant ($P<0.05$).

Conclusion: Both large and small air channels in patients with Coal-burning type arsenism were damaged, the injury were mainly obstructive lung function impairment, and the decline of lung function was associated with arsenic exposure.

Key Words: Arsenic poisoning; Lung function ; Obstructive pulmonary dysfunction; Restrictive pulmonary dysfunction; Coal

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Ginkgo biloba extract attenuates arsenicosis-induced disruption of the Th17/Treg cell balance in peripheral blood mononuclear cells of population

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Abstract:

Endemic arsenicosis is a public health problem that affects thousands of people worldwide. However, the biological mechanism involved is not well characterized, and there is no specific treatment. Exposure to arsenic may be associated with immune-related problems. In the present work, we performed an investigation to determine whether the Th17/Treg balance was abnormal in peripheral blood mononuclear cells (PBMCs) of patients with arsenicosis caused by burning coal. Furthermore, we investigated the effect of Ginkgo biloba extract (GBE) on the Th17/Treg imbalance in patients with arsenicosis. In this trial, 81 arsenicosis patients and 37 controls were enrolled. The numbers of Th17 and Treg cells, as well as related transcription factors and serum cytokines, were determined at the beginning and end of the study. Patients with arsenicosis exhibited higher levels of Th17 cells, Th17-related cytokines (IL-17 and IL-6), and the transcription factor RORγt. There were lower levels of Treg cells, a Treg-related cytokine (IL-10), and the transcription factor Foxp3 as compared with controls. There was a positive correlation between the levels of Th17 cells and IL-17 and the levels of arsenic in hair. Arsenicosis patients were randomly assigned to a GBE treatment group or a placebo group. After 3 months of follow-up, 74 patients completed the study (39 cases in the GBE group and 35 in the placebo group). Administration of GBE to patients upregulated the numbers of Treg cells and the level of IL-10 and downregulated the numbers of Th17 cells and the levels of cytokines associated with Th17 cells. The mRNA levels of Foxp3 and RORγt were increased and decreased, respectively. These results indicated that an imbalance of the ratio of Th17/Treg cells is involved in the pathogenesis of arsenicosis and that GBE can be effective in the treatment of arsenicosis through its influence on the Th17/Treg balance.

Key words: Endemic arsenism; coal; Ginkgo biloba extract; T helper 17 cells; Regulatory T cells This work was supported by the National Natural Science Foundation of China (81430077).
Effect of Xifeng Hot Spring on AKA, CCP and APF in People with Symptoms and Signs Related to Osteoarticular Disease

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Abstract:

Objective: To compare the detection of Anti-keratin antibody (AKA), Cyclic citrullinic peptide antibody (CCP) and Antinuclear perinuclear factor (APF) in the people with symptoms and signs related to osteoarthritis before and after the intervention of Xifeng hot spring, this paper provides a scientific theoretical basis for the clinical efficacy of Xifeng hot spring physiotherapy, and provides data support for the effective development of physiotherapy hot spring resources in Guizhou Province.

Methods: On the basis of epidemiological investigation in Xifeng hot spring area, 39 patients with clinical symptoms and signs of osteoarthritis but not rheumatoid arthritis were selected as the research objects. The subjects were treated with physiotherapy (bath intervention) in Xifeng hot spring, 5-7 days a week, once a day, 40-50 minutes each time for four weeks. Two milliliter fasting blood samples were collected before and after hot spring physiotherapy. The contents of AKA, CCP and APF were measured by enzyme linked immunosorbent assay (ELISA) after serum separation. The changes of three indexes before and after physiotherapy were analyzed by paired t test.

Results: After Xifeng hot spring physiotherapy, the contents of AKA, CCP and APF in serum of the subjects were all decreased, and the difference was statistically significant. In order to exclude the influence of age and sex on the results of the analysis, we found that the levels of AKA, CCP and APF in serum of different sex and age groups were also significantly decreased, and the difference was statistically significant. Conclution: Xifeng hot spring physiotherapy can significantly reduce the levels of AKA, CCP and APF in serum of people with clinical symptoms and signs related to osteoarticular disease. The results of this study suggest that Xifeng hot spring has a certain clinical effect on patients with corresponding clinical symptoms and signs of osteoarthritis, and can be widely used in clinical adjuvant treatment of rheumatoid arthritis.

Key words: Hot Spring, AKA, CCP, APF, Osteoarticular disease
Arsenic metabolism rate change in a person after 12 years and urinary arsenic peaks at first morning

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Abstract:
We carried out a dietary experiment on a volunteer during 14 days to evaluate arsenic metabolism rate changes over time and trend via measuring arsenic (As) speciation in every urine the volunteer excreted and comparing our result with the volunteer’s similar test result which was conducted 12 years ago. The quantity of drinking water, food and urine samples, as well as arsenic concentration and speciation of these samples was measured by Thermo high pressure liquid chromatograph (HPLC) coupled with the Thermo X-series ICP-MS at normal mode. The subject’s daily urinary arsenic excretion was dominated by dimethylarsenic acid (DMA) ranging from 9.8±0.3 μg to 21.0±3.0 μg as the average arsenic daily intake varied switch from 15.4 ± 2.6 μg to 36.4±2.8 μg, maintaining ~58% ingested arsenic excreted rate in the previous study. Compared with our result, aging comparatively reduced the arsenic excretion rate of the subject. And previous monitoring also shows that the subject had the highest urinary arsenic in daily first morning urine, which is confirmed by our study, suggesting the most effective methylation and excretion of arsenic from human body happen at night during sleep.

Key words: Arsenic speciation, Arsenic methylation, Ingested arsenic excretion rate change
Unravelling extremophiles diversity in Guizhou Karst Region

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Abstract:

The Karst topography in Guizhou Plateau is special and unique for extreme habitats. In our study, the water and soil samples were collected from a few virginal hot springs and caves in the Karst region of Guizhou. There were totally 243 culturable bacterial strains and 564 strains isolated from hot springs and Karst caves, respectively. Through the phylogenetic analyses, the strains from hot springs belong to 3 phyla, 5 classes, 20 genera, 25 species; and the ones from Karst caves are divided into 4 phyla, 6 classes, 11 orders, 17 families, 25 genera and 87 species, including 7 novel species of *Vulcaniibacterium*, *Oerskovia*, *Arthrobacter*, *Exiguobacterium* and *Bacillus*. In addition, the single thermophilic microorganisms are isolated at 45 °C-60 °C, suggesting that although the functional redundancy may be ubiquitous under environmental conditions, it may decline rapidly when environmental conditions exceed the tolerance limits of the species, and the community diversity rapidly decreases simultaneously. Furthermore, we discovered abundant actinobacterial strains with antimicrobial activity in Karst caves. The study shows rich diversity patterns of extremophiles in Guizhou Karst Region, which is the valuable asset for developing novel genetic technology and antimicrobial medicine in the future.

Key words: Karst; extremophiles; hot spring; cave; diversity
Cross-sectional study on the association between hot spring Bath and osteoarthrosis

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Abstract:

Objectives To understand the health condition of residents in hot spring areas of Guizhou Province, and to explore the relationship between hot spring and osteoarthrosis. Methods A face-to-face questionnaire survey was conducted among 3708 residents (1648 males and 2060 females) aged from 30 to 65 of five typical hot spring sites, including Xifeng (Xifeng County, Guiyang), Guiyu (Wudang District, Guiyang), Fodingshan (Shiqian County, Tongren), Jianhe (Jianhe County, Qiandongnan) and Shuijing (Suiyang County, Zunyi). Residents’ basic information, bone and joint disease prevalence, hot spring bathing condition, and health-related behaviors were investigated in this study. Participants were divided into four groups according to the frequency of hot spring bathing. Results The prevalence rate of osteoarthrosis were 25.00% (never taking hot spring), 21.71% (past bathers, but not taking hot spring bath in last year), 16.05% (occasionally taking hot spring) and 15.02% (frequent taking hot spring). Compared with the group who never took hot spring, the group who took hot spring frequently were with a lower risk of osteoarthrosis (OR=0.719, 95%CI: 0.534~0.969, P=0.031), whereas there was no significant difference between the group who used to taking hot spring and the group who took hot spring occasionally. Conclusions Hot spring Bathing may be linked to the decreased risk of osteoarthrosis. Therefore, improving the utilization of geothermal water resources in Guizhou Province may be conducive to the prevention and control of osteoarthrosis.

Keywords: Osteoarthrosis; Hot Spring bath; Cross-Sectional Study; Guizhou Province
Enrichment of fluorine in vegetables and soil around abandoned aluminum plants

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Abstract:
Guizhou Aluminum Plant was founded in 1958 and relocated in 2014. During this period, due to the large-scale production by using fluorine-containing bauxite, fluoride was continuously released into the environment as a by-product. After the relocation of the Guizhou Aluminum Plant, a large amount of idle land was reclaimed as a vegetable production site by local farmers. Since the solubility of fluoride in water is mainly controlled by the concentration of calcium ions. Therefore, in areas where carbonate rocks are widely distributed, only a small amount of fluoride that settles in the soil may be soluble in the surface and groundwater, and migrate with water, thereby limiting its bioavailability. However, the health risks of the vegetables produced on these lands are still not well understood. In this regard, we collected some soil, vegetable samples in September 2018, with a gradiental distance along the northeast, southeast, northwest and southwest directions within 10km of the abandoned aluminum plant. A total of 182 samples were collected from 16 vegetables, and paired with 38 soil samples. In general, soil total fluorine, water-soluble fluorine, and fluorine in vegetables far exceed the reference values of their background regions. Among them, the maximum and average values of soil fluorine content, soil water-soluble fluorine and vegetable were 2448.37mg/kg and 1328.82±481.54 mg/kg, 56.94mg/kg and 15±11.28mg/kg, 179.79 mg/kg and 6.08±14.29 mg/kg, respectively. Compared with Chinese National Agricultural Product Limits, the over-standard rate of vegetables reached 92.78%. In terms of distance, the maximum fluorine content in soil, water-soluble fluorine and vegetables appeared within 1km from the original plant area, indicating that the main area of fluoride deposition was within 1km from the plant area, accounting for more than 20% of the total release; affected by wind and wind direction in the year, soil total fluorine, water-soluble fluorine showed a significant negative correlation with the distance from the plant in the southwest direction; however, relationship between the enrichment of fluorine in vegetables and distance did not reach significance. The comparison of the degree of fluorine enrichment in vegetables showed that the leafy vegetables were significantly higher than others, and the accumulation of fluorine in the surface leaves was significantly higher than that in the underground roots. In addition, the larger the leaf of the vegetables, the stronger the ability to enrich the fluorine. Among them, pumpkin leaves are the most prominent (average 17.92±7.59 mg/kg), and their health risks are the highest among all vegetable varieties. The possible cause of this phenomenon is that a large amount of fluorine-containing dust is easily formed in the area and falls on the surface of the vegetable leaves. The vegetables absorb the particles through the pores of the leaves, thereby causing the leaves to contain a large amount of fluorine.

Key words: fluoride deposition; enrichment of fluorine; soil; vegetable;

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H3K18ac response to arsenic-induced hepatic damage in rat

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Abstract:
Arsenic is a known environmental carcinogen. Arsenic-exposure is associated with cancers in multiple target organs. Notably, the liver damage induced by long-term arsenic exposure is one of the primary health hazards in the areas of endemic arsenism in China. Numerous studies have shown that arsenic exposure could alter the level of histone modifications, which suggesting that histone modification may be a novel epigenetic mechanism of arsenosis. However, whether histone modification is involved in the progression of arsenic-induced liver injury has not been proved. In this study, we attempt to explore whether the hepatic damage in rats with arsenic poisoning is associated with histone modification of H3K18ac. Twenty-four wistar rats randomly divided into four groups. Those groups included a control group (received only deionized water) and low, middle, and high arsenic-exposure groups (received arsenic at a dose of 2.5, 5.0, and 10.0 mg/kg via gavage 6 days per week, respectively). The experiment was lasted for 4 months. Next, we used biochemical methods to measure liver biochemical indexes of the γ-glutamyl transpeptidase (γ-GT) and the total bile acid (TBA). The results showed that the levels of TBA and γ-GT in the arsenic-exposed group were significantly (P<0.05) higher than that in the control group. As the dose of arsenic exposure arised, the liver biochemical indexes in the serum increased. This founding suggested that arsenic exposure could induce liver damage in rat. In addition, we performed a sandwich enzyme-linked immunosorbent assay (ELISA) to measure the levels of histone 3 lysine 18 acetylations. The levels of H3K18ac modifications in the arsenic-exposed groups significantly decreased in comparison to the control group (P<0.05). The result suggested that the decrease of H3K18ac level may respond to arsenic-induced liver damage. Therefore, we performed a further analysis of the correlations between the H3K18ac modifications and liver biochemical indexes. The result demonstrated that the levels of H3K18ac was negatively associated with the content of TBA in all samples (r= - 0.478; P= 0.018, data were analyzed by pearson correlation coefficient). The similar result was not found in γ-GT. In summary, we revealed that the modification of histone H3K18ac is associated with liver damage induced by arsenic exposure. What's more, we provide an important reference for the mechanism of arsenic-poisoning induced liver damage.

Keyword: arsenosis; histone modification; H3K18ac, hepatic damage;

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The effects of hot spring soaking bath on glucose metabolism of sub-health people

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Abstract:
Hot spring soaking bath was considered to be a new therapy to improve people’s sub-health such as neurasthenia, insomnia, rheumatism, low back and knee pain. Recent literatures also suggested that hot spring soaking bath could improve the metabolism disorders, which might play a role in preventing the occurrence of metabolic diseases. This study aimed to explore the effects of hot spring soaking bath on glucose metabolism in order to reveal the protective effect of hot spring soaking bath on diabetes risk groups. We recruited 171 volunteers from Xifeng district, Guiyang and Suiyang county, Guizhou province, China. All volunteers were required to be the local sub-healthy residents aged 35 to 65 years, and had little experience of hot spring bathing (less than once a month on average). The exclusion criteria include diabetes mellitus, diabetic complications and some diseases which are not suitable for hot spring bath including hypertension, cardiovascular disease, chronic obstructive pulmonary disease, infectious skin diseases, and so on. The subjects who come from Xifeng and Suiyang underwent hot spring soaking bath for 1 month, at least 40min per day, five times a week, in Xifeng hot spring and Suiyang Shuijing hot spring, respectively. After a month in the soaking bath, 111 of the 171 volunteers completed the program. The glucose metabolism indicators including glycosylated serum protein, glycosylated hemoglobin, fasting insulin and fasting plasma glucose were measured before and after volunteers soaking bath. The results showed that the glycosylated serum protein level of the subjects was significantly lower compared with the before intervention ($P < 0.05$). No significant differences were found in the other indicators during self-comparison before and after intervention. The result suggests that hot spring intervention could affect the subjects sugar metabolism. To further explore the protective effect of hot spring soaking bath on diabetes risk groups, the subjects were divided into diabetes risk group and non-risk group according to WHO criteria for high-risk population of diabetes mellitus. Compared with the before intervention, the levels of glycosylated serum protein were significantly lower in the after intervention both in the diabetes risk group and non-risk group ($all P < 0.05$). Moreover, we also found that the decrease of glycosylated serum protein before and after intervention in diabetes risk group was 1.8-fold than that in non-risk group ($P < 0.05$). The results revealed that hot spring soaking bath might reduce the blood sugar levels in subjects, especially those at diabetes risk groups. Taken together, we speculated that hot spring soaking bath might improve the glucose metabolism disorders in diabetes risk groups, which could provide a novel insight in the early supportive intervention of glucose metabolism disorders.

Key words: hot spring soaking bath, glucose metabolism, diabetes risk groups.
The Expression of Cytochrome C gene in L02 cells exposed to organic extracts from drinking water and its significance

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Abstract:

Purpose: Observing the expression of cytochrome C (Cyt C) gene in human hepatocytes (L02) exposed to organic extracts from drinking water and its significance, to provide scientific basis for hepatotoxicity mechanism of organic extracts from drinking water.

Methods: Organic pollutants in water samples were extracted by solid phase extraction (SPE) methods. L02 cells were exposed to culture medium (blank control), 0.1% DMSO (solvent control), organic extracts from drinking water at the dose of 0.3125, 0.6250, 1.2500, 2.5000, 5.0000 L/ml for 72h respectively. The content of ATP was determined by luciferase method. The level of reactive oxygen species (ROS) was measured by flow cytometry. The relative mRNA expression level of Cyt C gene in the cells was determined by real-time fluorescence quantitative PCR (RT-PCR). The protein expression levels of Cyt C gene were detected by Western blot. The levels of caspase-9 and caspase-3 in L02 cells were detected by Elisa.

Results: (1) ATP content in the 5.0000L/ml group was significantly lower than that in the solvent control group and the blank control group (P< 0.05). (2) Compared with control groups, ROS levels in 2.5000 and 5.0000 L/ml groups significantly increased (P< 0.05). (3) mRNA and protein expression levels of Cyt C gene were significantly higher in 1.2500, 2.5000 and 5.0000 L/ml groups than those in the control groups (P< 0.05). (4) Compared with the control groups, caspase-9 and caspase-3 levels in the exposure groups presented a gradually increasing trend with the increase of exposure dose, and the difference was significant (P< 0.05).

Conclusions: Organic extracts from drinking water may induce the decrease of ATP synthesis in L02 cells, and the increase of ROS level, and up-regulate the expression level of Cyt C gene, cause the high levels of caspase-9 and caspase-3. These might be the reason for L02 cells oxidative damage caused by organic extracts from drinking water.

Key words: Organic extracts from drinking water, ROS, Cyt C, Caspase-9, Caspase-3
Effect of hot spring bath on immunoglobulin and complement in residents in Xifeng and Suiyang, Guizhou, China

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Abstract:
Hot spring is a green natural resource that integrates mineral, heat and water. It is rich in trace elements and minerals which can regulate human health by stimulating immune, nervous and endocrine systems. Immunoglobulin and complement system are important components of immune system which is a defense network covering the whole body and it has the functions of immune surveillance, defense and regulation. IgA, IgG and IgM are immunoglobulins with antibody activity or chemical structure similar to antibodies. C3 and C4 are important molecules in complement system and play an important role in complement activation. IgA, IgG, IgM and C3, C4 have become the routine indicators of immunoassay. This study aimed to explored and analyzed the effects of Xifeng and Suiyang hot spring bath in Guizhou Province, one of the eight hot springs in China, on serum immunoglobulin IgA, IgG, IgM, and complement C3, C4, which in order to provide theoretical basis for regulating immune function by hot spring physiotherapy. At the same time, it laid a foundation for building typical hot spring tourism development zones in Guizhou Province and forming compound "hot spring + recuperation" industry. We selected 111 volunteers in Xifeng and Suiyang as the subjects of this study, all volunteers were required to be age 35 to 65 years. All the participates underwent hot spring bath therapy for 1 months, at least 40min per day, not less than five times a week. All the above subjects excluded those who had serious heart, liver, kidney, hematopoietic system and other important organ pathological changes, History of immunodeficiency or autoimmune-related diseases and use of food and/or drugs that can possible interfere with immunity, recent history of surgery. In addition, some chronic non-communicable diseases (including hypertension, diabetes, cardiovascular disease, chronic pneumonia, and so on) that are not suitable for hot spring bath therapy are also the exclusion criteria we consider. With informed consent, fasting venous blood was collected in the morning. Serum IgA, IgG, IgM, C3 and C4 levels were measured by transmission immunoturbidimetry before and after hot spring bath. Compared with the before intervention, the levels of IgA, C3 and C4 were significantly increased in the after intervention (P<0.05). Serum IgG and IgM in the after intervention were slightly higher than in the before intervention, but these changes did not show statistical differences (P>0.05). Our results suggested that hot spring bath therapy can improve the immune system, which is good for health.

Key words: hot spring, Thermal bathing, Immune Function, Immunoglobulin, complement.
The Effects of Hot Springs Thermal Bathing on Serum Oxidative Stress Level of Body in Guizhou Province, China

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Abstract:
Oxidative stress is a negative effect of free radicals in body and an important factor in aging and disease. It is one of the feasible means to alleviate oxidative stress by improving the body's antioxidant function. Some trace components in hot spring waters such as selenium, strontium, zinc and metasilicic acid may be absorbed by body to promote the synthesis of antioxidant enzymes and enhance antioxidant capacity. The aim of this study was to assess the changes on the serum oxidative stress level of local residents under the influence of thermal bathing in Xifeng hot springs and Suiyang Crystal hot springs in Guizhou province, China. This study was assessed and authorized by the Ethical Committee of Guizhou Medical University. The study was described to all participants, and all provided written informed consent. According to the epidemiological questionnaire, doctor's diagnosis and follow-up laboratory examination in the health examination, 111 volunteers in Xifeng and Suiyang were selected to complete the project (age:50.18±7.45, Male: 46, Female: 65). All the participants receive hot springs thermal bathing for a period of 4 weeks, 40~60 minutes each time, five times a week, in Xifeng hot spring and Suiyang Crystal hot springs respectively. Suffering some chronic non-communicable diseases (including hypertension, diabetes, cardiovascular disease, stroke, cerebral insufficiency, chronic obstructive pulmonary disease, bronchial asthma, chronic bronchitis, chronic pneumonia, infectious skin diseases, and so on) that are not suitable for thermal bathing are the exclusion criteria of this study. Before and after 4 weeks of intervention, peripheral bloods were collected from participants and serum was separated. Total superoxide dismutase (T-SOD), Cu-Zn superoxide dismutase (Cu-Zn SOD), glutathione S-transferases (GSTs), glutathione peroxidase (GSH-px), sulfhydryl group (-SH) and malondialdehyde (MDA) value were detected in subjects fasting serum of morning by biochemical methods before and after treatment with thermal bathing, which represented serum oxidative stress level. After 4 weeks of thermal bathing, the antioxidant enzyme activities of T-SOD, Cu-Zn SOD, GSH-px in the serum of thermal bathing intervention objects significant increased ($P$ all $<0.05$). Upward trend but no significant difference was seen among the activity of antioxidant enzyme GSTs during self-comparison before and after intervention ($P>0.05$). Glutathione, which plays an important role in anti-oxidation in the body, its physiological function mainly relies on the redox effect of the active -SH in cysteine. The -SH concentration in serum obviously elevated in the after intervention ($P<0.05$). For lipid peroxidation, MDA value after intervention were lower than in the before intervention, the changes showed statistical differences ($P<0.05$). Overall, this study results indicate that thermal bathing of hot springs waters can enhance the activity and content of antioxidant enzyme and materials in serum, antagonize to lipid peroxidation. Improvement of anti-oxidation function may be an important aspect of health promotion of Xifeng hot springs and Suiyang Crystal hot springs in Guizhou province, China.

\textbf{Key words:} Hot springs, Thermal bathing, Oxidative stress, Anti-oxidation
Copper contents in blood and organs of SD young rats
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Abstract:

Cu is an essential trace element in human body that closely related to human health. Cu content variations in human blood could be indicators for certain diseases. The SD rats are an important model animal for various human disease researches, thus to achieve a better understanding of blood Cu levels in rats is of significance. Previous studies on metals in rats mostly focused on adult rather than young rats. In this study, Cu contents in whole blood, plasma, red blood cells, hearts, livers, spleens, lungs and kidneys of 12 healthy SD young rats (half male and half female) were measured by ICP-MS. The results showed Cu contents in whole blood, plasma and red blood cells were in the decreasing order: plasma>red blood cells>whole blood, and the difference of Cu contents between plasma and whole blood was statistically significant (P<0.05). Plasma is preferred for human Cu content evaluation since most blood Cu binds to ceruloplasmin in plasma. Furthermore, organ Cu contents were in the following descending order: lung>spleen>liver>heart>kidney. Cu was mainly concentrated in liver, spleen and lung, whose Cu concentrations were much higher than those in heart and kidney, which might be attributed to different functions of Cu in different organs. For instance, higher Cu in liver could due to that liver is an important site to produce metabolic enzymes, whose composition and activation is normally involved with Cu. However, young SD rat blood and organs of different sexes exhibited no significant Cu content difference. This study is of great significance for further human disease researches associated with model animal Cu contents, especially those on infant and young child diseases.

Key words: Cu; ICP-MS; SD young rat; blood; organ
**Ginkgo biloba extract attenuates arsenic-induced liver damage by restoring the balance of Th17/Treg cells in rats**

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**Abstract:**

Arsenic is an environmental toxicant and a known carcinogen, growing evidence have indicated the correlation between chronic arsenic exposure and hepatic disorders. However, its pathogenesis is still uncharacterized and there is no specific treatment. Recent researches reported that the balance between T helper17 (Th17) and T regulatory (Treg) cells is critical in maintenance of liver immune homeostasis and the disturbance of this balance may lead to hepatic injury and disease. A sub-chronic arsenic exposed rat model was established to investigate the role of Th17/Treg cells balance in arsenic-induced liver injury and explore the protective effect of *Ginkgo biloba* extract (GBE), which is extracted from *Ginkgo biloba* leaves and known as many benefits of medicinal properties including anti-inflammatory and modulation of immune. In the present study, we found that 2.5, 5.0 and 10.0 mg/kg NaAsO₂ orally for 4 months triggered the infiltration of inflammatory cells in liver obtained from histopathological examination, coupled with aberrant alteration of plasma biochemical parameters ALB, A/G, CHE and ALT corroborated liver injury. Meanwhile, chronic arsenic exposure increased the frequency of Th17 and Treg cells in peripheral blood. Impressively, decreasing tendency of Treg cells in high dose of arsenic exposed-group was observed. In addition, the increasing ratio of Th17/Treg cells and abnormal secretion of inflammatory cytokines IL-6, IL-17, IL-10, TGF-β1 were also detected in serum and liver. Subsequently, treatment with GBE (50 mg/kg) after arsenic exposure significantly restored arsenic-induced biochemical and histological alterations in liver and reduced the imbalance immune response. In summary, our present study suggested that chronic arsenic exposure might disturb the balance of Th17/Treg cells, and further leading to an imbalance inflammatory response, which was involved in arsenic-induced liver injury and GBE could attenuates arsenic-induced liver damage by shifting balance from Th17 dominance to Treg dominance in rats.

**Key words:** Arsenic; *Ginkgo biloba* extract; Liver damage; Inflammatory; Th17/Treg balance

**Funding:** This work was supported by the Key projects of Natural Science Foundations of China (81430077).
Ameliorative effect of Ginkgo biloba extract on coal-burning arsenic-challenged liver injury via regulating the expressions of apoptosis-associated proteins in rats

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Abstract:
Inorganic arsenic is ubiquitous in the environment. Arsenism, caused by burning coal containing high levels of arsenic or drinking arsenic-contaminated ground water, is an endemic disease that affects hundreds of millions of people worldwide. Molecular mechanisms underlying in arsenic-induced toxicity have remained unclear. The aim of our study was to detect the basis of coal-burning arsenic hepatotoxicity and the role of Ginkgo biloba extract (GBE) in antagonizing it. Rats exposed to 25,50,100 mg/kg doses of arsenic by feeding corn flour, which was baked using high-arsenic-containing coal from arsenism region Guizhou Province, China, presented obvious liver injury as evidence acquired from histological examination. ALB, TBA and ChE alterations further corroborated liver injury. Furthermore, results obtained from TUNEL assay confirmed that arsenic initiated effectively the occurrence of apoptosis in liver tissues and modulated the expression levels of apoptosis-associated proteins, including Bax, Bcl-2, Fas, DR5, p53 and p-p53. Notably, GBE was capable of reverting ALB, TBA and ChE levels thereby ameliorating arsenic-induced liver injury. Meanwhile, this study also confirmed that GBE attenuated arsenic-induced apoptosis by regulating the expression levels of apoptosis-associated proteins. Taken together, we provide a probable mechanistic insight toward apoptotic signaling pathway in response to coal-burning arsenic-challenged liver injury, and GBE was found to partly abrogate apoptotic signaling and thus exert its antitoxic effect against liver injury.

Keywords: apoptosis, coal-burning arsenic, liver injury, Ginkgo biloba extract

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Ophthalmopathology in the areas of oil and gas exploitation and refinery enterprises

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Abstract:
During the operation time of oil and gas extraction and refinery enterprises (OGERE), a number of factors affecting the health of the staff and population has been identified. Factors include toxic substances released in the stages of oil and gas exploitation, the production of certain marketable products, and climatic conditions accompanying oil and gas exploitation and refinery process, among others. All these factors negatively impact human health, including the organ of vision. A questionnaire survey directed to the staff of OGERE revealed the presence of ophthalmologic problems in 36.2 % of those examined, as well as the pathology of the organ of vision in 18 %, and the changing anterior chamber of the eye in 57.4 %. The structure of ophthalmopathology indicates a clear irritant effect of toxic factors in the working environment.

Air pollution from the emissions at adjusted to refineries territories is the most important factor that affects the conditioning of the environmental situation in the refinery territories. Environmental contamination is caused by multicomponent harmful production substances. Among the population living in the area where the oil and gas complex is located, the frequency of ophthalmopathology is as much as 20 % higher than in more ecologically healthy regions.

The progress of ophthalmopathology in the OGERE staff cohort and population living on adjacent territories occurs in the background of general changes in the organism, as evidenced by an imbalance of blood trace elements (a significant increase in sodium), a decrease in the concentration of a number of immunoglobulins - IgA, IgG, performing protective functions, and an increase in IgE, testifying to the sensitivity of the organism.

Key words: oil and gas extraction and refinery enterprises, air pollution, ophthalmopathology
Indoor radon GAS (222Rn) in a public workplace in aldama, Chihuahua, Mexico

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Abstract.

Inhalation of radon gas (222Rn) induces lung cancer in human. The municipality of Aldama in Chihuahua, Mexico, possesses high levels of natural uranium and; therefore, it was hypothesized that high radon concentrations are present in the environment due to the fact that this gas is a byproduct of the uranium decay. The objective of this study was to quantify the 222Rn levels in a public office and to determine the potential negative impact of exposure to workers. The study was conducted in two steps; in the first step (FS) it was determined the 222Rn concentration with a portable AlphaGuard device (Professional Radon Monitor, Genicron Instruments GmbH), at three high levels (0.74 m, 1.33 m and 2.06 m) in a public office during 3 complete days for each height. The device was positioned in the corner of the office more distant of the main door. In addition of quantifying 222Rn in Becquerels (Bq m⁻³), with readings every 10 min, ambient temperature (AT), air pressure (AP) and relative humidity (RH) were also measured every 10 min. The second step (SS) was similar to the first one, but the device was placed in the center of the office. An analysis of variance (ANOVA) was performed for each step (α=0.05), considering a factorial arrangement design 3×2; where the Factor A was the elevation with three levels (0.74 m, 1.33 m and 2.06 m) while Factor B was the time with two levels; during the day (9:00 to 21:00 h) during the night (21:00 to 9:00 h). The results showed that statistical differences were noted for height (P<0.05), for time (P<0.05) but not for the interaction (P>0.05). The 222Rn concentration was higher at 0.74 m with about 161.34 Bq m⁻³ in FS and 167.05 Bq m⁻³ in SS. These concentrations are higher than maximum recommended for the international agencies with stipulate a concentration of 157 Bq m⁻³; however, during the day the 222Rn values were lower. It is concluded that the 222Rn values during the day are not greater than the recommended concentration of international agencies; therefore, the workers are safe in their workplace.

Key words: heavy gas, miner disease, uranium by products, Chihuahua Mexico

Acknowledgments: This study was financially supported by the National Institute for Research in Forestry, Agriculture and Animal Production in Mexico (INIFAP-Mexico) and the Autonomous University of Chihuahua (UACH).

Whenever there is a rare and strictly locality related disease outbreak whose aetiology cannot be readily and clearly established, a suspected geoenvironmental factor(s) [co-factor(s)] is often implicated. In handling such situations, medical geologists work in teams of ready responders that include epidemiologists, public health specialists and toxicologists, who investigate the problem so as to identify causes and risk factors, implement prevention and control measures, and communicate with all stakeholders. The role of a medical geologist in such an investigative team would be: (1) to provide pertinent geoscientific information to the public health specialists to help ascertain whether or not a geoenvironmental factor (co-factor) is indicated (2) to determine the nature of the geological materials and/or processes that may be involved; (3) take appropriate action to prevent further contact/exposure to the implicated geological materials or processes.
Drawing correlations between disease distribution and some geoenvironmental factor(s) [co-factor(s)] often involve substantial amount of fieldwork, whereby medical geologists, just like public health workers, may be exposed to various hazards. Examples that engender such exposures include field surveys involving observations on patterns of silica dust emission and distribution; sampling of geophagic materials for microbiological analysis; sampling of radioactive tailings for determining uranium migration pathways and particle concentrations in ambient air, or conducting diagnostic experiments in areas of recently reported lead poisoning episodes such as was the case in Nigeria in 2010, and again in 2015. The purpose of a health and safety plan is to provide a means for minimising accidents and injuries that may occur at a specific location or while working on a specific project, and to communicate to all involved what safety procedures are to be followed. This paper prescribes health and safety procedures and actions to be taken by medical geology personnel as well as other members of the investigative team, and the general public during field investigations of a strictly locality related disease outbreak. A set of guidelines is presented depicting that, with knowledge, experience, adequate preparation, and strict observance of appropriate health and safety precautions, most health and safety issues in medical geology fieldwork can be avoided.

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This paper prescribes health and safety procedures and actions to be taken by medical geology personnel as well as other members of the investigative team, and the general public during field investigations of a strictly locality related disease outbreak. A set of guidelines is presented depicting that, with knowledge, experience, adequate preparation, and strict observance of appropriate health and safety precautions, most health and safety issues in medical geology fieldwork can be avoided.
The cytotoxicity of PM$_{2.5}$ during an air pollution episode in Nanjing, eastern China

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Abstract:

Atmospheric fine particulate matters (PM$_{2.5}$) induce adverse health effects through inhalation, determined by the pollution level. To compare the toxicity differences, the molecular mechanisms of autophagy of human alveolar basal epithelial cells (A549) induced by PM$_{2.5}$ was investigated, by testing samples before, during, and after a winter heavy pollution period in Nanjing city of eastern China. Results showed that, PM$_{2.5}$ exposure induced the autophagy, which may be a protective mechanism. In addition, the NF-κB signaling pathway is also associated with the autophagy induced by PM$_{2.5}$ exposure A549.

Key words: Atmospheric particles; cell toxicity, autophagy; NF-κB; signaling pathway
Identification of Key Candidate Genes and Pathways for Relationship between Ovarian Cancer and Diabetes Mellitus using Bioinformatical Analysis

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Abstract:
Ovarian cancer is one of the three major gynecologic cancers in the world. The aim of this study is to find the relationship between ovarian cancer and diabetes mellitus by using the genetic screening technique. By GEO database query and related online tools of analysis, we analyzed 185 cases of ovarian cancer and 10 control samples from GSE26712, and a total of 379 different genes were identified, including 104 up-regulated genes and 275 down-regulated genes. The up-regulated genes were mainly enriched in biological processes, including cell adhesion, transcription of nucleic acid and biosynthesis, and negative regulation of cell metabolism. The down-regulated genes were enriched in cell proliferation, migration, angiogenesis and macromolecular metabolism. Protein-protein interaction was analyzed by network diagram and module synthesis analysis. The top ten hub genes (CDC20, H2AFX, ENO1, ACTB, ISG15, KAT2B, HNRNPD, YWHAE, GJA1 and CAV1) were identified, which play important roles in critical signaling pathways that regulate the process of oxidation-reduction reaction and carboxylic acid metabolism. CTD analysis showed that the hub genes were involved in 1128 distinct diseases (bonferroni-corrected $P<0.05$). Further analysis by drawing the Kaplan-Meier survival curve indicated that CDC20 and ISG15 were statistically significant ($P<0.05$). In conclusion, glycometabolism was related to ovarian cancer and genes and proteins in glycometabolism could serve as potential targets in ovarian cancer treatment.

Keywords: Bioinformatics analysis, Microarray, Ovarian cancer, Diabetes Mellitus
Global climate changes and their impact on public health

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Abstract:
It has been established that the general development and health of a person by 20% depend on the state of the environment - natural, technogenic, and social. In the last 50 years, as a result of human activity, especially the burning of fossil fuels, carbon dioxide and other greenhouse gases have accumulated in the lower layers of the atmosphere in quantities sufficient to maintain excess heat and influence the global climate.

The general cyclicity of climatic changes of the planet has been considered and different climatic cycles have been established according to periodicity. The most noticeable are 1560 year cycle and 11 year cycle, which is controlled by solar activity. Increased solar activity causes additional ionization of air, and as a consequence, the density of ionospheric layers and their reflection capacity changes, the ozone layer is being partially destroyed and an increased amount of ultraviolet reaches the surface of the Earth. It has been established that magnetic and solar storms change the intensity of the geomagnetic field, adversely affecting the activity of the central nervous and cardiovascular systems of a human.

Technogenic type of civilization development in conditions of population growth requires the involvement of more and more natural resources in production processes. In particular, over the period from 1960 to 2015, more than 150 billion tons of fossil fuels were used in the world, more than 9 million artificially obtained chemical elements were registered. 15 billion tons of carbon monoxide are emitted annually into the atmosphere as a result of fuel combustion. Industrial and agricultural production has caused technogenic dangers. Ukraine is one of the most technogenically loaded states of Europe, therefore, the tendency of the technogenic emergencies increase, the significance of the consequences objectively compel to consider them as a serious threat to the safety of an individual, society and the environment, as well as the stability of the country’s economy.

The temperature increase creates favorable conditions for the development of diseases transmitted through water or animal carriers. Mutations and the lack of clean drinking water contribute to the growth of infectious intestinal diseases. Natural drinking water and mineral water cause a number of specific diseases depending on their chemical composition and dissolved minerals. Excess of minerals (strontium, fluorine, lack of calcium) leads to osteoporosis. Climate change leads to prolongation of transmissible diseases transmission seasons and changes in their geographical areas. Rapid reproduction of microorganisms in the air increases the incidence of asthma, allergies, and various respiratory diseases.

To solve the above-mentioned problems in Ukraine it is necessary to perform geological and medical mapping of the territory of Ukraine, which will enable to recognize and study the regulations of the morbidity of the population according to the indicators of the landscape, surface hydrosphere, sources of technogenic load, electromagnetic fields; to conduct an assessment of the risk of the influence of certain factors of the geological environment of natural-technogenic geosystems on the health of the population within the limits of local objects.

Key words: global climate, public health, climatic cycles, technogenic load, mapping
Medical Geology in Africa: an example of an educational initiative at the University of Johannesburg, South Africa

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Although there has been growing development of the field of Medical Geology throughout the world, it is in Africa that research in this field would be most relevant. However, it is in Africa that the field is still least developed. Apart from some local studies conducted in Ghana, Nigeria and some institutions in South Africa, which focus mostly on environmental issues in general, there was no dedicated program for Medical Geology studies. It is in this line that a dynamic and highly successful medical geology education initiative has been developed at the University of Johannesburg (UJ), South Africa starting in 2013. The initiative called “Medical Geology in Africa initiative @ UJ”, started with one part-time MSc student in 2013 supported by the Council for Geoscience of South Africa (CGS, evolved to two MSc students from Kenya supported by the prestigious University of Johannesburg Program called ‘Global Excellence and Stature” in 2015 then grew since then to host 15 postgraduate students in total (12 MSc and 3 PhD) from South Africa as well as other African countries including Nigeria, Namibia, Kenya and Ghana. These students were largely funded by the National Research Foundation of South Africa through the collaboration and postgraduate training program and the University of Johannesburg Global Excellence and Stature program with support from the University of Johannesburg Research Committee (URC) and the Faculty of Science research grants. The training of these students was conducted in collaboration with a large number of national and international institutions including the Witwatersrand (Wits); the University of Venda (UNIV); the Nelson Mandela Metropolitan University (NMMU); the PARC RGM - Radon Gas Monitoring and the Council for Geoscience in South Africa; the University of Aveiro, Portugal; the Federation University of Australia; Lineaus University, Sweden; the British Geological Survey, UK; the University of Texas at Dallas, USA; the South Eastern Kenya University; the Geological Survey of Namibia; the University of Lagos Nigeria and the University of development studies Ghana.

Since the inception of the initiative in 2013, up to 16 postgraduate student-led research projects on topics related to medical geology in Africa were initiated, 8 of them were completed and resulted in 30 publications in peer reviewed international journals and conferences abstracts, while others are still ongoing. This program clearly demonstrates that medical geology has broad appeal and, with dedicated leadership and necessary financial support, can result in activities that stimulate and retain student’s interest and enthusiasm.
Towards exploration of spatially varying relationships in environment and health in the big data era

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Abstract:

It is hard to identify the influencing environmental factors on health problems due their complicated relationships. One of the issues which has not been well recognized is that such relationships are “spatially varying”, meaning that they are different at different spatial locations. On the other hand, with growing databases available at regional, national, and global scales, studies on environment and health are facing the challenges of “big data”, but new opportunities arise for the exploration of such spatially varying relationships. In the meantime, the rapidly developing techniques in machine learning become useful tools for classification, identification of clusters/patterns, identification of relationships and prediction in big data. The geographically weighted regression (GWR) offers new opportunities to explore the relationships between environmental factors and health at the local level, which is effective in identifying the complex spatially varying relationships. In this presentation, examples are provided to demonstrate the power of GWR in revealing the spatially varying relationships in geochemical databases, with an aim to expand it in health.

It was found that in urban soils of London, the generally positive relationships between Pb and Al was disturbed in the city center areas with weakened correlations, while in the suburban area in the north London, the relationship even became negative due to the significantly elevated Pb concentration in areas close to the city center. Meanwhile, in large green areas in the city center, the positive relationships between Pb and Al remain unchanged. The relationships between soil organic carbon (SOC) and elevation in Ireland exhibit strong spatial variation which are related to the type of peat. In the mountainous areas, positive relationships were found between SOC and elevation, which was in line with the distribution of blanket peat. In the central area of Ireland where basin peat was formed, the relationships between SOC and elevation became negative, as basin peat was formed in areas of low elevation.

The spatially varying relationships provides new insight into the complicated relationships between environment and health, and it is highly recommended that more researches are performed in this area.

Key words: Spatially varying relationship; geochemical database; geographically weighted regression; Pb; Soil organic carbon
Thallium (Tl) in Geological Settings of Nigeria: Potential Ecological and Human Health Risk

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Abstract:

Thallium (Tl), a potentially toxic element than Pb and Zn has not received high attention compared to other toxic elements in many parts of the world especially in developing countries like Nigeria. This study was carried out to evaluate the concentration of Tl in Geological setting in the following media: soils, stream sediments, mine tailings, rocks, groundwater, surfacewater and minewater in three distinct Geological settings (Gold and chromite in Anka, Northwest Nigeria): Pb-Zn-F mineralization in Arufu Northeast Nigeria and precious stones in Ijero Southwest Nigeria: so as to unravel its possible impact on the ecology and human health.

A total of 408 samples were collected in 2017: 93 soils (42 from Anka; 31 from Arufu and 20 from Ijero), 43 stream sediments (22 from Anka; 6 from Arufu and 15 from Ijero), 33 mine tailings (13 from Anka; 6 from Arufu and 14 from Ijero), 40 rocks (19 from Anka; 9 from Arufu and 12 from Ijero), 116 groundwater (66 from Anka (33 in both dry and wet seasons each); 20 from Arufu (10 in both dry and wet seasons each); 30 from Ijero (15 in both dry and wet seasons each)), 60 surfacewater (28 from Anka (14 in both dry and wet seasons each); 12 from Arufu (6 in both dry and wet seasons each); 20 from Ijero (10 in both dry and wet seasons each)) and 23 minewater (10 from Anka (wet season only); 5 from Arufu (wet season only); 8 from Ijero (4 in both dry and wet seasons each)). Water samples were filtered, acidified and kept in the refrigerator at a temperature below 4°C prior to analysis. All solid samples were air-dried, crushed, pulverised and sieved to obtain fine fractions which were digested using aqua regia technique, filtered and diluted in a 1:50 ratio using a ultrapure water. All liquids and digestates were analysed for Tl using Agilent HPLC.
ICP-MS at the State Key Laboratory of Environmental Geochemistry, Institute of Geochemistry, Chinese Academy of Sciences, Guiyang, China.

The mean concentration of Tl in the geological media are as follows: (1) Anka: soils (0.36 mg/kg), stream sediments (0.37 mg/kg), mine tailings (7.89 mg/kg), rocks (8.83 mg/kg), groundwater (Dry season: 0.0218 mg/l; Wet season: 0.00397 mg/l) surface water (Dry season: 0.0033 mg/l; Wet season: 0.00553 mg/l) and mine water (Wet season: 0.018 mg/l). (2) Arufu: soils (0.31 mg/kg), stream sediments (0.40 mg/kg), mine tailings (10.65 mg/kg), rocks (7.95 mg/kg), groundwater (Dry season: 0.0029 mg/l; Wet season: 0.0037 mg/l) surface water (Dry season: 0.00107 mg/l; Wetseson: 0.00272 mg/l) and mine water (Wet season: 0.00495 mg/l). (3) Ijero: soils (0.36 mg/kg), stream sediments (0.37 mg/kg), mine tailings (7.89 mg/kg), rocks (8.83 mg/kg), groundwater (Dry season: 0.0218; Wet season: 0.00397 mg/l) surface water (Dry season: 0.0033 mg/l; Wet season: 0.00553 mg/l) and mine water (Wet season: 0.018 mg/l). The concentration of Tl in rocks and mine tailings in the areas are above the average crustal values. Study showed that under the best conditions, Tl poses no threat to soils, stream sediments and water in the three areas. However under the best conditions Tl in mine tailings and rocks may pose severe ecological risk in all the areas. Under the worst ecological conditions Tl poses great in all the media except in stream sediments. Calculated health quotient revealed that Tl in the media might contribute significantly to both carcinogenic and carcinogenic diseases in both children and adults in the study area.

**Keywords:** Ecology; Health; Nigeria; Risk; Thallium
High radon concentration in karst caves and how to minimize their exposure

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Abstract:
Radon (²²²Rn) and its’ decay products have been a major health issue since their discovered. Radon is a radioactive gas originating as an intermediate product of ²³⁸U decay series. It is ubiquitously released from soils and rocks depending on the concentration of its parent nuclide, ²²⁶Ra. Despite the very low uranium content in limestone, strong enrichment of uranium during weathering of carbonate rocks can occur, leading to a high uranium and radium content in residual soils which are widespread throughout the fissures and karst cavities. Combined with the enclosed space of cave systems, this leads to exceptionally high radon concentrations in karst caves worldwide. Epidemiological studies have shown a clear link between breathing high concentrations of radon and incidence of lung cancer. It is hence necessary to categorize personal dosimetry in view of the potential health hazards caused by inhaling radon and its daughter nuclides in such environments. In our study, continuous monitoring using a RAD7 radon detector revealed high concentrations and large fluctuations of ²²²Rn concentrations in Shawan Cave, southwest China. From August 2016 to July 2017, the average annual concentration was 47,419 Bqm⁻³ and ranged between 3720 and 123,000 Bqm⁻³, with lower values during summer than other seasons. We evaluate the potential dose exposure and a time limit of 31.9 h per year with an equal monthly time distribution is recommended, and not in exceedance of 79.7 h for any single year to meet the dose limit recommended by the ICRP. Due to the radon concentration variation in the cave, with an equal monthly dose distribution, a total time of 48.75 h can be spent without exceeding the limit of 20 mSv. Furthermore, we comparing results from this study with other studies in 35 caves worldwide, and conclude that there are three patterns of seasonal ²²²Rn variation. They were further classified into five types of ventilation mode based on diversity of cave locations, geometry and connectivity of bed rock fracture networks, together with temperature differences between outside atmosphere and cave air. Finally, we suggest a framework of “When to visit” to minimize exposure to hazardous levels of ²²²Rn in karst caves.

Key words: Radon, Radiation, Dosimetry, Karst Cave, Ventilation
Azorean volcanic soils: iodine and cobalt bioavailability and health effects

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Abstract:

Volcanic soils cover only about 1 % of the Earth’s surface, yet they support 10 % of the world’s population due to their inherent fertility. However, deep magmatic processes may lead to the depletion of certain elements in volcanic rocks. The imbalance of essential elements in the environment, especially in soil parent materials, can affect the health of plants and grazing animals and thus of humans. Within the particular geographical and geological context of the Azores, this study aims to assess Iodine (I) and Cobalt (Co) bioavailability in volcanic soils in order to predict the risk of deficiency in animals and humans.

Samples from agricultural topsoil and pasture grass were collected in six volcanic regions (VR) of São Miguel Island and their physicochemical properties were determined, including iodine (I) and selected transition metal element contents, such as iron (Fe), manganese (Mn) and Co.

Iodine concentration in soil and grass through the island was determined in summer and winter. The concentration of iodine in soil was higher in winter for all the VRs, being consistently lower in Sete Cidades<Furnas<Povoação<Nordeste/Picos/Fogo. Fogo VR showed the highest Iodine values for soil samples, reaching 28.77 ± 5.4 ppm in summer and 35.3± 7.8 ppm in winter. The iodine concentration in grass samples was much higher in winter than in summer, and it does not seem to follow the soil concentration trend.

The soil Co concentration was below 5 mg/kg in Povoação<Furnas/Congro<Sete Cidades<Fogo and was higher than 10 mg/kg in Picos<Nordeste. Co in plants has very low concentrations, presenting adequate values to fulfill animals needs only in Nordeste. The concentration of Fe and Mn were also significantly higher in the two latter VRs. These differences result from the pedogenesis of volcanic rocks with distinct geochemical compositions related to different degrees of magmatic evolution.

Results show that there is a significant lack of Co in agricultural soils of São Miguel and that it is important to predict the risk of Co deprivation due to its significant biological value. Soils deficient in Co can reduce plant growth, result in the impairment of vitamin B12 formation in animals and, consequently, affect animal and human health.

This study demonstrates that the concentration of cobalt in plants depends directly on the concentration of this element in the soil, whereas the concentration of iodine in plants seems to be mainly affected by other factors than soil, such as proximity to the sea shore, wind direction, slope and raining fall.

Keywords: Cobalt; iodine; soil; grass; volcanic islands.
Fungi and the Goldfields: Food for Thought

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Abstract:
Environmental impacts of historical mining activities are well established. With a mining history of more than 150 years, the Goldfields of Victoria, Australia, provide a case history of an evolving geochemical landscape. Mercury is a significant impactor in that environment. Gold extraction by means of mercury amalgamation has resulted in the generation of significant financial wealth and has been accompanied by significant loss of mercury to the environment. In the Ballarat goldfields alone, it is estimated that between 1868 and 1888 a minimum of 7.394 tons of mercury was lost, and the overall Victorian average for the same period is 69.71 tons (Davies et al, 2015).

The metal content of fungal fruiting bodies (sporocarps or mushrooms) from mine dumps and surrounding landscapes was quantified to enhance understanding of the fate of mercury and other mining linked elements in the local the environment. Mushrooms are potential bio-extractors of Hg (amongst other metals) from contaminated soils, but their use as bio-indicators of soil health is less widely discussed. The global dispersion of many wild mushroom species makes them ideal indicators of soil contamination as they grow in both disturbed and pristine environments.

Good practice in repurposing mining affected landscapes, post-mining, is to plant indigenous vegetation (ground cover, understory and trees). Such vegetation returns benefits in the form of commercial timber, wildlife habitat, soil stability, water catchment protection, and other environmental benefits (Davis et al 2012). However, historically, and continuing in many parts for the world, exotic pines such as Pinus radiata are planted over the extended mining landscape and bio-accumulating mushroom species such as Lactarius deliciosus (Saffron Milk Cap) and Boletus portentosus (Slippery Jack) commonly accompany the planting. These bio-accumulating mushroom species provide convenient media for assessing mining disturbed landscapes.

Mercury and other indicators of gold mining contamination, in samples of the target species collected from the Goldfields of Victoria correlated positively with the levels of soil contamination. Analysis of sets of data available worldwide support this correlation. The potential to identify target species for bio-indication of soil quality is considered. The fruiting bodies of Lactarius deliciosus and Boletus portentosus are edible and are nutritionally desirable and provide a highly sought after foraged foodstuff, and Pinus Radiata plantations offer a particularly rich source. Consuming these foraged species from mining contaminated environments may put the consumer at risk, although the absorption rate of Hg compounds contained in ingested mushroom is not well established.

Metal content of mushroom samples from mine waste material is quantified to aid understanding the fate of mercury and other metals in the local the environment. The implications for consumption, contamination, assessment and remediation are considered.

References:

Key words: Goldfields, mining contamination, mercury, fungi
Methylation microarray analysis in a cross-sectional study of children with fluoride exposure identifies *NNAT* as a novel candidate gene for the development of intelligence

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Background and Objectives

Excessive fluoride may affect learning and cognitive function of the human body, which is mainly manifested in the decline of intelligence quotient (IQ) level. However, the effects of mild to moderate fluoride exposure on intelligence remain unclear. It has been reported that changes in DNA methylation status involve a variety of diseases, including learning and memory dysfunctions. To date, epidemiological and toxicological studies have found that alterations in intelligence are accompanied by changes in DNA methylation, however the evidence supporting this finding is insufficient. Therefore, we combined epidemiology and bioinformatics in the present cross-sectional study to explore the relationship between fluoride exposure, DNA methylation and children's intelligence in endemic areas.

Methods: We performed a cross-sectional study in Tongxu County of the Henan Province in China in 2017, a total of 822 primary school students aged 8 to 12 years were eligible. Participants were divided into a high fluoride-exposure group (HG, 393 students) and a low-fluoride exposure group (LG, 429 students) with a cutoff value 1.4 mg/L fluoride concentration in urine. Firstly, eight male students from fluorosis villages with a relatively high concentration of urinary fluoride (UF) and dental fluorosis were selected as the case group, another eight students from non-endemic fluorosis villages matched age and gender were selected as the control group. All sixteen children were randomly numbered, and the 850K methylation BeadChip was used to screen the differentially methylated regions (DMR) of genomic DNA between the two groups. Secondly, a total of 100 children in the HG and LG were selected (excluding the 16 samples chosen in the analysis of 850K methylation BeadChip) to test the consistency of the DMR. Among them, fifty children (25 boys and 25 girls) with a high UF concentration and dental fluorosis were in the HG, and another fifty children without dental fluorosis were in the LG on a 1:1 matching ratio of age and
gender. Finally, methylation specific PCR was used in 822 genomic DNA samples of the whole population to verify the DMR of NNAT gene, including 393 cases in the HG and 429 cases in the LG. In addition, differences in IQ between the two groups were compared, and the relationship among fluoride exposure, NNAT gene methylation, and children's IQ was explored.

Results: A total of 237 differentially methylated sites, 139 differentially methylated genes and 212 differentially methylated regions were screened by 850K methylation BeadChip. The differentially methylated genes were statistically analyzed and their functions were described. Totals of 70 biological process terms, 15 cell component terms and 24 molecular function terms were screened by GO enrichment analysis between the case and control group. A total of 11 cell pathways were filtered by KEGG enrichment analysis.

Next-generation sequencing verified that there was still statistically significant in the DMR of CALCA, NNAT and MTHFD1 genes from the 9 input DMR in the study. Methylation specific PCR results showed that the methylation level of DMR of NNAT gene in children from the HG was no significant difference compared with children from the LG (P>0.05). After stratified by age, NNAT gene methylation levels in HG children aged 10 and 11 years were significantly lower than those in the LG (P<0.05, respectively). When the concentration of UF was lower than 1.2 mg/L, the methylation level of NNAT gene was decreased with the increase of UF concentration. When the concentration of UF was higher than 1.2 mg/L, the methylation level of NNAT gene was increased with the increase of UF concentration. The mediating effect model analysis did not observe the changes in intelligence level caused by fluoride exposure induced by the methylation of NNAT gene in the whole population. After stratifying the children by age, the mediating effect of NNAT gene methylation was found in the 10-year-old children.

Conclusion: Fluoride exposure may affect the methylation patterns, biological functions and signaling pathways in children's. Specifically, fluoride exposure may change the methylation level of NNAT gene and IQ in children. Methylation of NNAT gene may be an important link in the influence of fluoride exposure on children's intelligence.

Keywords: endemic fluorosis; 850K methylation BeadChip; next-generation sequencing; intelligence; NNAT gene
Geochemical features of environmental components in the distribution area of Kaschin-Beck disease (Transbaikal region, Russia)

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Abstract:
In some regions of Russia and China, Kaschin-Beck disease is widely spread. The etiology of this disease is uncertain and quite complex; therefore, the scientific literature discusses geological, landscape-climatic, geochemical, biogeochemical, alimentary-toxic and other hypotheses. To date, according to majority of investigations etiology of this disease is considered due to biogeochemical features. Among them the most often discussed theories are related to Ca-P (A.P. Vinogradov, P.N. Paley et al.), Ca-Sr (V.V. Kovalsky, V.V. Ermakov et al.), P-Mn (A.V. Voschenko, L.V. Zaiko, N.N. Alexentseva), Se (Chinese scientists, L.V. Anikina, L.P. Nikitina, etc.).

We have studied 12 different components of the environment (soil, surface waters and underground waters, bottom sediments, lichens, mosses, wormwood, poplar leaves, potatoes, children's hair, etc.). Moreover, the effect of the disease was studied on the example of the bones of a domestic pig (Sus scrofa domesticus) that is a new object in biogeochemical investigations. Samples were taken both from the area of the disease and from the background areas where the disease was absent according to the literature data. Chemical composition of the samples was studied using INAA (28 chemical elements) method. A number of objects have been also studied by ICP-MS (62 chemical elements), including domestic pig bone.

The results suggest that the disease is of polyetiological genesis. Landscape and climatic conditions (low temperatures, development of permafrost meadow-marsh and marsh landscapes) plays an important role in its development. They lead to the formation of a geochemical barrier for P, Mn and other elements. The Kaschin-Beck disease is based on the imbalance of the elemental composition of drinking water, soil, local food sources, which cause the flow of chemical elements into the human body.

It is worth highlighting the role of water as the main route of chemical elements. In the studied area we have found the following geochemical features: the high contents of Mn and low content of Ca, Se and I. In some cases, we identified elevated concentrations of phosphate ion, but they are below the MPC. However, the same samples are characterized with high rates of silicon.

Almost all established geochemical features of waters correlate with those established for rocks and soils of the area of Kaschin-Beck disease manifestation (G.S. Butko, N.N. Aleksentseva, V.V., Ermakov, etc.).

Key words: Kaschin-Beck disease, environmental geochemistry, Transbaikal region
Aberrant DNA methylation of Cyclind1, CDK4 and p21 gene is associated with chronic fluoride poisoning

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Abstract:
Endemic fluorosis continues to be a public health problem worldwide, affecting thousands of people. Abnormal osteoblast activation plays a leading role in the occurrence of skeletal fluorosis, and osteoblast proliferation is finely regulated by the cell cycle. The most important cell cycle regulation system of eukaryotic cells is the "Cyclin-CDK-CKI" system. At the same time, aberrant DNA methylation has been shown to be a frequent mechanism to silence cell cycle related genes, and DNA methylation changes have been also used to be early biomarkers for chemical-induced toxic effects. However, limited reports are available on fluoride induced DNA methylation, and the role of DNA methylation of Cyclin-CDK-CKI regulatory network in the skeletal fluorosis is not investigated. Therefore, this study aims to address the epigenetic features of Cyclind1-CDK4-p21 regulatory network in the process of fluorosis. First, we selected a population in the Guizhou province poisoned by fluoride through exposure to burning coal. The fluoride content in their urine was measured, and the levels of expression and DNA methylation of the Cyclind1, CDK4 and p21 gene in their peripheral blood mononuclear cells (PBMCs) were determined. Further, we measured the levels of expression and DNA methylation of Cyclind1, CDK4 and p21 in human osteoblast model of fluorosis. Subsequently, changes after exposure of the cells to 5-AZA-dC were also assessed. The results showed that a positive relationship between fluoride exposure and expression of Cyclin/CDK4, and a negative relationship between fluoride exposure and expression of P21. Further, hypermethylation of the p21 was found in the population exposed to fluoride and NaF-treated osteoblasts. However, no change in methylation status of Cyclind1 and CDK4 gene was observed. Subsequently, to further validate if suppression of the p21 gene was due to aberrant regulation of its hypermethylation, we evaluated the DNA methylation and expression of p21 of cells treated with NaF together with 5-AZA-dC at various concentrations. The results showed that 5-AZA-dC reactivated p21 expression by reversing hypermethylation, which established that aberrant methylation of p21 was involved in fluoride-related toxicity. These results provide new insight into the interplay between DNA methylation of p21 gene and osteoblast proliferation in skeletal fluorosis. Furthermore, the effects of CyclinD1 and CDK4 gene on aberrant proliferation and activation of osteoblasts in fluorosis are worth further exploration.

Key words: Coal-burning fluorosis; Cyclind1/CDK4/p21 gene; DNA methylation; Osteoblast activation

Acknowledgements
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Geochemical characteristics of hot spring water in the metamorphic rock area of southeastern Guizhou and its health care function

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Abstract:
The distribution of geothermal water resources in Guizhou Province is mainly based on the thermal storage of carbonate rocks, mainly concentrated in the central and western parts of Guizhou Province. However, there are large metamorphic rocks in the eastern part of Guizhou Province, and there are many hot springs. Through hydrogeochemical analysis, ion correlation analysis, stable isotope tracing and radioisotope dating, the hydrogeochemical characteristics, environmental isotope characteristics and health care function of hot spring water in the metamorphic rock area of southeastern Guizhou are analyzed. The temperature of hot spring water is 41.8~53.0°C, the pH is 7.7~8.96, and the TDS is 281.9~1103.21. Both are weak alkaline water. The main anions and cations in water are HCO₃⁻ and Na⁺, and the water chemical types are HCO₃⁻-Na. The δD-δ¹⁸O isotope characteristics indicate that the hot spring water sources are all atmospheric precipitation recharge; The δ¹³C_DIC value is -19.32~10.3‰, indicating that the CO₂ involved in the water-rock reaction has both biological and slow source causes; The Sr content in hot spring water is relatively low, 0.01~0.2 mg/L, but the ⁸⁷Sr/⁸⁶Sr value is higher, 0.7178~0.7316, and the ⁸⁷Sr/⁸⁶Sr value (0.716~0.720) range of Sr with silicate weathering source in the world Consistent. The ³H and ¹⁴C isotope ageing test results are compared with the corrected hot spring water age, and the isotope ageing results are too large; The mass concentration ranges of H₂SiO₃, F and Li are 31.2~56.27 mg/L, 0.3~6.0 mg/L, 0.06~1.4 mg/L, respectively. In addition to the individual hot spring water samples, the mass concentrations of Sr, F and Li in the hot spring water have reached the concentration standard of health care, and have certain health care effects. Combined with the comprehensive analysis of hydrogeochemical characteristics and environmental isotope characteristics of hot springs, The water quality of the hot springs in the metamorphic rock area of southeastern Guizhou is good. The water source is the recharge of atmospheric precipitation. After the fracture is infiltrated, it is discharged into the hot spring after the surrounding rock is heated. The hot spring water body is mainly controlled by the dissolution of silicate rock minerals. The CO₂ involved in the water-rock reaction has both biological and slow source genesis, and the hot spring water isotope dating results are too large; The physiotherapy elements in the hot spring water are rich in content, which can create good conditions for hot spring bathing and recuperation.

Key words: metamorphic rock area hot spring water; hot spring water chemistry; environmental isotope; health care function; southeastern Guizhou.
Pollutant Trend and Environmental Health Impacts in an E-waste Recycling Area

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Abstract:

Electronic waste or e-waste describes discarded electrical or electronic devices. E-waste recycling has become a global environmental health issue. Our research focuses on e-waste exposure and children’s health, and early life exposure and disease risk. We here report the temporal trends of heavy metals and persistent organic pollutants (POPs) in biospecimen of neonates and children from Guiyu (e-waste exposed group) and Haojiang (reference group) areas of China between 2004 to 2017. Our results showed that Guiyu children and neonates had significantly elevated heavy metals and POPs, including lead (Pb), cadmium (Cd), chromium (Cr), manganese (Mn), mercury (Hg), Polybrominated diphenyl ethers (PBDEs), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) Perfluorooctanoic acid (PFOA), phthalate esters (PAEs) and Bisphenol A (BPA) level in their blood, urine and other biospecimen than the reference group. Children in the exposed group have alterations in blood composition, neuro-endocrine-immune response, molecular biochemical levels, and impairment in cardiovascular and respiratory systems. Our studies suggest that exposure to improper e-waste recycling in the e-waste exposed area has adversely affected child and infant health and development. This kind of exposure may cause long-term adverse outcomes for health. These alterations and impairments may increase the risk of some chronic diseases such as metabolic diseases, cardiovascular disease, and respiratory disease.

Key words: Human Health, Environmental Pollutant, E-waste, Heavy Metal, Organic Pollutant.
Progress on coal-burning endemic arsenic poisoning in Guizhou Province, China
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Abstract:
Arsenic poisoning caused by the burning of coal in unventilated indoor stoves is unique to China and used to be a major environmental public health concern in the Guizhou Province. A population-based 20-year follow-up study was conducted to systematically study the epidemiological characteristics, health damage, pathogenesis, preventive and control measures of the disease. The results clearly show the significantly reduction of total arsenic level both in external environmental medium (coal, soil, drinking water, air, and corn and chili pepper) and biological samples (urine and hair) in the coal-burning arsenic poisoning (CBAP) region, especially in the latest 10 years. During the past 20 years, the age, duration of consuming high arsenic-containing coal and smoking status were found to be the most significant risk factors for CBAP, and the annual household income had always been an important influence factor. However, the room ventilation and grain drying modes were no longer to be risk factors since 1998 survey. Population with CBAP have multiple organ and multiple system damages such as skin, liver, kidney, lung, and nervous system. And the persistent genetic damage has also been observed (Increased prevalence of DNA single-strand breaks, micronuclei and chromosomal aberrations, and sister chromosome exchanges in peripheral blood lymphocytes). In recent years, the incidence of cancer has shown an upward trend, mainly skin cancer, lung cancer, liver cancer and so on. Further studies have found that oxidative stress (the inhibition of metabolic enzymes, antioxidant enzymes and DNA synthetase; the increasing of DNA oxidative damage marker 8-hydroxy-2-deoxyguanosine), immune inflammation (the reduction of CD3+, CD4+, CD4+/CD8+; the increasing of IL-6, TGF-β, TNF-α; Treg/Th17 imbalance), genetic (GSTT1, GSTO2, ERCC1 and XPD gene polymorphisms) and epigenetic (high-methylation of P53, P16 GSTP1, MGMT, hMLH1, hMLH2, XPD, ERCC1, ERCC2, hOGG1; the change of histone H3K36me3, H4K20me1, H4K20me2 modification levels; increasing of miR-21, miR-145, miR-155 and miR-191 levels), and interfering signaling pathways (including Keapl-Nrf2/ARE, MAPK, PKC/Ca2+/NF-AT and HIF1α signaling pathways) are involved in the pathogenic and carcinogenic processes of CBAP populations. GSTs and As3MT are CBAP susceptibility genes. Serum glutathione S-transferase, hyaluronic acid and urinary microalbumin, urinary N-acetyl-β-D-glucosidase, urinary β2-microglobulin, serum cystatin C are the most sensitive biomarkers for evaluating arsenic-induced hepatocyte damage, liver fibrosis and renal damage, respectively. Moreover, our study demonstrated that selenium, zinc, ginkgo preparation, thorn pear preparation, bamboo fungus polysaccharide, curcumin, etc. have good application prospects for improving arsenic poisoning. The study can provide a scientific basis for a further understanding of the causes of the arsenic-induced multi-organ damage, diagnostic biomarkers for early damage of liver and kidney, and the improvement of prevention and control strategies.

Key words: coal-burning arsenic poisoning; organ damage; pathogenesis; biomarkers; treatment.

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Improving the Accuracy of PAH Source Appraisal: Traditional Versus New Tools
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Abstract:
Source abatement must rely on the ability to identify the provenance of emitted contaminants. Several tools have been used for PAH source appraisal. Most common have been the diagnostic ratios, Principal Component Analysis and other traditional statistical analysis. We added to these traditional tools the evaluation by means of Fuzzi Logic and performed a comparative study using PAH data (47 compounds: parental plus alkylated) obtained for ocean sediments in an oil exploration basin, estuarine and river sediments, suspended particulate matter and PM2.5. The results highlight Fuzzy Logic as an important advance in data treatment, since it successfully incorporates uncertainties in the differentiation among sources and allows perception of natural forces contributing to dispersion and fate. Fuzzy Logic organizes samples in degrees of pertinence among several groups to which it may belong. In the classical statistics of source apportioning a sample is considered to be either petrogenic, pyrolytic, or from natural source. The advantage, therefore, is to consider the environment as it really is, a mixture of overlapping inputs. Even considering the Principal Component Analysis associated with Multiple Linear Regression (PCA-MLR), which is a quantification of relative sources, Fuzzy Logic goes beyond since uncertainty is incorporated in the model. The results obtained so far, compared to usual tools, highlight the advantages of the Fuzzy Logic Approach.

Key words: source appraisal, PAHs, Fuzzy Logic
Medical Geology Study on Typical Physiotherapy Hot Springs in Guizhou, China
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Abstract:
Physiotherapy types of hot springs in Guizhou, investigated by applying geochemical, geological and environmental isotope methods to thoroughly analyse its geochemical characteristics and formation mechanism, are mainly classified into three types, namely type a physiotherapy hot spring with strontium, silicic acid, calcium and magnesium bicarbonate; type B: a physiotherapy hot spring with radon and silicic acid and type C: a silicic acid hot spring. Several hot springs in Guizhou, China, Crystal hot spring in Suiyang County - FoDingshan hot spring in Shiqian County - Guiyu hot spring in Guiyang City (type A), Xifeng Hot Spring (type B) and Jianhe hot spring (type C) was selected for relevant studies on geology and chronic diseases. It is indicated that the component of type A is generated from the weathering of carbonate rocks and the dissolution of sulfate rocks from the Cambrian Tsingshsutung Formation (∈₁q) to the Ordovician Honghuayuan Formation (O₁h), and Strontium as well as Sulfur is mainly generated from the dissolution of gypsum in the reservoir; the component of type B is mainly the weathering of the carbonate rocks of the Sinian Dengying formation (Pt₃₃b∈₁dy); the component of type C is dominated by weathering and dissolution of albite and other silicate minerals in Qingshuijiang Formation (Pt₃₁dq) of Qingbaikou System. According to the epidemiological investigation, compared with those who never had hot spring, hot spring bathers had lower prevalence of cardiovascular and cerebrovascular diseases, hypertension, bone and joint diseases, skin diseases and diabetes mellitus. Furtherly analysis to be found that different typical hot springs were associated with different chronic diseases. Combining analysis with chemo-component characteristic of hot spring and different correlations of health and hot spring bathing, physiotherapy value of hot spring depends on component characteristic of mineral in a hot spring reservoir, which is dominated by rocks and distribution characteristics of mineral assemblages.

Key words: hot spring; medical geology; noncommunicable chronic disease; geochemistry; thermal reservoir
Environment and health risks assessment of artisanal small scale gold mining activities in western part of Nigeria

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Abstract:
This research critically reviewed the state of artisanal gold mining activities in Nigeria, its adverse effects on the environment and associated health hazards especially with regards to the use of mercury for gold processing. Geochemical assessment of stream sediments, soil and water samples within the vicinity of artisanal gold mine sites in both Southwestern and Central parts of Nigeria was carried out using ICPMS to determine concentration of toxic elements and the health impacts on the populace. Results of different contamination indices such as enrichment and contamination factors revealed that soil and sediments in the study areas showed extremely high enrichment with Zn, Mn, Fe, Th, La, Cr, Ti, Sc, Ce, Pr, Nd, Sm, Gd, Ta, Nb and In, significant enrichment with Pb, Co, W, Eu and Dy and low enrichment with Mo, Cu, Ag, Co, V, P, La, Ba, Al, Sn, Y. Potential ecological risk factor (RI) showed that soil and sediments in the study areas fall between low to considerable risk with toxic elements. Ninety percent of both soil and sediment samples showed that Total Health Risk Index (THI) values were above 1 which depicted great potential non carcinogenic health hazard for both young and adults in the study area. Twenty-five percent of the water samples showed pollution index (PI) above 1 with highest contribution (37.8%) from Pb. Mn, Al, Ni, Fe and As contributed 29.3%, 19.13%, 8.66%, 4.25% and 0.82% respectively. The health risk index calculated for toxic elements through both ingestion and dermal exposure showed that 16% of the water samples were within unacceptable risk for non-carcinogenic adverse health effect based only on dermal exposure route and Cr, V, Mn, Sb, Fe and arsenic contributed highest to the risk. Cancer risk showed that only Arsenic exceeded acceptable risk for carcinogenic adverse health risk for children and adults and this make Arsenic to be carcinogenic in the water of the study area.

Key words: Gold; Mining; Health; Mercury; Nigeria.
Health Impacts of Waste Management and Medical Geology

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Abstract:

Modern society produces an enormous quantity of wastes. No matter whether it is ordinary garbage (municipal solid waste), hazardous, medical, electronic, pharmaceuticals and personal care products, or nuclear waste, all have the potential to negatively impact human and ecological health, unless managed properly; which, unfortunately, has not been the case. Despite the large volume of published scientific studies on acute and chronic health problems and deaths caused by careless and uncontrolled disposal of wastes, open dumping of solid, hazardous, and other wastes is common in many countries even today. Of a total estimated quantity of over 2 billion metric tons of municipal solid waste, generated globally in 2016, nearly 0.7 billion tons, or 33%, ended up as dumps, mostly in developing countries—albeit in low-income African countries 93% of the waste was deposited at dump sites. These dumps are frequented by the socially- and economically-disadvantaged people of the society who make their living by picking up any and every marketable material, even food for subsistence. These workers include children and women who sift through the garbage pile, spending long hours without any protection from heat, cold, rain or toxic fumes and other dangerous substances. The unsanitary and hazardous conditions to which the ‘garbage pickers’ are exposed to on a regular basis, result in disease and chronic health problems, in addition to impairment of air, soil, surface and groundwater quality; and harming plants and wildlife in the region. Fires, floods, and landslides that often occur at these dump sites cause additional deaths and injuries. Recycling of electronic wastes and large ships—that is being carried out in several developing countries of the world—has brought to fore yet another serious health and ecological problem, including workers morbidity and mortality, that needs attention.

Solution to health problems associated with waste management requires a multi-disciplinary approach by earth and environmental scientists, health care professionals, social and behavioral experts, administrators, politicians, and legal professionals. The presentation aims at initiating scientific discourse on this important topic that has not been adequately addressed, and to find ways to solve the problem. The presentation also provides an overview of the universe of waste generated in modern society, their potential to cause adverse impact on human and ecological health; along with case studies to highlight the urgent need for serious discussion by medical geology and health science professionals in collaboration with administrators and policy makers to develop workable solutions.

Key words: waste management and health, medical geology, open dumping, garbage pickers, fire and landslide hazards.
Cadmium relative bioavailability in rice: application to predict cadmium urinary excretion and mitigation using dietary mineral supplements

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Abstract:

While numerous studies have examined Cd levels in foods, there is a paucity of direct evidence showing the relationship between food consumption and Cd body burden. In addition, dietary Cd intake is often calculated using total Cd concentration in foods and consumption rate without considering Cd bioavailability. We hypothesized that incorporating of Cd bioavailability in foods to assess dietary Cd intake provides a valuable tool to accurately estimate human Cd exposure using urinary Cd as the biomarker. In this study, paired rice Cd and urinary Cd data was included to assess Cd exposure in a Cd-impacted cohort from Yixing, Jiangsu Province, China. Measured urinary Cd for a cohort of 119 nonsmokers with rice as a staple was compared to predicted values from rice-Cd intake with and without considering Cd relative bioavailability (RBA) in rice based on a steady state mouse kidney bioassay and toxicokinetic model. The geometric mean (GM) of urinary Cd and β2-microglobulin was 1.08 and 234 g g⁻¹ creatinine. Applying Cd-RBA in foods to aggregate Cd intake (41.5±12.4, 48.0±9.3, 48.8±21.3% for rice, wheat, and vegetables), rice was the largest contributor (71%). For 63 participants providing paired urine and rice samples, the predicted GM urinary Cd at 4.14 g g⁻¹ based on total Cd in rice was 3.5 times that of measured value at 1.20 g g⁻¹, while incorporating Cd-RBA to assess rice-Cd intake made the two closer with GM at 1.07 g g⁻¹. The results suggested incorporating Cd bioavailability to assess dietary Cd intake is a valuable tool to accurately estimate human Cd exposure and associated health risk. Since rice is a dominant contributor to dietary Cd intake, especially in Southeast Asia where rice is a staple, developing strategies to decrease Cd relative bioavailability (RBA) in rice may be important to lower Cd exposure and its associated health effects. Since Cd utilizes the same intestinal transporters as Zn, Fe, and Ca in both animals and humans and rice is usually poor in mineral nutrients including Zn, Fe, and Ca compared to other cereals, it was hypothesized that mineral
supplements may have the potential to decrease Cd absorption from food and its accumulation in tissue, i.e., Cd bioavailability. To determine the effectiveness of mineral dietary supplements to modulate cadmium (Cd) exposure, an in vivo mouse bioassay was conducted to determine Cd relative bioavailability (RBA) in a Cd-contaminated rice (0.80 mg Cd kg\(^{-1}\)) with and without Zn, Fe, and Ca supplements as nitrate or chloride salts. Without mineral supplements, Cd-RBA was 43±5.3% using combined Cd accumulation in the liver plus kidneys as the endpoint. Among Ca(NO\(_3\))\(_2\), Zn(NO\(_3\))\(_2\), and Fe(NO\(_3\))\(_2\) supplements, 150–5000 mg kg\(^{-1}\) Ca was the most effective in reducing rice Cd-RBA by 31–80% to 8.5–29%, while 30–200 mg kg\(^{-1}\) Zn supplements were ineffective with Cd-RBA being at 33–57%. Low Fe at <40 mg kg\(^{-1}\) has little impact on rice Cd-RBA (39–47%), while high Fe at 80–200 mg kg\(^{-1}\) decreased Cd-RBA by 37% to 26–27%. The ineffectiveness of Zn supplements in reducing Cd-RBA was probably due to coincident 8.34- and 3.09-fold increases in Zn accumulation in mouse kidneys and liver with Zn supplements, while Ca and Fe supplements led to much lower increase in Ca and Fe accumulation in mouse tissues (1.34–1.59-fold). In addition, compared to Ca(NO\(_3\))\(_2\) supplements, Cd-RBA values determined with CaCl\(_2\) supplements were significantly higher (25–67% vs. 8.5–29%), suggesting chloride enhanced Cd-RBA. Results of this study have important implications for developing effective dietary strategies to reduce dietary Cd exposure and associated health risks in humans.

Key words: Cadmium; Mineral nutrients; Relative bioavailability; Rice; In vivo mouse bioassay
City-wide monitoring and spatial variations of micropollutants in sewage sludge in Xiamen, China

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Abstract:

With the population growth and rapid urbanization, great environmental pressure has been raised in China. The wastewater treatment system has been considered as an effective process to restrict pollutants from entering the receiving aquatic environment via the degradation, transformation or adsorption processes. Large numbers of studies have reported that the sewage sludge was a major sink for a broad range of micropollutants, including pharmaceuticals and personal care products (PPCPs), major and trace amount of elements, and so on. However, the information on the micropollutant distribution with the urbanization is limited. Therefore, the occurrence and spatial variations of micropollutants in sewage sludge from city-wide wastewater treatment plants should be investigated. In this study, the return sludge was collected from seven wastewater treatment plants in Xiamen City, China. 49 PPCPs were pretreated by using ultrasonic extraction followed solid phase extraction, and then analyzed by liquid chromatography triple quadropole mass spectrometry. 52 major and trace elements were pretreated by using acid digestion and then analyzed by inductively coupled plasma optical emission spectrometry or inductively coupled plasma mass spectroscopy. In addition, geochemical fractionations of heavy metals in sewage sludge samples were sequentially extracted using sequential extraction procedure.

In the case of inorganic pollutants, 48 elements were detected with concentrations ranging from mg kg\(^{-1}\) (Re) to g kg\(^{-1}\) (Fe) on the basis of dry sludge weight. Sequential extraction procedure showed that residual and oxidizable fractions were the main geochemical fractions of most studied elements. However, Ca, Mn, Sr, and Ni were mainly bound to acid-exchangeable fractions, while Fe, Zn, Cd, Cr, Co, and V were mainly distributed in the reducible fractions. In the case of organic micropollutants, 41 PPCPs were detected in the sludge while antibiotics and antimicrobial agents showed highest abundance. The network analysis indicated the strong co-occurrence of PPCPs or elements in the sewage sludge due to the similar usage, properties, disposal and environmental behavior. In addition, spatial variations of both PPCPs and inorganic elements were observed, which mainly due to the composition of wastewater source (domestic or industrial wastewater) and the processes of the wastewater treatment plants. Although the PPCP mass loads in the wastewater were significantly positively correlated to the urbanization levels, no significant correlation was observed between micropollutants in sewage sludge and urbanization. Results from the present study indicated the occurrence of a broad range of organic and inorganic micropollutants in the sewage sludge. Therefore, the sludge disposal strategy should be well organized to limited environmental risks of the micropollutants.

Key words: Sewage sludge; PPCPs; major and minor elements; spatial variations
Toxicological significance of methylation and sulfurization in the metabolic process of inorganic arsenics: Active species caused by metabolic redox and molecular aspects of redox homeostasis in cell transformation

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Abstract:

Although inorganic arsenics such as arsenite and arsenate are known to be carcinogenic for skin, lung and urinary bladder, the carcinogenic mechanisms of arsenics so far remain obscure. In our research directing our attention to not only inorganic arsenics but also their metabolites, we have demonstrated that oral administration of dimethylarsinic acid [(CH3)2AsO(OH), DMAV], a major metabolite of inorganic arsenics, in humans induces DNA damage with oxidative stress for skin. On the other hand, in recent arsenic research, trivalent dimethylated arsenic like dimethylarsinous acid [(CH3)2AsOH, DMAIII] that may be metabolically reduced from DMAV has attracted considerable attention from standpoint of arsenic carcinogenesis because of its high cytotoxicity and genotoxicity by reactive oxygen species (ROS) produced in a redox reaction between DMAIII and DMAV. Furthermore, dimethylmonothioarsinic acid [(CH3)2AsS(OH), DMMTAV], a sulfur-containing metabolite of DMAIII and DMAV, has also been noted because of its higher toxicity, similarly to that of DMAIII. In the present session, we would like to talk about the metabolic process associated with the methylation of inorganic arsenicals, the subsequent metabolic sulfurization, and the chemical properties of their intermediate active metabolites. We would also like you to interest in our recent study regarding a possible cell-transformation mechanism based on the redox modification with arsenite.

Key words: arsenic;methylation;sulfurization;redox;transformation
The Importance of Guizhou Province, P. R. China to Modern Medical Geology

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Abstract:

Guizhou Province, P. R. China and scientists from this region have played a central role in the emergence of modern medical geology. The impacts of geologic materials and processes on human health have been recognized for centuries with Chinese scholars among the earliest to recognize the importance of these relationships more than a thousand years ago. However, the formalization of medical geology as a scientific discipline can be trace back to work done on Zheng Baoshan and his colleagues and students starting in the 1970s in Guizhou Province. Because of the geology, agrarian lifestyle, economy, and remoteness of the province large segments of the population were exposed to unusually high concentrations of naturally occurring trace elements resulting in multiple health issues recognized as such by Zheng Baoshan and his colleagues. In 1996 Zheng Baoshan invited a contingent of U.S. scientists to visit Guizhou Province to see these health problems that included arsenic poisoning, fluorosis, selenosis, thallium poisoning, possible mercury exposure, and other environmental health issues. This visit ultimately resulted in a series of medical geology short courses and workshops and conferences in North and South America. This, in turn, lead to medical geology short courses presented globally, the formation of the International Medical Geology Association and several other organizations devoted to geology and health, the MedGeo conferences, a series of books on medical geology, including a Chinese translation by Zheng Baoshan and Wang Binbin of Guizhou Province, Without Guizhou Province and Zheng Baoshan it is doubtful that modern medical geology would have evolved into the robust discipline that it is today.

Key words: medical geology, Guizhou Province, Zheng Baoshan
Environmental and social costs of current mining activities and the need for more sustainable practices

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Abstract:
Mining industries are a pillar for the functioning of modern societies through provision of commodities ranging from fossil fuels (coal, oil, gas), to essential metals (copper, iron, tin, aluminum, etc.), rare earths to modern electronics (tantalum, niobium, etc.), and radioactive metals (uranium, thorium). Past mining has been one of the human activities most devastating to the environment and the ever growing quest for raw materials and energy sources continues. Lessons from the past are to be learned and future directions are to be identified yet. Furthermore, today mining is also facing the additional challenge to adapt to climate changes.

Past mining activities, in particular in the last two centuries, caused vast devastation particularly due to lack of good waste management practices, impacts on public health, and contamination of natural resources such as water and soils. These have generated heavy economic and social costs and left unresolved legacies in many regions.

At the present there is acceleration in international concentration of mining companies and in the opening of new grounds for exploration and mining (in Central Asia, Africa, at the ocean floor, hydrothermal sources, etc.). At the same time, in many countries there is a lack of adequate mining laws and regulations for the mining sector. For example, many current mining projects do not have plans for environmental restoration after the mine closure and regarding the upcoming ocean floor mining there is a total lack of regulations. Notwithstanding, the global impacts of many of these projects may impinge on natural resources essential to life and thus ecosystems may be compromised. Several sectors of mining, such as oil and gas, metals, and uranium, are reviewed herein to introduce occupational and environmental hazards and provide examples of unsustainable practices.

There is an urgent need to define future directions in mining activities such as to introduce the life-cycle concept of mines; to introduce mining laws and regulations in developing countries; to protect natural resources and public health; to enforce good mining practices including waste management plans, and provisions for funding environmental restoration work after mining; and to adapt mining to climate change (waste dams failure, freshwater and groundwater contamination, sea level rise and waste dumps, etc.). Moreover better practices are needed to ensure sustainability of mining, while protecting the environment and human life.

Key words: natural resources, mining, environmental impacts, ecosystems, sustainability.
A comparative study of the physicochemical properties of natural zeolites from Cuba and Mexico for oral and topical applications in human beings

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Introduction

Natural zeolites as microporous crystalline aluminosilicates, found over the past decades increased interest in applying as active ingredients in human and veterinary supplements. They are used either in oral supplements for endogenous well-being or in topical application for skin care treatments (Rodríguez-Fuentes et al. 1997; Rodríguez-Fuentes et al. 2006; Colella 2011; Laurino and Palmieri 2015; Cerri et al. 2016; Torres et al. 2019). Zeolites of natural occurrence are composed of different crystal lattices and the most common one in medical application is clinoptilolite. However, the mixture of clinoptilolite and mordenite as found in the Cuban zeolite is efficient for medical use (Selvam et al. 2014). In the present investigation, we have focused on the effects of particle size, mineralogical composition and histamine binding capacity of two natural zeolites from Cuba and Mexico; and the oral application of Cuban zeolite as contemporaneous drug in bowel movements caused by neuroendocrine tumors as well as the topical application for skin care treatment by a special paste formulation.

Experimental Methods

The zeolites used in the present study were procured from Cuba, San Andrés (particle sizes: ± 3 µm and ± 40 µm) and Mexico, Mina San Francisco, San Felipe, Guanajuato (particle size: ± 20-150 µm). The X-ray diffraction (XRD) patterns of the samples were recorded on a Philips X-ray diffractometer using Cu-Kα radiation. The XRD patterns were collected in the 2θ range between 2-50° (step size: 0.03°; time per step: 10 s; total scan time: 270 min). The morphology of both zeolites was studied using an environmental scanning electron microscope (FEI Quanta 200). The BET surface areas and total pore volumes of the samples were determined by an automated nitrogen adsorption analyser (Quantachrome Instruments) at 77 K. Prior to the sorption measurements, all the samples were pre-treated under high vacuum at 250 °C for 12 h.

Histamine binding studies of Cuban and Mexican zeolites were carried out as reported previously (Selvam et al. 2014). Typically, 3 g of zeolite sample was dispersed in double distilled water (100 ml) in a polypropylene bottle, and then histamine (0.3 g) was added into the above mixture, and the mixture was incubated in a mechanical shaking (90 cycles per min) water bath at 36 °C for 2 h. The histamine uptake was monitored by taking small aliquots at different intervals, filtered, dried and analyzed by thermogravimetric (TG-DTA) analysis (TA instruments SDT 2960) at 10 °C/min from room temperature to 900 °C under air atmosphere. The difference in weight loss between histamine loaded and pure zeolite samples in the temperature range of 350-600 °C was considered as the amount of histamine uptake by the respective samples.

Results and Discussion
As revealed by XRD, Mexican zeolite contains only the medium-pore 10-membered ring zeolite clinoptilolite, while the Cuban zeolite contains additionally the large-pore 12-membered ring zeolite mordenite (Selvam et al. 2014). Cuban zeolites exhibit high BET surface areas and total pore volumes in comparison to the Mexican ones as shown in Table 1, due to their different mineralogical compositions. Furthermore, the histamine uptake capacity of both zeolites having smaller size particles is significantly higher than those larger size particles (Selvam et al. 2018).

Table 1. Textural properties and histamine uptake capacities of Cuban and Mexican zeolites having different particle sizes.

<table>
<thead>
<tr>
<th>Zeolite</th>
<th>Particle size (µm)</th>
<th>BET surface area (m² g⁻¹)</th>
<th>Total pore volume (cc g⁻¹)</th>
<th>Histamine uptake (mg/g zeolite) at different incubation time intervals</th>
</tr>
</thead>
</table>
| Cuban   | ± 3               | 98                       | 0.220                    | 15 min: 16.3
|         |                   |                          |                          | 30 min: 18.8
|         |                   |                          |                          | 60 min: 19.9
|         |                   |                          |                          | 120 min: 22.4
| Cuban   | ± 40              | 119                      | 0.199                    | 15 min: 7.3
|         |                   |                          |                          | 30 min: 13.7
|         |                   |                          |                          | 60 min: 16.0
|         |                   |                          |                          | 120 min: 15.7
| Mexican | 20–100            | 30                       | 0.182                    | 15 min: 4.4
|         |                   |                          |                          | 30 min: 9.0
|         |                   |                          |                          | 60 min: 9.5
|         |                   |                          |                          | 120 min: 10.2
| Mexican | > 150             | 31                       | 0.154                    | 15 min: 4.1
|         |                   |                          |                          | 30 min: 6.6
|         |                   |                          |                          | 60 min: 5.7
|         |                   |                          |                          | 120 min: 5.7
| Mexican | as received       | 30                       | 0.145                    | 15 min: 6.0
|         |                   |                          |                          | 30 min: 5.6
|         |                   |                          |                          | 60 min: 6.9
|         |                   |                          |                          | 120 min: 6.5

Another important biogenic amine is serotonin, well known as the ‘hormone for fortune’ in the brain, but excessive peripheral blood levels (caused by neuroendocrine tumors, usually known as “carcinoids”) provoke amongst others severe diarrhoea. Zeolite clinoptilolite has already been proven as an effective anti-diarrheic drug (Rodríguez-Fuentes et al. 1997); and zeolite powder (Detoxsan® Pulver) has recently been applied to patients suffering from severe diarrhea. The clinical results show that about 70% of patients benefit from taking Detoxsan® Pulver for reducing bowel movements from numerous defecations to normal level – and thereby increasing significantly living quality. The roles of different biogenic amines and their interactions with zeolites will be discussed in detail.

Zeolite paste (Detoxsan® Paste) is based on petrolatum, contains additionally squalane as natural lipid component, adheres to the skin surface and forms a thin mineral layer, which is able to fulfill its properties as adsorbent. The positive effect on skin irritations by Detoxsan® Paste seems to be due to significant amounts of adsorption of histamine (inflammation promoter) and water (prerequisite for microbial growth), and can also be used effectively in skin affected by mycosis, intertrigo and psoriasis (Torres et al. 2019).
Medical Geology: the essential and most neglected aspect of Public Health System in Developing Countries-Examples from Ghana

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Abstract:
Inadequate information linking geology and health in developing countries particularly Ghana contributes immensely on the challenges to identify sources and causes of many emerging diseases. Though relationship between doses of trace element ingested, inhaled or absorbed through dermal contact controls human health. Possible health outcomes based on elements uptakes through any of the pathways during exposure is demonstrated by 2868 soil geochemical samples analyzed at field sheet 0503 B areas. The samples were sieved to < 106 µm fraction and analyzed for elements, As, Ba, K, Zn, Co, Cr, Cu, Mn, Ni, Pb, Mg and Fe by XRF technique and Au by Fire Assay method. Some community soils were depleted of essential elements whilst others were enriched with harmful elements or both. Results showed geospatially the disease-causing elements hotspots and cold spots.

The study identified disparities in averages of As, Cr, Fe and Mg, which resulted in enrichment and deficiencies when compared with the worldwide background average. The measured averages for As and Cr were 17.27 mg/kg and 89.25 mg/kg respectively for the entire area. Both averages exceeded the worldwide background values of 10 mg/kg and 8 mg/kg of As and Cr. The four traditional towns with varied activities recorded As concentrations ranging from 6.11 mg/kg at Samreboi, 16.29 mg/kg at Asankragwa, 17.42 mg/kg at Akropong and 25.99 mg/kg at Bogoso. Principal component analysis revealed a good association among Ba, Cr, Cu, Fe, K, Ni, Pb, and Zn in Group 1, and their main source was interpreted as the underlying geology. Arsenic, Cr, and Mg in Group 2 show a relatively weak correlation, and their sources were ascribed to a combination of geologic and anthropogenic sources. Gold had a good correlation with As, which was associated with the hydrothermal veins in the underlying rocks. The spatial plots generated from transformed soil data by Getis Ord Gi\textsuperscript{*} treatments visually showed clearly geographically the hotspots and cold-spots of elements that cause diseases.

Proper treatment of environmental diseases that can affect millions of people essentially should start form source identification magnitudes of elements concentrations and distributions, exposure degrees and pathways but these are wantonly neglected. Meanwhile diseases at a place particularly from the natural environment are best identifiable with medical geology knowledge. This discipline collaborating with medical scientists including Public Health workers can outline and define elements- causing- disease hotspots to stop many of the public health disease outbreaks.

\textbf{Key words:} Disease hotspots, Elements, Exposure, Concentration levels, Geospatial
External radiation hazard and radium equivalent activity index of the Sogut plutonic rocks (Turkey)

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Abstract:

The aim of this study was to determine the external radiation hazard ($H_{ex}$), radium equivalent activity index ($B_{aeq}$) concentrations of the Sogut plutonic rock samples. The plutonic samples were measured by a gamma-ray spectrometer in the physics laboratories at Akdeniz University. According to the measured values, the min-max external radiation hazard index ($H_{ex}$) values and radium equivalent activity index ($B_{aeq}$) values in the plutonic samples were found as 0.15-1.24, 58.27-461.14, respectively.

The $H_{ex}$ values (<1) and $B_{aeq}$ values (370 Bq/kg) of the Sogut plutonic rocks were calculated and compared with the world mean values. According to these values, the $H_{ex}$ and $B_{aeq}$ values are lower than world mean values in ST-52, ST-80, ST-89 Sogut plutonic samples, whereas $H_{ex}$ and $B_{aeq}$ values are higher than world mean values in ST-1, ST-59, ST-87 Sogut plutonic samples.

Keywords: Sogut plutonic rocks, Gamma-ray spectrometry, External radiation hazard ($H_{ex}$), Radium equivalent activity index ($R_{aeq}$), Turkey
Water and Human Health
Medicinal Potentials of Evaporites (Kanwa) from Lake Chad Basin

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Abstract:

Evaporites locally known as kanwa have become multipurpose salts in most rural and urban homes of Nigeria and other West African Countries. A survey was carried out in some parts of Kaduna state of Northern Nigeria to document the applications of evaporites in traditional medicine and local industries with the view to identify candidate substances that could be useful in drug development. The outcome of the study showed that the Hausa and Fulani communities of Northern Nigeria have been practicing/using evaporites for centuries as medicine, tanning agents, preservative and for veterinary purposes. Among the samples of kanwa collected during the survey, farar kanwa, jar kanwa, ungurnu, manda and dutes-dan-Libya were found to be most popular medicinal salts. Health conditions managed traditionally using these substances include gastrointestinal tract (GIT) problems, skin infections, ulcers, wounds, pains and for expulsion of helminths in animals. The users and marketers of kanwa claimed that the substances are safe and efficacious. Elemental analysis showed that the minerals are rich in Na, K, Ca, Mg Fe and Zn among others. Preliminary studies have indicated that farar kanwa, jar kanwa, ungurnu, manda and dutes-dan-Libya are relatively safe with oral LD₅₀ greater than 2000 mg/kg body weight. Evaporite deposits are believed to be found in abundance in Northeastern Nigeria, Niger Republic, Chad basin and Sudan.

Keywords: minerals, evaporites, kanwa, Hausa, Fulani
Geochemical and bacteriological evaluation of ado-awaye suspended lake in iseyin area, oyo state, southwestern nigeria

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Abstract:

This study was aimed at investigating the geochemical and bacteriological quality of Ado-Awaye suspended lake in Iseyin area of Oyo State, Southwestern Nigeria. Water samples were collected from four sampling points and analysed for physico-chemical, bacteriological properties following standard methods while heavy metal, trace metal and rare earth element (REEs) were analysed at the Activation Laboratory in Canada using Inductively Coupled Plasma Mass Spectrometry (ICPMS). Data collected were subjected to both descriptive and inferential statistics using MS Excel and SPSS statistical packages. The values of the physico-chemical parameters analysed are as follows: pH(7.27–8.78), temperature (29.6–30.78°C), electrical conductivity(20.20–26.23μS/cm), TDS(10.13–13.46mg/L), TSS(16.13–17.12mg/L), total hardness(17.86–22.00mg/L), Ca(12.66–18.66mg/L), Mg(3.33–6.00mg/L), Na(4.00–5.00mg/L), K(2.00–2.66mg/L), HCO$_3$-(1.03–2.66mg/L), Cl(13.66–25.66mg/L), NO$_3$-(0.11–0.54mg/L), SO$_4$(2.95–16.07mg/L), PO$_4$-(0.04–0.45mg/L), COD(20.16–59.00mg/L), DO(2.04–2.26mg/L), BOD(6.30–12.36mg/L), CO$_2$(0.40–1.63mg/L) and NH$_3$(0.22–0.39mg/L). Variation of heavy metals analysed ranges as follows: Pb(0.78–10.10μg/L), Al(267.00–37100.00μg/L), Cr(4.97–9.99μg/L), Mn(51.50–82.90μg/L), Fe(390.00–670.00μg/L), Co(0.04–0.38μg/L), Zn(4.99–13.30μg/L), Mo(0.99–1.99μg/L), Ag(1.98–3.98μg/L) and Cd(0.09–0.24μg/L), Trace metals analysed included: Li(9.99–20.00μg/L), Be(0.99–2.00μg/L), Ti(1.00–9.00μg/L), As(0.30–0.60μg/L), Se(1.99–3.98μg/L), Rb(2.96–3.95μg/L), Sb(0.10–3.77μg/L), Ba(14.00–35.60μg/L), and REEs analysed ranges as follows: La(0.01–0.45μg/L), Ce(0.01–1.97μg/L), Pr(0.01–0.09μg/L), Nd(0.01–0.44μg/L), Sm(0.01–0.05μg/L), Eu((0.01–0.02μg/L), Bacteriological analysis indicated total coliform count ranging from (1.60–1.80) and Enterichia coli count (0.30–0.66).

Results showed that majority of the water quality parameters fell within the permissible limits of WHO and SON, and were comparable with results from non-polluted African lakes. Thus, it was concluded that the lake water in Ado-Awaye can be used for various domestic and industrial purposes but must be treated before consumption.

Keywords: Lakewater, Geochemical, Bacteriological, Ado-Awaye, Quality
Evaluation of Iron (Fe) Load in Ingested Groundwater and the Health Risk Assessment in Dumpsite Environment

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Abstract:

Depending on the quantity, iron (Fe) could be beneficial or detrimental to human health. Iron overload in groundwater has been reported in dumpsite environment in Benin City, southwestern Nigeria. Excess iron in human system can cause gene mutation, hemochromatosis, kidney and reproductive dysfunction as well as mental retardation. The study was aimed at using integrated hydrogeological and geochemical data as well as structured questionnaires to evaluate groundwater quality and the level of exposure to health risk of iron in the groundwater around Asoro, Ikhueniro and Otofure dumpsites in Benin Metropolitan City. Fifteen (15) groundwater samples were obtained from borehole (five in each site) to evaluate the groundwater quality while nine (9) borehole litho logs was also obtained to determine the subsurface geology and groundwater flow direction in the study area. Water samples were analyzed following American Public Health Association procedures while the health risk was calculated based on World Health Organization (WHO) and National Research Council (NRC) recommendation. The results show that iron in the groundwater has mean values of 0.54 ± 0.46 mg/L to 5.82 ± 1.93 mg/L. The litho logs revealed that the study areas were capped with red tropical soil followed by medium to coarse grained size and in some part, clay to silt. The dumpsites were dominated with plastic wastes, ferrous and none ferrous waste, chemical containers and sewage sludge. It was observed that the level of exposure to health risk R > 1 was high with all population class examined at risk. The study confirmed that indiscriminate dumping of wastes in open dumpsite can adversely affect the quality of groundwater and put the health of the consumers at high risk of infection diseases.
Hydrochemical factors of groundwaters in Ukraine and their impact on public health

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Abstract:

Geological environment affects human health in the following directions: surface and underground hydrosphere, landscape-geochemical and geophysical spheres, geodynamic and techno-natural processes. Problems relating to quantitative, qualitative, environmental and other aspects of water resources, especially of drinking quality, are extremely important. In general, hydrosphere affects human body through the upper respiratory tract, digestive tract and skin. Decisive factor that affects health and living conditions of the population is chemical composition of drinking water with appropriate quality. In big cities throughout Ukraine groundwaters to a depth of 15–20 m, and subsurface aquifers to 100 m are mainly contaminated and unsuitable for drinking without special measures of water treatment. An alternative source of drinking water supply of Ukrainian population is pressure groundwater, which are protected from direct contaminants and include stable in time chemical composition. However, an aspect that attracts the attention of experts is the specificity of chemical composition of groundwater aquifers in Ukraine and impact of regional characteristics of the quality composition of drinking groundwater on public health.

Drinking groundwaters within the Transcarpathian Interior Trough are characterized by excess of calcium (which can lead to D-hypervitaminosis), manganese, sulfur and shortage of water bromine, molybdenum, zinc, copper, iodine (which leads to endemic goiter), fluorine (leads to tooth decay, that’s why it is recommended to fluoridize drinking water, consume iodized salt, F-rich food). Carpathian Foretrough groundwaters are characterized by shortage of calcium, high content of strontium, chromium, molybdenum, copper and absence of iodine and fluorine, as it is in Carpathian Fold-Mountain Region.

Within South-Western Margin of East-European Platform there are regions with Ca-rich groundwater areas, and those where Ca content is negligible (lack of calcium causes osteoporosis, rachitis); The content of F is extremely negligible in water, sometimes F is absent, while in zones of tectonic faults drinking water is enriched...
with fluorine, bromine, iodine. Waters of the Black Sea Basin (Odessa Oblast) are characterized by low background content of fluorine (up to 0.4 mg/dm³). High content of fluorine chemical elements (up to 7 mg/dm³) strontium are also confined to zones of tectonic disturbances. The waters of Dnieper-Donets basin are characterized by an increased content of fluoride, total iron and index of dry residue with low calcium and magnesium content and significant number of chlorides. In the waters of Donbas there is an excess of boron, zinc and abnormal content of heavy metals that is associated with man-made load. In the waters within the Ukrainian Shield a high content of radon was recorded; an increased mineralization level is observed in fault zones. Deficiency or excess of chemical elements in drinking waters and consumption of drinking waters, which are characterized by mineral composition disbalance, may arise as negative factors affecting the population health. Hydrogeochemical processes in geological environment determine the state and interconnections in the system “geological environment–human”. Some territories in Ukraine require the development of medical and hydrogeochemical models, based on mineral disbalance of groundwater. In order to provide qualitative drinking groundwater it is necessary to solve a number of issues, in particular to improve monitoring of river contamination within Prypiat and Dnieper basins, in consequence of the Chernobyl catastrophe; to improve control over wastewater contamination of underground aquifers and to develop requirements for the use of land plots, where the groundwater deposits occur.
Hydrochemical assessment of impacts of artisanal mining on groundwater quality of Awo and Ede, Southwestern Nigeria

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Abstract:

Pegmatites around Awo, in southwestern Nigeria, were found to contain economic minerals such as beryl, tourmaline, tantalite, columbite and clay. Artisanal mining activities have been carried out in the area to exploit these mineral resources. Artisanal mining is a major contributor to environmental pollution including groundwater contamination. Thus, groundwater quality is usually at risk in areas where artisanal mining activities are being carried out. The restoration of the contaminated water to its natural composition is difficult and very expensive, hence regular monitoring of water sources is necessary. Few studies have been carried out to assess the impacts of artisanal mining on the groundwater quality in Nigeria. This study, therefore, aims at assessing the possible impacts of the artisanal mining of pegmatites of Awo area on the hydrochemical quality groundwater of the mining district and its possible dispersal across neighbouring areas like Ede. Fifty-nine (59) groundwater samples from the mining district and its environs were collected and analysed. Major anions and heavy metals concentrations were determined using Atomic Absorption Spectrophotometry, while major anion concentrations were determined using Colorimetry and Titrimetry. Physical parameters (Temperature (°C), pH, EC (µS/cm) and TDS (ppm)) were measured in-situ using a Portable pH/EC/TDS/Temperature HI9813-6 meter. The groundwater has modified its chemistry from the weathered materials derived from the underlying bedrocks. The concentration of the cations in the study area is in the order of Na+>K+>Ca2+>Mg, while that of anions is HCO3->Cl->NO3->SO42->PO43->CO32-. The concentrations of the heavy metals, Pb, Cd, Cr, Mn, Cd, Zn and Cu were all below the WHO permissible limit in groundwater thus making the water potable for drinking. Whereas 7 samples had concentrations of Mg greater than the required NSDQW limits. Irrigation quality assessment using the indices of Magnesium Ratio, Sodium Adsorption Ratio, Kelly Ratio, Permeability Index, Residual Sodium Carbonate, and Electrical Conductivity also revealed that the groundwater of the study area is
generally good for irrigation except for some cases of high magnesium recorded in about half of the samples which can hamper irrigation. The average values of pH (6.47), EC (0.41 µS/cm), TDS (277.29 ppm), and average ionic concentrations in mg/L {Ca²⁺ (13.56), Mg²⁺ (10.89), Na⁺ (23.59), K⁺ (27.15), HCO₃⁻ (41.82), Cl⁻ (32.91), NO₃⁻ (11.98), SO₄²⁻ (1.05), Fe²⁺ (0.01), Mn (0.06), Zn (0.04); CO₃⁻, Cu, Cd, Pb, Co, Cr (0)} of the groundwater samples from the mining districts in Awo area and its environs showed no significant difference from the average concentrations of samples from the other parts of the study area with average values of pH (6.51), EC (0.47 µS/cm) TDS (322.79 ppm), and average ionic concentrations in mg/L {Ca²⁺ (16.98), Mg²⁺ (10.72), Na⁺(25.60), K⁺(20.58), HCO₃⁻ (73.15), Cl⁻(44.75), NO₃⁻ (6.48), SO₄²⁻(0.85), Fe²⁺ (0.14), Mn (0.08), Zn (0.01); CO₃⁻, Cu, Cd, Pb, Co, Cr (0)}. However, bicarbonate ion got significantly introduced into the groundwater system during transportation due to ion dissociation resulting from CO₂ charge-recharge to produce bicarbonate ions.

Most ion concentrations thus show that the groundwater of Ede and Awo is low mineralized, chemically potable, within WHO standards and suitable for irrigation. Artisanal mining has not impacted the groundwater.

**Keywords:** Artisanal mining, Groundwater contamination, Pegmatites, Ede, Awo
Synthesis of Manganese Dioxide with Different Morphologies for Thallium Removal from Wastewater

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Abstract:

Manganese dioxide (MnO₂) with different morphologies (rod-, wire-, tube-, and flower-like) was synthesized via hydrothermal method and then applied for thallium (Tl) removal from wastewater. At short reaction time (6 h) and low temperature (110 °C), it is prone to form multi-crystalline flower-like MnO₂, while long reaction time (24 h) and high temperature (240 °C), it is inclined to form multi-crystalline wire-like MnO₂; moderate reaction time (12 h) and low temperature (120 °C/140°C) lead to form mono-crystalline rod- and tube-like MnO₂, respectively. Wire-like MnO₂ is the most effective adsorbent for Tl removal from both the synthetic and industrial wastewater, followed by the flower-like, rod-like and tube-like MnO₂. Effective Tl removal (99%) can be achieved with wire-like MnO₂ at an initial pH of 6, and adsorbent dosage of 0.25 g/L. The adsorption can be described with the pseudo-second order kinetic, and can be well fitted with Freundlich isotherm, with the maximum adsorption capacity of wire-like MnO₂ for Tl of 361.9 mg/g. Based on the XRD, SEM-EDS, FT-IR, and XPS analyses, the removal of Tl using wire-like MnO₂ is primarily due to surface complexation and oxidative precipitation. Overall, wire-like MnO₂ is a highly effective adsorbent for the removal of Tl (I) from both synthetic and actual wastewater.

Keywords: manganese oxide; thallium; adsorption; wastewater; heavy metal;
Geochemical analysis of groundwater from shale aquifer in arimogija area of ondo state, southwestern nigeria

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Abstract:

Shale is known for ages as an aquitard. However, for shale to be an aquifer it must have undergone fracking. This therefore makes the groundwater in shale aquifer to be liable to contamination, methane pollution and exposure to toxic chemicals. This study assessed the geochemical and bacteriological level of groundwater in the shale aquifer of Arimogija Area of Ondo State, Nigeria. A total of twenty (20) hand-dug wells was collected and analysed for physico-chemical, bacteriological, cations and anions using standard methods, its suitability for irrigation purpose was also determined. Data collected from hand-dug wells in the study area were subjected to simple descriptive and inferential statistical analysis. The results of the physical and chemical analysis were obtained in the following range: pH (5.99 – 8.16), temperature (27.90 – 30.13 °C), electrical conductivity (203.33– 583.33 μS/cm), total dissolved solids (98.33-283.33 mg/L), sodium (5.60-32.55 mg/L), potassium (0.90-15.23 mg/L), calcium (1.60-60.80 mg/L), magnesium (24.40-67.08 mg/L), sulphate (0.007-0.21 mg/L), bicarbonate (45.30-134.00 mg/L), chloride (70.60-127.50 mg/L), nitrate (1.51-32.35 mg/L) and phosphate (0.03-0.42 mg/L). The bacteriological result values range as follows: total coliform count (160-370 cfu/mL) and the dominant bacteria type are Escherichia coli, Enterobacteraerogenes and Bacillus subtilis, for irrigation water quality parameters the values are: Sodium Adsorption Ratio (SAR) (0.15-0.93 meq/l), Soluble Sodium Percentage (SSP) (4.64-25.73 %), Residual Sodium Bicarbonate RSBC (-0.26-1.80 meq/L), Permeability Index PI (18.10-59.56 meq/L), Magnesium Adsorption Ratio MAR (56.05-98.51 meq/L) and Kelley’s Ratio KR (0.04-0.30 meq/L). Results showed that most of the measured parameters fell within the maximum acceptable standards set by the World Health Organization (WHO) except for magnesium content and magnesium adsorption ratio, which were higher than the acceptable limit for drinking water and suitability for irrigation purpose, respectively. In order to ensure suitability of water samples for drinking purposes, treatment of the groundwater is recommended before consumption.

Keywords: Bacteriological, Hand-dug, Irrigation, Shale, Aquitard and Aquife
Removal of thallium(I) from wastewater by titanate nanomaterials: Behaviors and mechanisms
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Abstract:
Thallium (Tl), a toxic and non-essential trace metal to organisms, occurs widely in the natural environment. Toxicity studies have verified that Tl is highly toxic to humans and many other aquatic organisms, since Tl\(^+\) has biogeochemical properties similar to K\(^+\) and can be indiscriminately assimilated and bioaccumulated. Therefore, Tl has been added to the list of priority metallic pollutants owing to its high potential cytotoxicity and genotoxicity to the human body. Due to the more thermodynamically stability than that of Tl(III), Tl(I) is usually the predominant species in natural water and industrial wastewater, and the cleanup for Tl(I) from the environment is of significance and necessity.

Titanate nanomaterials (TNMs) with excellent ion exchange ability are applied to remove heavy metals from contaminated water. Herein, TNMs were synthesized via a hydrothermal reaction at different temperatures and times, and used to remove Tl(I) from solutions. Results indicated that TNM prepared at 130 °C was nanotubular, while prepared at 180 °C was nanowire-like. These TNMs exhibited excellent Tl(I) adsorption capacities and wide pH and temperature application ranges but different adsorption kinetics. High concentrations of K\(^+\), Na\(^+\) and Ca\(^{2+}\) significantly influenced Tl(I) interactions with TNMs. The inhibiting effect of coexisting heavy metal ions followed the sequence Pb(II) > Cu(II) > Cd(II) > Zn(II), and TNMs preferentially adsorbed Pb(II) over Tl(I) due to the lower separation factor \(\alpha\) value. High Tl(I) uptake mainly depended on complexation with –ONa functional groups in the interlayers and Ti–OH on the surfaces of TNMs as well as ion exchange with Na\(^+\)/H\(^+\). TNMs are promising for potential applications in efficient Tl(I) elimination from wastewater, especially tubular TNM synthesized at 130 °C for 6 h due to cost and time savings.

Key words: thallium; titanate nanomaterials; adsorption behavior; mechanism
Factors influencing the distribution of arsenic, fluorine and iodine in shallow groundwater in the oasis zone in the southern margin of the Tarim Basin in Xinjiang, P. R. China

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Abstract:
To investigate the distribution of arsenic, fluorine and iodine in shallow groundwater in the southern margin of the Tarim Basin, and discuss the causes of enrichment of groundwater with these elements, 302 shallow groundwater samples were collected in the oasis zone of the southern margin of Tarim Basin (Moyu County-Ruoqiang County) from 2014 to 2017. The chemical indexes, including pH, Eh, total hardness, TDS, K+, Na+, Ca2+, Mg2+, Cl-, SO42-, HCO3-, F-, As, I-, total dissolved Fe and Mn, etc, were determined. We use hydrogeochemical and mathematical statistics methods in our data interpretations. Results show that groundwater pH values varied from 7.60 to 10.50 with an average of 8.06, indicating weak alkaline conditions. Na+ and Cl- ions dominated in groundwater compositions, generating a main Na-Cl type. High Fe and Mn concentrations were commonly detected in groundwater, averaging at 2.61 mg/L and 0.17mg/L, respectively. Groundwater Eh value ranged from -59 to 255 mV, indicating weakly oxidizing to strongly reducing conditions. Aqueous As, F and I concentration ranged from 0.5 to 91.2 µg/L, 0.05 to 28.3 mg/L and 0.01 to 2.64 mg/L, respectively, in groundwater from the southern margin of the Tarim Basin. 6.3% of samples had an arsenic concentration greater than the WHO guideline value of 10 µg/L for drinking water. Forty-six percent of samples contained F over the maximum contaminant level of 1 mg/L in China and 31.5% exceeded WHO guideline value of 1.5 mg/L. Six percent of samples contained I higher than the toxic exposure level of 0.15 mg/L in China. Groundwater with high arsenic, fluorine and iodine concentrations were mainly distributed in the Minfeng County in the central part of the study area. Shallow
groundwater in the southern margin of the entire Tarim Basin generally had high fluorine concentrations. The distribution of arsenic and fluorine in groundwater were similar. The pH value had a positive correlation with groundwater As, F and I concentrations. With the increase of pH value, adsorption of groundwater arsenate and arsenite on positively charged colloids and clay minerals reduced, which lead to the increase of groundwater As. As concentration in shallow groundwater in the Tarim Basin is also related to reductive dissolution of Fe(III) oxides. High TDS (ranged between 199 and 358694 mg/L, with an average of 11532 mg/L) and pH values in groundwater in the study area inhibit the formation of CaF2 and promote the enrichment of groundwater F. High As and F groundwater had relatively low SO42- and NO3- concentrations, indicating that reducing environment can promote groundwater As and F enrichment. Under weak alkaline conditions, I- adsorbed on the sediment will migrate to groundwater, which indirectly promotes the enrichment of groundwater I. In the study area, groundwater samples had relatively high F (>5 mg/L), positive correlations between As and F, I and F, as well as As and I were observed. The results could provide a theoretical basis for promoting the construction of new rural areas that can be provided with good and safe drinking water.

Key words: The Tarim Basin in Xinjiang; Shallow groundwater; Groundwater arsenic, fluorine and iodine.
Human health risks due to long-term exposure to contaminated groundwater near a Chemical Complex, Portugal

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Abstract:

The Potentially toxic elements (PTEs) are known to threat human health due to exposure to contaminated groundwater. Some of these PTEs can lead to long-term carcinogenic and non-carcinogenic health risks. The Estarreja Chemical Complex (ECC), NW Portugal, has had an intense industrial activity since the early 1950s, which lead to high levels of soil and groundwater contamination. Local populations traditionally rely on groundwater for human and agricultural uses. Although rehabilitation measures have been implemented for the last 20 years, groundwater contamination levels remain high for some PTEs, whose concentrations may be several orders of magnitude higher than human consumption. Two groundwater sampling campaigns were conducted showing the temporal evolution of groundwater quality and allowing for the calculation of non-cancer and cancer risks due to exposure to PTEs by the ECC-surrounding population, considering groundwater ingestion and dermal contact as exposure pathways. Hair and urine PTE contents were collected during of the second sampling groundwater campaign and were used as biomonitoring to validate the exposure of local population to PTEs. The results show that As is the contaminant with highest non-cancer and cancer health risks for the exposed population, presenting high values particularly in Veiros, Beduí do and Pardilhó localities. The most groundwater-contaminated areas coincided with the localities in which inhabitants exhibit higher hair and urinary PTE concentrations. Hair samples show high levels of As, Hg and Ni, while urine samples show high levels for Al, As, Cd, Hg, Pb, Ni and Zn are elevated in localities close to the ECC. Urine and hair proved to be suitable to evaluate short- and long-term exposure to PTEs and are strongly correlated with groundwater PTEs’ concentration.

Key words: groundwater contamination, cancer risk, biomonitoring, urine, arsenic.
Desalination of water through organic nanocomposite membranes

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Abstract:

Membranes are used to reduce the concentration of ions that cause brackish water. The objective of this study was to evaluate three types of lab scale membranes to analyze the removal of certain ions and the electric conductivity of the water. Three kinds of nanoparticles were tested; the magnesium oxide nanoparticles (MgONPs), the copper oxide nanoparticles (CuONPs) and the iron oxide nanoparticles (FeONPs). The nanocomposite membranes were elaborated using the nanoparticles with the cellulose triacetate (CTA). The synthesis of membranes was particularized with 2 g of CTA and 0.02 g of nanoparticles; hence, the treatments were CTA unaccompanied (T1), CTA with MgONPs (T2), CTA with CuONPs (T3), and CTA with FeONPs (T4). Previous to carry out the experiments, the mechanical properties of membranes were carried out in a Dynamic Mechanical Analyzer (DMA) in the International Center for Advanced Materials (CIMAV), Chihuahua, Mexico. Synthetic brackish water (anions and cations) was prepared and used to feed the membranes. The synthetic water contained the ions: cations (sodium, Na⁺; potassium, K⁺; magnesium, Mg²⁺; calcium, Ca²⁺; ammonium, NH₄⁺) and anions (fluoride, F⁻; chlorides, Cl⁻; nitrate, NO₃⁻; sulfate, SO₄²⁻) and electrical conductivity (ECw), and these were quantified Ion Chromatography. Membrane removal percentages for cations were: Na⁺=68%, K=69%, and ECw=63% in T1; Na⁺=13%, K=12%, and ECw=0.5% in T2; K=43%, Na⁺=42%, and ECw=46% in T3 and Na⁺=1.4%, K=2%, and ECw=53% in T4. While in anions were: SO₄²⁻=N.D. and ECw=N.D. in T1; SO₄²⁻=14% and ECw=8% in T2; SO₄²⁻=N.D. and ECw=N.D. in T3 and SO₄²⁻=16% and ECw=8.8% in T4. The results showed the best performance for removal cations T1 and T3 and for anions T2 and T4. It is concluded that nanocomposite membranes may be an option or alternative to decrease the concentrations of ions that cause brackish water.

Key words: water quality, brackish water, anions and cations, nanoparticles, Mexico

Acknowledgments: This study was financially supported by the National Institute for Research in Forestry, Agriculture and Animal Production in Mexico (INIFAP-Mexico) and the Autonomous University of Chihuahua (UACH).
Extraction of alkaline earth metals in natural runoff water using filters packed with zeolite

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Abstract:
Zeolites have been used successfully to adsorb organic and inorganic compounds in polluted water. The aim of this research was to evaluate the removal of alkaline earth metals in natural runoff water using filters packed with a natural zeolite of different granulometry. Four treatments were evaluated; with zeolite size of 70 mm (T1-large), 30 mm (T2-medium), 500 μm (T3-small) and a combination of those three sizes (T4). The zeolite was properly characterized at the laboratory of Mexican Geologic Service (MGS) and the adsorption isotherms were obtained in the laboratory of the Advanced Material Research Center. The concentration of the following 7 alkaline earth metals were obtained in a natural runoff water (crude water) used for decontamination; Ba, K, Li, Mg, Na, Ca and Sr. In addition, potential hydrogen (pH), electrical conductivity (ECw), and total dissolved solids (TDS) were also evaluated. Crude water was filtered three times in the treatments with two replications. A univariate analysis (ANOVA) was performed to detect treatments differences using a significance level of 0.05 (α=0.05). The results showed that the zeolite was a heulandite type (CaAl₂Si₇O₁₈•6H₂O) with 61.43%. The concentration in crude water of the alkaline earth elements were; Na with 452.18 ppm>Ca with 23.90 ppm>K with 20.09 ppm>Mg with 18.17 ppm>Sr with 1.20 ppm>Li with 0.408 ppm>Ba with 0.025 ppm.

The results showed that, with the exception of Ca, the zeolite’s four treatments were efficient in removing alkaline earth metals; nevertheless, T3-small and T4-mixed treatments were more resourceful. It is concluded that the zeolite may be used to decontaminate alkaline earth metals in natural runoff water because of accessibility and low cost

Key words: alkaline earth, metals, natural zeolite, decontamination, water

Acknowledgments: This study was financially supported by the National Research Institute for Agriculture, Forestry and Animal Production (INIFAP-Mexico) as well as the Autonomous University of Chihuahua (UACH) in Chihuahua, Mexico.
Removal of Multiple Dyes using Magnetic Biochar Coupled with Binary Oxidants

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Abstract:
In recent years, there have been many reports on the treatment of single organic dye wastewater by magnetic biochar, but few studies have focused on treatment of multi-component dyes that often exist in real wastewater. In this study, Fe3O4-based magnetic biochar composites (Fe3O4@C) were prepared by chemical co-precipitation of Fe3O4 on biochar derived from watermelon peel. Then Fe3O4@C was coupled with hypochlorite and persulfate to remove multiple dyes of methyl orange (MO), rhodamine B (RhB) and methylene blue (MB) and organic macromolecular matter humic acid (HA). The structure of Fe3O4@C was characterized by X-ray Diffraction (XRD), Fourier Transform Infrarspectrometer, Scanning Electron Microscope, and X-ray photoelectron microscopy. The effects of different initial dye concentration, reaction pH, and oxidant species on dye removal were examined. The kinetics of the oxidative adsorption was also analyzed. The results show that when the dosage of adsorbent and oxidant are 1 g/L and 5 mM, respectively, the dye removal rate was the highest. Hypochlorite-Fe3O4@C was prone to remove MO and RhB, with the removal efficiency was 98% and 99%, respectively. Persulfate-Fe3O4@C was superior to remove HA and MB, and the removal efficiency was 88% and 99%, respectively. The color removal of multiple dyes when combined with binary oxidants of hypochlorite and persulfate was 73%. In addition, the regeneration and reuse of adsorbent was also effective and stable. This study shows that the approach of Fe3O4@C coupled with binary oxidants has promising application prospects for multiple dyes removal from wastewater.

Key words: magnetic biochar; dye; adsorption; oxidation; wastewater.
Hardness of drinking water and cancer

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Abstract:

The consumption of low mineral drinking water has been increasing around the world with the shortage of water resources and the development of advanced water treatment technologies. Several epidemiological investigations conducted in Taiwan showed a possible protective effect of water hardness toward the risk of dying from pancreatic, esophageal, gastric, rectal, colon and prostate cancers. What’s more, some researches showed negative correlations between cancer mortality rates and the concentration of Ca and Mg, individually or in combination. The importance of low concentrations of minerals in drinking water in mediating the role of trihalomethanes (THMs) and nitrate in some cancers has been advanced in several recent publications. The causal relationships between exposure to low mineral water and malignancies are poorly understood. Nriagu et al proposed that low mineral drinking water can critically upset the body's electrolyte balance due to its low concentrations of calcium, sodium, potassium, and magnesium, ultimately leading to tumorigenesis and full-fledged cancer. There is a strong need for further research on the association of drinking water hardness and cancer.

Key words: Drinking water; Hardness; Cancer.
The mechanism of arsenic adsorption in sediments and its effect on arsenic enrichment in groundwater of Yinchuan plain, China

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Abstract:

Yinchuan plain is one of the high arsenic groundwater distribution areas in China. The extraction experiments of arsenic from sediments were carried out, the relationship between total arsenic in sediments, arsenic adsorption by different forms and arsenic content in groundwater was analyzed, and the effects of different sedimentary environments on arsenic content in groundwater were discussed. High arsenic groundwater occurs most in the shallow aquifers in the north of alluvial-lacustrine plain. The contents of total arsenic and extractable arsenic in sediments are affected by sedimentary environment and particle size. The sediments in the high arsenic area are mainly dark fine sand, and the reduction environment is more favorable for the release of arsenic adsorption. The exchangeable arsenic in sediments is the direct source of arsenic in groundwater.

Key words: arsenic, sediment, adsorption, groundwater, Yinchuan Plain
Hydrogeochemical control of groundwater salinity and fluoride in the sedimentary aquifers of Datong Basin, Northern China

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Abstract:
Groundwater pollution associated with elevated salinity and fluoride concentration is one of the most serious environmental problems in Datong Basin, Northern China. In order to identify the spatial distribution and enrichment mechanisms of high fluoride and salinity occurred in the shallow groundwater of Datong Basin, the hydrochemical and stable isotopic analysis of representative groundwater samples (n=128) were investigated. The study area has a large spatial heterogeneity of groundwater chemistry. Fluoride and TDS concentrations of groundwater range from 0.01 to 8.69 mg/l and 208.9 to 10,661 mg/l respectively, indicating a dramatic variation within the study area. 58.6\% of samples are high fluoride groundwater (F\textsuperscript{-}>1.5 mg/l), while 32.8\% of the samples contain elevated TDS (TDS>1000 mg/l). Both fluoride and TDS concentrations tend to increase along with the regional groundwater flow path from the margin to the central area of the basin.X-ray diffraction (XRD) and environmental scanning electron microscopy (SEM) analysis of representative sediment samples collected from different depths showed that the sediments mainly consist of clay (montmorillonite, chlorite, illite and kaolinite), quartz, calcite and fluorite, and the mass fraction of fluorine element in sediments ranges from less 0.5 to 3.18\%. Fluorine-bearing sediments are not only the source of fluoride, but also the sink of fluoride in groundwater. Adsorption-desorption by clay mineral and dissolution-precipitation of fluorine-bearing materials are the main hydrogeochemical processes dominated in the fluoride release.

Groundwater with high F\textsuperscript{-} concentration and high salinity has distinctive major ion chemistry, being generally HCO\textsubscript{3}\textsuperscript{-}-rich, Cl\textsuperscript{-}-rich, Na\textsuperscript{+}-rich, Ca-poor and having relatively weak alkaline pH values (7.2 to 9.0). These data indicate that variations in the groundwater major ion chemistry and possibly pH, which are controlled by water-rock interaction in the aquifer, are important in mobilizing F\textsuperscript{-}. Alkaline subsurface environment of circulating water benefits leaching of fluoride from the aquifer matrix. The positive correlation of F\textsuperscript{-} with Na\textsuperscript{+} and HCO\textsubscript{3}\textsuperscript{-} facilitate to stabilize F\textsuperscript{-} ions in the groundwater. The Gibbs plot substantiates that rock dominance and evaporation are the dominant processes controlling the saline groundwater in the study area. Positive correlations between fluoride with LNa and HCO\textsubscript{3}\textsuperscript{-} in groundwater show that high fluoride content and alkaline sodic characteristics of groundwater are resulted from dissolution of fluorine-bearing minerals. The occurrence and behavior of fluorine in groundwater are mainly controlled by fluorite precipitation as a function of Ca\textsuperscript{2+} concentration which depends on several geochemical processes such as dissolution of Ca-bearing minerals, calcite precipitation, and cation exchange.

High fluoride and high salinity groundwater samples contain elevated \(\delta D\) and \(\delta^{18}O\) and low F/Cl ratios, also reflecting the effects of evapotranspiration, particularly in the aquifers occurred locally with shallow depths. Evapotranspiration is the dominant process for F\textsuperscript{-} and salinity in shallow groundwater while water-rock reactions are prominent in deep aquifers. In the summary, hydrogeological setting, sediment geochemistry, groundwater hydrochemistry and evaporation are all important factors controlling the occurrence of high fluoride groundwater. A longer residence time of groundwater promotes water-rock interaction, which further sustains high fluoride ions and salinity in shallow groundwater under the semi-arid climate condition.

Key words: Fluoride; Salinity; Hydrogeochemical processes; sedimentary aquifers; Evaporation
Spatial evaluations of the NO$_3$-N distributions in groundwater in Jianghan Plain
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Abstract:
Semi-variogram model and Ordinary Kriging interpolation method were used to analyse the spatial distribution and variation of the NO$_3$-N concentration based on 825 groundwater samples collected from 2011 to 2014 in Jianghan Plain. Seven hydrological factors, including net recharge, depth to groundwater, hydraulic conductivity, vadose zone material, land use type, soil type, and soil total nitrogen, were used to predict the posteriori probability distribution map of the NO$_3$-N concentration, where the contributions of factors were calculated using Weights of Evidence method. Results indicated that the NO$_3$-N concentration in Jianghan Plain followed the normal distribution after Box-Cox transformation. A spherical model was appropriate to evaluate the spatial distribution of the NO$_3$-N concentration. The spatial correlation of NO$_3$-N concentration existed within a range of 68.02 km with autocorrelation rate of 89.73%. The NO$_3$-N concentration showed that the higher values located in south region while the lower values in north and west region. The area with the NO$_3$-N concentration exceeding 10mg/L accounted for 8.61% of the total area. In addition, the success rate curve indicated a good performance of the WofE model at a precision value of 0.91. The groundwater recharge indicated a positive relationship with the vulnerability to nitrate contamination as well as hydraulic conductivity and soil total nitrogen, while the groundwater depth indicated a negative relationship. When the lithology of vadose zone was sand and gravel, the type of land use was for the urban or construction, and soil type was alluvial; the aquifer was very easy to be polluted by NO$_3$-N.

Key words: Semi-variogram; Spatial variation; Weights of Evidence.
Pollution status and consideration of groundwater and soil in high incidence of cancer areas

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Abstract:
The groundwater, soil and food pollution in 20 areas with high incidence of cancer were analyzed and evaluated, and it was found that most of the pollutants were consistent with the pollutant components discharged by local chemical plants, which to some extent had adverse effects on human health. Some Suggestions and countermeasures are put forward.

Introduce and Method: The disordered discharge of industrial "three wastes" in an economic zone of China has led to a sharp decline in the quality of soil and water environment and the rapid emergence of areas with high incidence of cancer. The authors analyzed and evaluated the soil and water pollution in 20 areas with high incidence of cancer by collecting various samples for chemical composition testing.

Results and Discussion: The study found that the contents of organic pollutants and heavy metals in groundwater, soil, surface water and food samples in areas with high cancer incidence were significantly abnormal, and the abnormal components were consistent with the pollutant components in the "three wastes" discharged by chemical plants. Taking AZC001 cancer high incidence area as an example, the contents of dichloroethylene and trichloroethylene in groundwater reached 416.95 g/l and 66.62 g/l respectively, and Al, Fe, Mn and Pb exceeded the national groundwater quality standard. Dichloroethylene, tetrachloroethylene and naphthalene were detected in soil and rice samples, and Pb of rice samples reached 1.43 mg/kg. Research suggests that the lack of environmental knowledge, the relocation of polluting enterprises and the one-sided pursuit of GDP are important reasons for the occurrence of cancer in high incidence areas.

Key words: high incidence of cancer areas, groundwater, soil, pollutant.

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Preliminary groundwater hydrochemistry studies from Salto Northwest Uruguay as drinking water and their possible effects in human health.

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Abstract:

One of the main source of drinking water and irrigation supply of the North of Uruguay come from groundwater. Inhabitants from this region drink groundwater without previous treatment resulting in several health problems (i.e.: gastroenteritis) caused by the interference of sewage from septic tank infiltration. Agriculture, as largest water consumer uses huge amounts of groundwater to produce crops as well as feed livestock, often with severe impacts on the hydrological resources, modifying the water quality with pollutants from anthropogenic activities (e.g. agro effluents). Some authors have showed the presence of nitrates, phosphorous and arsenic in groundwater in North Uruguay exceeding in some cases guideline levels (UNIT 883:2008 guidelines for drinking water quality). Moreover, natural baseline of ions and metalloids in hydrogeology formations are necessary to evaluate. With this aim, we have collected historical data of groundwater arsenic distribution in South-western Uruguay, however there are a lack of information about North Uruguay. Furthermore, there are no epidemiological studies in Uruguay associated to environmental exposure on geogenic metals or metalloids as arsenic, or contaminants from agriculture or seepage into aquifers from septic tanks. In order to shed more light in the aforementioned issues with a special focused in the hydrogechemistry quality in groundwater aquifers in North Uruguay sampling campaigns are undergoing. Preliminary results from 20 groundwater wells monitored shown Arsenic (4.0 - 49.3 ug/L), Zinc (15.4 - 396.0 ug/L), Cr (3.1 ug/L only one well), phenols (0.01 – 0.05 mg/L), Total Phosphorous (50.0 – 178.5 ug/L) as well as other physicochemical and microbiological parameters. Relevant information is being generate towards to the characterization and baseline groundwater, the presence of metals and metalloids and their possible effects in human health.

Acknowledgements: National Agency for Research and Innovation (ANII).

Key words: Groundwater, Arsenic, Zinc, Total Phosphorous.
Mechanisms of iodine enrichment in the groundwater system of Datong basin: Evidence from batch experiments on the natural sediments

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Abstract:
Iodine is an essential element for thyroid hormone synthesis. According to a recent worldwide survey of median urinary iodine, 11 countries around the world have an excess of iodine intake, which can trigger iodine toxicity disorders (IED) and cause immune responses such as autoimmune thyroiditis. In China, excessive iodine intake is widespread, with approximately 31 million people in 11 provinces affected. Our previous studies found the occurrence of high iodine groundwater in the Datong basin and North China Plain, which increases hypothyroidism risk for residents using the groundwater as the main source of drinking water. However, the current understanding of the hydrochemical cycling of iodine in the groundwater systems is very limited.

Our previous studies found that iodine concentration in groundwater can be up to 1187 µg/L at the Datong basin. In the basin, the iodine-loaded metal (oxy)hydroxides are considered as the primary hosts of soil/sediment iodine, and dissimilatory reduction of metal (oxy)hydroxides would lead to iodine mobilization from sediment into groundwater. Therefore, in order to better understand the iodine mobilization in this groundwater system, a series of batch incubation experiments investigating the transformation of iron minerals were performed under both aerobic and anaerobic conditions.

Two sediment samples of DXZ04 and DXZ147 at depths of 4.35 m and 281 m, respectively, were collected from the iodine-affected area of the Datong basin to perform the batch incubation experiments which involved the iron reducer \textit{Shewanella oneidensis} MR-1. Iron K-edge X-ray absorption near edge spectroscopy (XANES) and PHREEQC (Version 3, 3.4.0-12927) were used to identify the transformation of Fe phases and iodine species, respectively. The results showed that for the shallow sediment DXZ04, after treatment with the iron reducer MR-1 and Na-lactate (used as an electron donor for MR-1), iodine release from sediment into solution was observed under anaerobic conditions compared with no evident release of iodine under aerobic conditions. The redox-derived transformation of sediment Fe phases from the crystalline Fe to HCl-extractable Fe phases was considered as the main factor causing the iodine release. For the untreated deep sediment DXZ147, a higher ratio of HCl-extractable Fe fraction to natural sediment Fe phases was observed. Consistently, the groundwater from the deep aquifer had the higher iodine concentrations (up to 732 µg/L) than the shallow aquifer, suggesting that the long-term transformation of Fe minerals under the reducing conditions of the deep aquifer led to iodine mobilization from the sediment into the groundwater. In addition, during the iodine release, the transformation of iodine species from organic iodine or iodate to iodide further promotes its mobilization. The evidence gained from this study provides new insights on the genesis of natural high iodine groundwater.

Key words: Iodine; Groundwater; Iron minerals; Enrichment;
Seasonal distribution, accumulation and potential risk of heavy metals in Zam Reservoir on Yarlung Tsangpo River, Tibet

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Abstract:

Zam Reservoir is first and largest reservoir built for several years in the main stream of Yarlung Tsangpo in Tibet. To investigate the effects of the dam constructed on the heavy metals transformation, transportation and potential environmental risk in the plateau river system, samples of surface water, suspended particulate matter (SPM) and sediment cores from Zam Reservoir were collected in wet season (August2017), dry season (January2018) and normal season (May2018) respectively. Heavy metals including Cr, Co, Ni, Cu, Zn, As, Cd and Pb were analysed. Results showed that except for As which was a little higher in the normal flow period, other dissolved heavy metals in surface water of Zam Reservoir were lower than the limit value of the Chinese Sanitary Standard for Drinking Water (GB5749-2006) and the WHO Guidelines for Drinking Water Quality. Dissolved concentrations of Cr, Co, Ni and As were lowest in the wet season, while Cu and Pb were highest in this period. Data shows that there was little spatial difference in dissolved metal concentrations in the surface water. Concentrations of heavy metals in SPM were generally higher than that of sediments. Most metals concentrations in SPM in wet season were lower than that of dry and normal seasons. And little spatial difference existed too for the metals concentration in SPM. Heavy metals concentrations in sediment cores at the tail of the reservoir were generally higher than that at the head which showed that heavy metals could be enriched in the sediments of tail area for its weaker hydrodynamic conditions. Except for Pb, other metals concentrations in sediments of Zam Reservoir were higher than that of Yarlung Tsangpo River surface sediments and the background value of Tibetan soil. Compared with the data of Sediment Quality Guidelines (SQGs), most of the sediments Zn, Cd and Pb could rarely cause adverse effects while Ni, As, Cr and Cu had the potential to commonly cause adverse effects in Zam Reservoir. Results of geo-accumulation index ($I_{geo}$) and enrichment factor (EF) revealed that Cu was the only heavy metal reached the level of moderately polluted. According to the results of pollution load index (PLI) and mean probable effect concentration quotient (mPEC-Q), sediments of Zam Reservoir were polluted and all sampling sites reached the “medium-low priority site” level. Principal component analysis (PCA) and correlation analysis (CA) suggested that the studied metals in sediments of Zam Reservoir were mainly dominated by natural geological sources and controlled by similar processes.

Key words: heavy metals, reservoir, distribution, risk assessment, Yarlung Tsangpo River

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Uranium in water formed scale deposits of the Republic of Bashkortostan and stomach cancer incidence

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Abstract:

Study of the interrelation between uranium in water formed scale deposits and stomach cancer incidence has been carried. The results of assessing 467 water scale samples on the content of uranium by INAA method (Instrumental Neutron Activation Analysis) in 267 settlements were correlated with stomach cancer incidence. The content of uranium in the limescale ranged from 0.148 to 45.7 g/t. The increase of stomach cancer incidence is associated with an increase of uranium in drinking water.

Study of the interrelation between uranium in water formed scale deposits of the area and stomach cancer incidence has been carried out in the territory of the Republic of Bashkortostan (RB), Russia. Scale is highly informative in assessing the quality of drinking water, as well as for the ecological and geochemical study of the territory. The results of assessing 467 water scale samples on the content of uranium by INAA method (Instrumental Neutron Activation Analysis) in 267 settlements were correlated with stomach cancer incidence. The stomach cancer incidence in RB for 2012–2017 was analyzed. The population included in the study was 4,066,972 people. The content of uranium in the limescale ranged from 0.148 to 45.7 g/t. Analysis of the incidence of stomach cancer found a significant variation, reaching 3 times difference – from 11.9 per 100,000 inhabitants to 36.9. The average incidence was 22.7 per 100,000 population. A higher level of the uranium content is confined to the outcrops of the Permian system’s red sediments, the area of less deep occurrence of the crystalline basement and to the outputs of acidic effusive rocks. Increasing the uranium content is also associated with technogenic factors as deposits exploitation (hydrocarbons in the west of the republic and metal ores in the east) and underground nuclear explosions (in the south). The increase of stomach cancer incidence is associated with higher concentration of uranium in drinking water. The radioprotective factors of the natural environment include areas of development of calcium-rich carbonate rocks – limestones. The data obtained indicates the promise of conducting comprehensive studies of the geoeccological factors to predict the cancer incidence and to develop prevention measures.

Key words: medical geology, uranium, cancer, Russia, drinking water
Environmental geochemical characteristics and genetic model of shiqian hot spring group in guizhou province

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Abstract:
As a kind of new energy source, geothermal energy has attracted the attention of many countries due to its characteristics of small environmental pollution, wide distribution, easy exploitation, wide applicability, cheap and renewable. As for Guizhou, a large geothermal resources area in western China, has a large amount of geothermal resources, and several hot springs in the shiqian region form a hot spring group, which is of great research and development value.

Taking Shi Qian hot springs in the population as the research object, by collecting the previous Shi Qian regional geology and geothermal exploration data and drilling data, and the integrated use of methods such as geology and hydrology geochemistry, environmental isotope of Shi Qian region of hot spring distribution, geological structure, environmental geochemical characteristics and Shi Qian hot springs group of genetic model for research. It also supplements the blank of previous studies on the causes of hot springs in shiqian region, and puts forward some Suggestions on the sustainable development and utilization of geothermal water resources in shiqian region. Group study Shi Qian county of hot spring is mainly by through Shi Qian county in central north east to hongshi fracture and north-south Shi Qian fracture control together, the two fracture belongs to regional fracture of thermal conductivity, the geothermal cut off in the side of the fracture, thus Shi Qian hot springs on the north side of the group of fracture development in the most close to the hongshi and Shi Qian fracture.

The main chemical components in the hot spring water in the whole shiqian region are Ca\textsuperscript{2+}, Mg\textsuperscript{2+}, K\textsuperscript{+}, Na\textsuperscript{+}, HCO\textsubscript{3}\textsuperscript{-}, SO\textsubscript{4}\textsuperscript{2-}, Cl\textsuperscript{-} and other major elements, and also rich in strontium, metasilicic acid, fluorine, lithium and other trace elements. According to the classification criteria of shuchanglev, the hydrochemical types of shiqian hot spring group are all sulfuric acid bicarbonate-calcium magnesium
type (SO₄-HCO₃-CaMg), and due to the influence of faults and tectonic geology, the hydrochemical types of foding mountain hot spring in the south direction of shiqian region are sodium bicarbonate type (HCO₃-Na). Based on isotopic analysis, the groundwater in shiqian region is mainly from meteoric precipitation. The hot spring group in shiqian area belongs to the deep circulating groundwater which is controlled by the fault under the closed condition, its retention time is over 7ka, and the renewal cycle rate is low. The recharge elevation is about 1300-1800m, circulating around 3000m depth, mineral and fluid chemical equilibrium and combined with the different geothermometer can estimate the regional internal temperature of 79.17 °C. The ratio of cold water mixing is 67.75-82.76% by means of silicon enthalpy diagram and silicon mixing model.

By comparing Shi Qian south hot spring and the top mountain hot spring water quality and water chemical characteristics, combined with the surface of sample microscopically thin section analysis, infer from various elements in the hot springs group of components in the process of hot spring water outward migration and leaching solution with surrounding rock, namely water - rock reaction, in the process of the displacement of surrounding rock are extracted from the elements in the components, and with the hot spring water overflow surface. Special elements such as metasilicic acid, strontium, fluorine and lithium are extracted from different special rock minerals.

Shi Qian hot springs group for geothermal systems in the low temperature convection and its formation mechanism is: in normal or low temperature geothermal area background, in the mountains around the Shi Qian supplies by atmospheric precipitation, make-up water down the mountain area of fracture, fracture and pore channel seep into the ground, along the fault fracture zone 2-3 km deep underground, in the earth's crust deep circulating heating, heating up, and slowly lower migration to the pressure. In the process of migration, driven by topography and pressure difference, the hot spring water starts to slowly dissipate upward. In the process of dissipation, the geothermal water reacts with surrounding rocks and special rock minerals in water-rock reaction and continuously extracts various elements. In the process of rising to shallow area, the geothermal water will mix with shallow strata in cold water, because of the shallow strata water and geothermal water contains chemical composition is not the same, in the blend to get new chemical composition, finally mix will continue upward dissipation, geothermal water excretion in the form of hot spring group, eventually form now Shi Qian hot springs group.

**Key words:** shiqian hot spring group, environmental geochemical characteristics, genetic mechanism, water-rock reaction
Discussion on the chemical characteristics and genesis of the metasilicate-radon spring in Guizhou Xifeng

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Abstract:
Guizhou Xifeng Hot Spring is known as “the first spring in Asia” and is rich in elements or components such as strontium and me-tasilicate. However, there are rare research about the source and rationale of Metasilicate and radon components. Here we try to explore the conditions, material sources and transport mechanisms of metasilicate component and radioactive strontium through tectonic geology, hydrogeochemistry, environmental isotope instrument according to the geological background of the formation of Xifeng Hot Spring. The results show that the content of radon in hot spring water is 100~148.9 Bq/L, which is significantly higher than other specimens. For example, the concentration of radon in catchment area and underground diving is 2.2~3.1 Bq/L and 21~28 Bq/L respectively. The concentration of fissure water in the uranium layer of the Cambrian Niutitang Formation is 15.9~21.6 Bq/L. At the same time, the concentration of metasilicate in the hot spring water is 52.65~58.75 mg/L. The $\delta^2$H-$\delta^{18}$O isotope illuminates that the rainfall infiltrates to the deep 2890~2929m and transforms into geothermal water with 85~97°C under the geothermal heat; the data of $\delta^{13}$C between the specimens, which ranges from 4.87‰ to -8.25‰, and the far-off mantle gas or magma source, which ranges from -4‰ to -8‰, is proximity. Those indicate that the deep-source CO₂, CH₄, H₂S and other gases are continuously released through the structural fracture which caused by the regional active fracture. In summary, the formation of metasilicate in hot spring water is mainly controlled by tectonic action and water-rock action. The high content of metasilicate, fluorine and higher radioactivity in the elements assemblage of hot spring reflects that the hot fluid component is related to the fracture zone with strong silicification alteration. Meanwhile the higher H₂S in the water reflects that the hot spring fluid comes from a relatively reductive environment. It is preliminarily considered that the source of radioactive radon in hot spring water may be related to the polymetallic uranium deposit in the area of the Cambrian Niutitang and the nearby phosphate rock. The regional active fault causes the helium gas accumulated in the deep rock fissure under high pressure conditions. Then hot spring water is formed through the helium gas combined with hot water in high pressure condition.

Key words: Metasilicate-radon spring, environmental isotope, water-rock reaction, Guizhou Xifeng
Human exposure to arsenic in North auriferous regions of Burkina Faso, Africa

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Abstract:

Ground water contaminated by arsenic was evidenced in the auriferous regions of North Burkina Faso. In these arid areas, deep wells were drilled during the last decades to face the increase demand in water resources. The population is mainly composed of farmers, however in some villages the local development is driven by artisanal gold mining.

In order to evaluate the level of exposure to arsenic, the associated risk factors and clinical conditions we compared the situation in two villages; Tanlili previously described as exposed to arsenic contamination and Roba where no arsenic was never reported. We included 186 people, seven years old and above, randomly selected from the general population. In a multivariate analysis, using urine arsenic concentration as an outcome, we observed higher exposure in population from Tanlili than Roba (64.1 µg/g vs 25.2 µg/g) and in children than adults (70.3 µg/g vs 34.4 µg/g). However, the main risk factor of exposure to arsenic was the consumption of water from deep tube wells with 123.4 µg/g vs 33.3 µg/g for people who drink only water from traditional superficial wells. The metabolic profile of arsenic elimination in urine showed a high level of monomethylarsonic-acid that reached 19.4% in Tanlili and a relatively low level of dimethylarsinic-acid (68%). Sole hyperkeratosis was the unique clinical condition found to be associated with monomethylarsonic proportion in urine. The high level of monomethylarsonic is a source of concern, since it is usually found associated with health impact. To put in perspective these observations, we compared the proportions of methylated arsenic species with other population around the world.

These results confirmed the importance of screening arsenic water contamination and human exposure in this auriferous region of north Burkina Faso to inform the population. Little information is already available about arsenic exposure of African populations, a topic that deserve more interest of the scientific community.

Key words: Human arsenic exposure, water, gold rush, health
Enhanced removal of thallium from wastewater by hypochlorite oxidation assisted with nickel ferrite-based hydrochar derived from tannery wastewater

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Abstract:
In this study, NiFe₂O₄-based hydrochar composite (NiFe₂O₄@C) was synthesized using tannery wastewater as a carbon source, and then the NiFe₂O₄@C was applied as a reusable adsorbent coupling with hypochlorite oxidation to efficiently remove thallium (Tl) from wastewater. Characterization techniques including X-ray power diffraction, high-resolution transmission electron microscope, X-ray photoelectron spectroscopy, and electron spin resonance were used to shed light on the mechanisms of Tl removal and adsorbent regeneration. Influencing factors of solution pH, adsorbent dosage, oxidant dosage, and co-existing cations on Tl removal were examined. In addition, the adsorption isotherms and kinetics, as well as adsorbent regeneration methodology were investigated. Results obtained show that the thickness of NiFe₂O₄@C, which was inversely proportional to the magnetization and the amount of NiFe₂O₄ used in synthesis, had little impact on Tl removal performance. The magnetic composite itself or the addition of hypochlorite alone had poor Tl removal efficacy. The combined use of hypochlorite and NiFe₂O₄@C led to substantially enhanced Tl removal due to oxidation-induced precipitation and adsorption over a wide pH range (6.0–11.0). The maximum Tl adsorption capacity was 1699 mg/g at an adsorbent dosage of 0.25 g/L, which is the highest value reported in the literature. Adsorption conforms to a pseudo-second kinetic model, while the Freundlich model adequately describes the adsorption isotherm. Characterization analyses indicate that Tl removal predominantly occurred via oxidation-induced precipitation, pore adsorption, and surface hydroxyl complexation. Electron spin resonance spectra suggest the formation of free hypochlorite radicals by activation through NiFe₂O₄@C, which greatly enhanced Tl removal. Consecutive cyclic regeneration tests reveal excellent and robust desorption and regeneration properties of the composite. In addition, efficient Tl removal from synthetic and industrial water can be achieved via the composite when assisted with hypochlorite oxidation. The findings of this study are a useful theoretical and technical reference for Tl removal from wastewater. Besides, the NiFe₂O₄@C derived from real organic wastewater, coupled with strong oxidants, is an effective methodology that can be extended for application to efficient removal of other environmental pollutants.

Key words: thallium; nickel ferrite; hydrochar; adsorption; hypochlorite; wastewater.
Medical Geology approach for Arsenic studies in Uruguay: advantages and difficulties

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Abstract:

Geogenic Arsenic (As) levels present in groundwater destined to the population's supply, is a very recent issue of concern in Uruguay given the international scientific evidence of adverse effects such as cancer, caused by low levels of As in water but still higher than those recommended by WHO (<10 μgL-1). Safe drinking water is supplied to 94% of the population by a state company (OSE) but only 28% of all drinking water supplied is provided from groundwater sources, while the majority of the population receives drinking water from surface water sources. In 2010, maximum permitted As concentration level in drinking water was lowered from 50 μg L-1 to the target value of 10 μg L-1 with a provisional level of 20 μg L-1. However, Uruguayan population studies on low-dose As exposure health risks are very scarce or null.

The aims of this work are to present and discuss some advantages of research studies with a Medical Geology approach that have been developed in Uruguay, to evaluate the influence of these kind of geological factors in the geographical distribution of health problems associated with arsenic exposure and to highlight the main difficulties found in the process. This approach could provide the tools for overlaying local geochemical data and arsenic levels with data from the disease registry, to potentially identify the possibility that the water consuming population will develop a particular type of disease over time. As a first attempt, the available geochemical data in groundwater sources provided by OSE were processed as well as the epidemiological data available from the National Atlas of Cancer prevalence. The epidemiological data were geo-referred in the areas where preliminary arsenic data in water were available. We proceeded to carry out a cross-over treatment data, to evaluate possible failures or deficiencies for their further analysis and correlation. For example, it was found that not all available analytical As results were obtained by laboratory standardized methods and/or the geo-refering data was lacking. Regarding
epidemiological available data, they are classified only by territorial divisions and harmonized by age, no data exists on the possible relationship of these cancer cases to environmental factors, such as chemical pollution or radiation and there are not any records about drinking water sources. However, the maps were elaborated with the refined data of the arsenic levels of those wells that presented analytical quality results, contrasted with the incidence data of cancer types associated with arsenic such as lung cancer, bladder, melanoma, non-melanoma skin, liver and kidney, for men and women respectively, in selected localities.

It was demonstrated that overlapping the Uruguayan cancer atlas data with As levels in wells can be a potential tool to estimate the contribution of As, to the incidence of cancer, although the retrospective data provided, presented several difficulties and inconsistencies.

As a conclusion, it would be important to develop an interinstitutional and multidisciplinary common framework, to share available data in order to create high quality registers that could be useful for research purposes and to improve and harmonize links between registry data obtained by geology and epidemiology methods.

Key words: Arsenic, drinking water, cancer, Uruguay, Medical Geology.
Drinking water exposure and human health – examples from Denmark

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Abstract:

In Denmark, drinking water is entirely based on groundwater. The drinking water supply system is decentralized consisting of approximately 2,700 larger water supplies and 50,000 smaller private waterworks. Water quality can be assessed with a high degree of certainty for the major part of the population. Drinking water quality is monitored routinely, and data on drinking water quality have for decades been archived in the public-available database JUPITER.

Assessing the health impacts of geogenic natural occurring elements in drinking water requires sufficient data on life-long exposures. Thus, high-quality data on both spatial and temporal variation of drinking water quality are of paramount importance when assessing public health related to geogenic exposures. In addition, utilizing Danish nationwide population-based registers, we can identify the exact geographical residential location on a personal level and link this information with later health outcomes. The combinations of these unique data sources allow a longitudinal population-based assessment of the potential health impact of drinking water quality. We present findings from different recent studies on the relation between different elements in drinking water and health outcomes as for example nitrate in drinking water and the risk of colorectal cancer (Schullehner et al., 2018).

References:

Extraction of metalloids (As, B, Sb) from natural runoff water using filters packed mexican zeolite

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Abstract:

The mineral zeolite was discovered about 160 years and, recently, has been used as water’s decontaminant. The objective of this study was to evaluate the removal of three metalloids in water using filters packed with a natural zeolite of different granulometry. Four treatments were evaluated; zeolite size of 70 mm (T1-large), size of 30 mm (T2-medium), size of 500 μm (T3-small) and a combination of those three sizes (T4). Beforehand, the zeolite was previously characterized at the laboratory of Mexican Geologic Service (MGS), and in addition, the adsorption isotherms were obtained in the laboratory of the Advanced Material Research Center located in the city of Chihuahua, Mexico. The concentration of the metalloids As, B and Sb was measured in natural runoff water (Crude water), before passing to the zeolites filters. In addition, potential hydrogen (pH), electrical conductivity (ECw), and total dissolved solids (TDS) were also evaluated. The crude water was filtered three times in the treatments using two replications. A univariate analysis (ANOVA) was performed to detect treatments differences using a significance level of 0.05 (α=0.05). The results showed that the zeolite was a heulandite type (CaAl2Si7O18•6H2O) with 61.43%. Crude water contained 0.189 ppm of As, 1.339 ppm of B and 0.001 ppm of Sb. The zeolite’s four treatment were effective in removing the three metalloids from the crude water; nevertheless, the T3 and T4 treatments, in general, were more efficient. The As concentration after passing the zeolites filters was 0.10 ppm in T3-small and 0.12 ppm in T4-mixed treatments. With respect to B, after passing the filter this metalloid was removed about 75% in T3-small and T4 mixed treatments. Finally, the Sb was not detected in the effluent water. It is concluded that the zeolite may be used to decontaminate the metalloids As, B and Sb, because of easy accessibility and low cost.

Key words: metalloids, natural zeolite, metal decontamination, water

Acknowledgments: This study was financially supported by the National Research Institute for Agriculture, Forestry and Animal Production (INIFAP-Mexico) as well as the Autonomous University of Chihuahua (UACH) in Chihuahua, Mexico.
Hydrogeochemistry of co-occurring geogenic arsenic and iodine in shallow aquifer along the middle reaches of Yangtze River

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Abstract:
Long-term intake of geogenic contaminated groundwaters that contain naturally occurring hazardous components (arsenic, fluoride, iodine, etc.) with elevated concentrations have caused environmental health problems among billions of people worldwide. Natural occurrence of high arsenic, iron, manganese and ammonium in shallow groundwater have been widely distributed in the Yangtze river basin. In this research, we firstly discovered co-occurring geogenic arsenic and iodine in the shallow groundwater along the middle reaches of Yangtze river, which is characterized by concentrated distribution of oxbows and meandering banks of Yangtze river. To understand the major processes controlling geogenic arsenic and iodine mobilization in shallow aquifers, hydrochemical and H, O, C isotopic compositions of groundwater samples were analyzed, arsenic and iodine speciation were characterized, excitation emission matrix with parallel factor analysis (EEM-PARAFAC) of dissolved organic matter were used to clarify the potential relationships among arsenic/iodine species and DOM.

Results show that high As and I groundwater was characterized by neutral pH, high HCO3−, Fe(II) and DOC concentrations with As(III) and iodide as the dominant species. The arsenic concentrations of groundwater range from 0.26 to 625 μg/L with 63% samples exceeding the Chinese drinking water guideline of 10 μg/L. It was found that the ratios of MMA and DMA to total arsenic in groundwater ranged from 5.7%-10.8% and 1.9-6.2%, respectively. Thirty percent of groundwater samples have iodine concentrations greater than 100 μg/L, with the highest concentration up to 1640 μg/L, while 40% of samples have ratios of organic iodine to total iodine greater than 20%. EEM-PARAFAC analysis demonstrates the dominance of terrestrial DOM sources and the presence of microbial activities in shallow aquifer. Most high arsenic and iodine groundwater co-occurred in the meandering banks and oxbows along the middle reaches of Yangtze River. Channels shifting and sedimentological evolution of the central Yangtze river have great impacts on spatial variation of arsenic and iodine in the shallow groundwater. Oxbows with abundant reactive organic carbon supported microbial respiration in an anoxic environment that triggers the degradation of organic matter and reductive dissolution of iron oxy-hydroxides, which are major hydrogeochemical processes responsible for the mobilization of arsenic and iodine.

Key words: geogenic contaminated groundwater; arsenic; iodine; floodplain; middle reaches of Yangtze river.
Co-pyrolysis biochar preparation and its adsorption characterization for toxic Cd\textsuperscript{2+} wastewater control

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Abstract:

In order to investigate the adsorption characteristics of co-pyrolysis biochar for Cd\textsuperscript{2+}, the adsorption characteristics of co-pyrolysis biochar prepared under different conditions as adsorbent for Cd\textsuperscript{2+} were studied. Bamboo and pork bones were used as raw materials, and they were mixed at different mixing ratios (1:1, 3:1, 1:3) and pyrolyzed at different pyrolysis temperatures (350\textdegree C, 550\textdegree C, 750\textdegree C). Their surface structures and characteristics were characterized. A series of experiments were carried out to study the adsorption isotherms and kinetics of co-pyrolysis biochar for Cd\textsuperscript{2+} and its adsorption mechanism. The results showed that the adsorption of Cd\textsuperscript{2+} by co-pyrolysis biochars accorded with Langmuir adsorption model and quasi-second-order kinetic model. It could be seen that co-pyrolysis biochars adsorbed Cd\textsuperscript{2+} in a single molecular layer, but the fitting Freundlich model had a high non-linear correlation coefficient, suggesting that complex multi-layer adsorption also played a role in Cd\textsuperscript{2+} adsorption.

**Keywords:** co-pyrolysis; biochar; Cd\textsuperscript{2+}; Adsorption; water sanitation.

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Hydro-geochemical evolution analysis of typical geothermal water in Southwest Guizhou, China—using stable isotopes and geochemical modeling approaches

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Abstract:
The exploitation of geothermal water in Southwest Guizhou, China, requires comprehensive assessment including hydro-chemical properties and medical elements. This study investigates the geothermal water chemicals using hydro-geochemical analysis, stable isotopes and geochemical modeling methodologies. 6 geothermal waters, 7 cold springs and 6 surface waters were sampled and measured. The result finds that, the temperatures of the geothermal waters are 36~64 °C, and the TDS are 253.44~794.19 mg/L. The major hydro-chemical types of the geothermal waters are HCO³⁻-Ca and HCO³⁻-Ca.Mg. Similar results have been found in other regional waters as well (local cold springs and surface water). In addition, of the 6 geothermal waters, 4 are from Permian geothermal reservoir; 1 is from Carboniferous reservoir; 1 is from Devonian reservoir, which represent various geochemical backgrounds. From the calculated mineral saturation index values by PHREEQC, the origins of major elements including H₂SiO₃, HCO₃⁻, SO₄²⁻, Ca²⁺ and Mg²⁺ are confirmed. Carbonates are the major sources for HCO³⁻, Ca²⁺ and Mg²⁺, and H₂SiO₃ is mainly from silicates. The δ²H-δ¹⁸O stable isotope data indicates the geothermal water receives recharge mostly from local precipitation. Low ⁸⁷Sr/⁸⁶Sr (average value is 0.708) illustrates the origin of Sr is not controlled by water-rock interaction, and the geothermal water is formed in a relatively open and shallow groundwater system. The hydro-geochemical paths of the geothermal water are associated with regional geological and tectonic structures such as faults and fractures. On the other hand, there are 4 geothermal waters presenting higher H₂SiO₃ concentrations (27.27~43.74 mg/L), which implies medical effect for human health. The geochemical modeling results also explain that temperature is one of the most important factors that control the concentration of H₂SiO₃ in geothermal waters. In conclusion, this research reveals the hydro-geochemical processes that control the chemical compositions of the geothermal water. The results provide referential information for further exploitation and medical use of geothermal water in the study area. The coupled methodologies could also be introduced to similar geothermal water researches.

Key words: geothermal water; stable isotopes; hydro-geochemical modeling; silicic acid; Southwest Guizhou.
Lessons Learned from Arsenic Mitigation

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Abstract:

More than two decades have passed since arsenic was recognized as a major public health threat to the private well populations in more than 70 countries. Many thousands of research papers have been published on the occurrence, health effects and mitigation of arsenic in drinking water sourced from groundwater in these countries. Here an attempt is made to summarize this large body of knowledge into a small number of lessons, reflecting on why we are far from the goal of eliminating this silent and widespread poison in drinking water to protect the health of many millions. The lessons are also drawn from the author’s research in Bangladesh, USA and China, representing a range of economic development and cultural contexts. Although socio-economic development and the replacement of household wells with centralized water supplies has reduced population level exposure to moderate (50-100 g/L) and high (>100 g/L) levels of arsenic in drinking water in some countries, there remains a very large rural population in all countries where the exposure to low levels (10-50 g/L) of arsenic continues due to its dispersed occurrence in the environment.

A set of natural (geological and biological), socio-economic and behavioral barriers to progress informed the lessons. They range from challenges in identifying the exposed households due to spatially heterogeneous arsenic distribution in groundwater, difficulties in quantifying the exposure let alone reducing the exposure, failures in maintaining compliance to arsenic drinking water standards, to misplaced risk perceptions and environmental justice issues. To overcome these challenges, six lessons learned from two decades of research are offered. First, avoiding arsenic should be prioritized before treating for arsenic so hydrogeologists can help by identifying arsenic safe groundwater for water supply. Second, testing all wells in the geographic proximity of known high As wells because one high As value means that there are other non-compliant wells nearby. Third, always test well water for arsenic to identify the exposed population, even with field test kits to enable testing among the rural poor. Fourth, test a biomarker for arsenic to confirm exposure, even better, analyze arsenic species when urinary total As is above 15 g/L. Fifth, implement a monitoring program for water treatment because the smaller the water supply, the higher the failure rate of arsenic treatment is. Sixth, pay attention to biological, behavioral, and socio-economic vulnerabilities among As exposed population. A public-private partnership that encourages testing and further develops a market for arsenic treatment is called for as it represents a win-win for small businesses and private well households that hold promise to address this dispersed natural hazard.

Key words: Arsenic, Groundwater, Spatial Heterogeneity, Optimistic Bias, Environmental Jus
The importance of natural beneficial minerals in drinking water for balanced diet of Chinese people

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Abstract:

Balanced diet, also known as healthy diet, refers to the nutrients contained in the diet are sufficient, complete, appropriate proportion, and maintain the needs of the body. Due to various reasons, the imbalanced diet is very prominent in Chinese population, which is most in imbalance of minerals, for example, excessive intake of sodium and chlorine, insufficient intake of calcium, magnesium, potassium, zinc, copper and selenium, especially severe deficiency of calcium. Long-term mineral hungry in body can increase the risk of birth defects, developmental retardation, and multiple chronic diseases, such as diabetes, cardiovascular disease, osteoporosis, tumor, etc., it will seriously affect the population health and economic development of the country. In generally, natural drinking water contains calcium, magnesium, sodium, potassium, bicarbonate and other dissolved mineral ions, which are good supplements for the body's nutrition, especially under the condition of hunger in dietary minerals. Through analyzing the mineral content of domestic tap and bottled water, we find that drinking water not only provide quite amount of calcium and magnesium supply, it also provide plenty of natural alkaline bicarbonate supplements, all of them can neutralize and mitigate the metabolic acid load of the body caused by modern net acid generated diet. The author explicitly points out that healthy drinking water, which characterized in naturally sourced minerals, abundant types of minerals, reasonable combined of minerals, and appropriate total concentration of minerals, should be considered one of important part of balanced diet of Chinese people, and promoting healthy drinking water is of great significance to improve the nutritional structure and prevent chronic diseases for Chinese people.

Key words: Balanced diet; Mineral hungry; Natural drinking water; healthy drinking water
Investigation of the potential pollution of the hazardous trace elements in the entrained-flow coal gasification by-products from Northwest China

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Abstract:

The rapid development of the coal chemical industry in China has resulted in the increased generation of various coal gasification by-products. To prevent the adverse effects of the potentially hazardous trace elements (PHTEs) on human health and the environment, there are important incentives for studying the chemistry and migration of the PHTEs in the wastewater and solid residues derived from commercial coal gasification activities. In the present study, the feed coal, coal gasification residues, and wastewater samples were collected at key technical links of the gasification facilities from two entrained-flow coal gasification plants in Northwest China. Combining the column leaching procedure M1314 by US EPA, the concentration of the PHTEs in the wastewater and the leachates were characterized using inductively coupled plasma mass spectrometry (ICP-MS) and atomic fluorescence spectrometry (AFS) to understand their potentially environmental and health impacts. The result show that the black water samples have higher concentrations of the PHTEs than do other water samples. More particulate materials in the black water, accumulation effect of grey water circulation, and the use of additives in the sedimentation procedure contributed to this phenomenon to a great extent. Except for Sr, Mo, Sb, and Cs, most of the elements in the original water samples can be reduced effectively by removing the particulate matter. In some cases, Zn, As, Se, Cd, and Pb in the original wastewater exceed the limit for industrial use as indicated in the Chinese Environmental Quality Standards for Surface Water and the Emission Standard for Pollutants from Coal Industry. As and Se show consistent distribution patterns in the water samples and their potentially environmental impacts in the wastewater cannot be relieved by filtration. The leached concentrations of the PHTEs from the coal gasification residues are generally low and only Mo in the leachate of GSP fine residue is moderately soluble. Sb and Tl in the leachate of GE coarse residue and the concentrations of As, Se, Mo, Sb, and Tl in the leachates of GE fine residue, GSP coarse residue, and GSP fine residue exceed the third level of the Chinese Quality Standard for Ground Water. The environmental impacts of these elements should be evaluated.

Key words: Entrained-flow coal gasification; wastewater; residues; potentially hazardous trace elements
The bioaccumulation of mercury (Hg) in fish is a potential threat to human health. Recent studies reported much lower methylmercury (MeHg) proportions but higher inorganic Hg (IHg) in farm-raised fish, however, the mechanism of Hg distribution in farm-raised fish body remains not well understood. In this study, we investigated the distributions of primary amino acids, MeHg and IHg in body tissues of two commonly farm-raised fish species (common carp: *Cyprinus carpio*; grass carp: *Ctenopharyngodon idellus*) in Guizhou Province, SW China, to understand the effects of amino acids on MeHg and IHg metabolism in farm-raised fish. The two fish species showed low THg concentrations (grass carp: 7.2 to 41.6 ng/g; common carp: 6.6 to 42.7 ng/g, dry weight) and low MeHg proportions (grass carp: 2-45%; common carp: 6-37%) in their tissues, which are mainly due to the simple food web structures and the fast growth of the farm-raised fish. Positive correlations were observed between MeHg and several primary amino acids (e.g., cysteine, arginine, threonine, phenylalanine, leucine, valine, glutamate, cysteine, serine and tyrosine) in fish tissues, which may be driven by the formation of MeHg-Cys complexes within fish body. However, no clear correlations were observed between IHg and any primary amino acids, indicating the metabolic processes of IHg and MeHg are different. This study advances our understanding that cysteine and its related/derived amino acids may be an important driving force for MeHg distribution and translocation in fish.
Soil Pollution and Remidation
Application of Sequential Extraction Procedure in Determination of Heavy Metal Concentration in Mkpuma-Akpatakpa Farm-area Abakaliki Mine District Nigeria

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Abstract:

This research aimed to investigate the level of contamination/pollution of heavy metals in the soils of Mkpuma-Akpatakpa in Abakaliki mining district of Ebonyi state Nigeria in order to determine their bioavailability and overall health implications. Mkpuma-Akpatakpa soil was sampled and analyzed for heavy metal pollution/contamination using the Standard Measurements and Testing Programme of the European Union (SM&T). This was done to determine the heavy metal (Pb, Cu, Fe, Zn and Cd) flow into the biosphere as the elements in the environment cannot be reliably predicted on the basis of total heavy metal concentration. A total of seven (7) soil samples (two from major mine sites, three from farmlands and two from stream sediments) were obtained from the study area and geotagged. The samples were sequentially extracted using acetic acid, hydroxylammonium chloride, hydrogen peroxide with ammonium acetate and aqua regia for the exchangeable, reducible, oxidisable and the residue. Plants (rice and cassava) were also sampled, digested and analyzed as well. The result of the soil samples were compared with that of plants and the results confirmed the hypothesis that the heavy metal absorbance into the biosphere falls within the range of the readily available and potentially available fractions of the sequentially extracted samples thereby opposing earlier held belief. This showed an absorbance level which fell within the agro-acceptable limit for cultivations and its animal injection.

Keywords: exchangeable, reducible, oxidisable, absorbance, bioavailability and biosphere
NIP1;2 is a plasma membrane-localized transporter mediating aluminum detoxification in Arabidopsis

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Abstract:

Members of the aquaporin (AQP) family have been suggested to transport aluminum (Al) in plants; however, the Al form transported by AQPs and the roles of AQPs in Al tolerance remain elusive. Here we report that NIP1;2, a plasma membrane-localized member of the Arabidopsis nodulin 26-like intrinsic protein (NIP) subfamily of the AQP family, facilitates Al-malate transport from the root cell wall into the root symplasm, with subsequent Al xylem loading and root-to-shoot translocation, which are critical steps in an internal Al tolerance mechanism in Arabidopsis. We found that NIP1;2 transcripts are expressed mainly in the root tips, and that this expression is enhanced by Al but not by other metal stresses. Mutations in NIP1;2 lead to hyperaccumulation of toxic Al3+ in the root cell wall, inhibition of root-to-shoot Al translocation, and a significant reduction in Al tolerance. NIP1;2 facilitates the transport of Al-malate, but not Al3+ ions, in both yeast and Arabidopsis. We demonstrate that the formation of the Al-malate complex in the root tip apoplast is a prerequisite for NIP1;2-mediated Al removal from the root cell wall, and that this requires a functional root malate exudation system mediated by the Al-activated malate transporter, ALMT1. Taken together, these findings reveal a critical linkage between the previously identified Al exclusion mechanism based on root malate release and an internal Al tolerance mechanism identified here through the coordinated function of NIP1;2 and ALMT1, which is required for Al removal from the root cell wall, root-to-shoot Al translocation, and overall Al detoxification in Arabidopsis.

Key Words: aquaporin, nodulin 26-like protein, aluminum, organic acid exudation, malate
Heavy metal pollution in agricultural soils and health risk assessment in southwest Guizhou, China

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Abstract:

Heavy metal pollution in sulfide mineralized area was increasingly concerned. In the present study, the pollution characteristics and health risk of Hg, As, Tl and Sb were assessed based on heavy metal concentrations in soils and crops in the Tl-rich sulphide mineralized Lanmuchang area, using the enrichment factor ($EF$) and potential ecological risk index ($RI$) that were calculated to quantitatively assess the potential hazards of Hg, As, Tl and Sb. The results showed that average concentrations of Hg, Tl and As exceed the threshold value of Chinese Environmental Quality Standard for soils. The potential ecological risk index showed that pollution levels were in the order of Tl $>$ Hg $>$ As $>$ Sb for agricultural soils. The enrichment factor of heavy metals ranked in the order of Hg(281.7) $>$ Tl(171.9) $>$ As(34.1) $>$ Sb (15.7) in soils close to the Tl-rich sulfide mine. Local mining activities have significant influenced on heavy metal accumulation in soils and crops. Moreover, human health risk assessment indicated that noncarcinogenic values of Hg, As and Sb exceeded the threshold values, and carcinogenic value for As was higher than the safe value ($1 \times 10^{-6}$). The main exposure pathway of Hg, As and Sb for both children and adults is ingestion of soil particles. Calculation of heavy metal ingestion via crops showed that \textit{Brassica Oleracea} might have potential health risk because of high enrichment for Tl. The results may provide basic knowledge and guidelines for metal pollution remediation in this area.

Key words: Agricultural soil; Pollution characteristics; Risk assessment
Antibiotic Resistance Genes and Associated Environmental Factors in Agricultural Soil Nearby a Smelting Plant

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Abstract:

Soil contamination with antibiotics and heavy metals is a worldwide problem especially in China. The interrelation of antibiotic resistance genes (ARGs), antibiotics, heavy metals and bacterial community in soil is still unclear. Here, seven agricultural areas (G1-G7) were sampled with different distances (741 to 2556 m) along the west of a smelting factory in Henan province in China. High-throughput quantitative PCR was used to detect relative abundances of 310 kinds of ARGs. Ultra performance liquid chromatography-tandem mass spectrometry was used to detect the concentrations of five antibiotics. Eight heavy metals and five physicochemical properties were also measured. The soil bacterial community was analysed by Illumina Miseq. Results showed that a total of 149 ARGs were found in 7 soil samples. The total relative abundances of ARGs (1.09×10^{-2}~3.63×10^{-1}) in G1 sample was the highest (3.63×10^{-1}). In all kinds of ARGs, the sulfonamide resistance genes had the highest relative abundances (3.44 × 10^{-1}). The worst heavy metal pollution was in the nearest farm soil sample (G1) to the factory. The concentrations of Cd, Pb and As in G1 sample were 18.900, 1938.000 and 50.000 mg·kg\textsuperscript{-1} respectively. Cd pollution was found in all 7 samples. The most serious antibiotics contamination was tetracycline (TC) found in G7 sample (1738.534μg/kg). Pearson correlation and Spearman rank correlation displayed relative abundances of 84 ARGs were impacted by 39 certain bacterial phyla, 4 kinds of soil antibiotics, 8 heavy metals, and 5 physicochemical properties. Redundancy analysis and structural equation models both revealed that antibiotics and heavy metals significantly impacted the structure of bacterial community. Network analysis present significant co-occurrence patterns between ARGs and bacterial phyla, indicating strong associations between ARGs and bacterial communities. Taken together, our results indicate that bacterial community was the main influencing factor on abundances of antibiotic resistance genes, while contents of soil antibiotics and heavy metals may influence the distribution of ARGs by affecting bacterial community structure in agricultural soils near a smelting plant.

Key words: Heavy metal; Antibiotic resistance genes; Agriculture soil; Bacterial community structure
Distribution of heavy metals (As, Cd, Pb, Zn) in soil under the influence of the enterprise fundidora avalos in chihuahua, mexico

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Abstract:
Heavy metal pollution in soils has been increasing in last years, due to anthropogenic activities. This pollution generates an alteration to the whole ecosystems as well as might affect human activities included health problems. The objective of this study was to determine the concentration of As, Cd, Pb and Zn in soil within the surrounding area of the former still manufacturing Fundidora Avalos located in the city of Chihuahua, State of Chihuahua, Mexico. A second objective was to define the geographical distribution of those metals within the soil of surrounding neighborhoods. In order to get the soil samples, an imaginary line was draw to the North, South, East and West from the center of the fundidora. In every cardinal direction about each 500 m were collected about 500 g of surface soil which was properly transported to the laboratory for heavy metals determination. Hence, a total of 47 randomly sampling points were selected. Metal concentration was quantified using and an Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES) Perkin Elmer 8300. An ANOVA was performed to detect statistical differences among cardinal points and also, descriptive statistics were used. The ANOVA detected statistical differences among cardinal point in all elements (P<0.05). The As concentration was higher at the East side with 1,281± 14.14 mg kg-1 while slighter amount was noted in the West side with 9.59 ± 16.15 mg kg-1. Likewise, Cd concentration was highest at the East side with 470± 55.1 mg kg-1 while lesser amounts were noted in the West side with 4.18±3.24 mg kg-1. The element Pb was higher in the East side with 2,511±20.71mg kg-1 while lesser amount was observed in the West side with 136± 65.9 mg kg-1. Similarly, the Zn amount was higher at the East side with 3,607± 4842 mg kg-1 and smaller amounts were noted in the west side with 187.9 ± 58.9 mg kg-1. According with these results, it is concluded that some Chihuahua´s neighborhoods are affected for soil pollution in the Fundidora surrounding area.

Key words: Pollution, health, soil, heavy metals.

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Biochar derived from municipal sludge for Cr(VI) reduction

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Abstract:

Chromium (Cr) is one of the most concerned heavy metals in soil pollution. As for that Cr(VI) is far more toxic and mobile in environment than the other stable valence Cr(III), reduction coupled with immobilization is one of the most commonly adopted strategy in the remediation of Cr-contaminated soils. Biochar is a kind of carbon-rich material with abundant active functional groups as well as large adsorptive capacity, and thus received more and more attention in recent years. In the present study, biochar derived from municipal wastewater treatment plant sludge was investigated for its potential application in Cr(VI) reduction. Results obtained from batch tests indicated that the sludge derived-biochar could efficiently remove Cr(VI) from solution through reduction and adsorption. The reduction reaction was very sensitive to pH, as that the Cr(VI) could be directly transformed to Cr(III) by the studied biochar only when \( pH \leq 2 \). The removal efficiency was dependent on biochar dosage and reaction period. Low molecular weight acids, i.e. acetic acid, oxalic acid, malic acid and citric acid, which are ubiquitous in soils, enhanced the reduction efficiency by biochar, though they did not shown significant reduction effect on Cr(VI) solely. The results suggested that the sludge-derived biochar might be a promising amendment for the remediation of Cr contamination. The interaction of biochar and environment properties, i.e. coexisting acids, needs to be further explored.

Key words: chromium, reduction, sludge, biochar
Cadmium contamination of Wetland Sediments in part of Lagos Metropolis, Nigeria

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Abstract:
Cadmium (Cd) is a known human carcinogen and its occurrence in environmental media had elicited several research interests globally, especially among the industrialised nations. However, despite the toxic, non-degradable properties and the health effects of cadmium contamination that have been reported, very little is known about the presence and potential effects of cadmium in developing countries such as Nigeria. This study was therefore undertaken to assess the level of cadmium contamination in Lagos metropolis wetland sediments and the potential health effects. Wetland core (30cm length) sediment samples were collected from identified wetlands in Lagos metropolis. The samples were dried, prepared and analysed for Cd contents using ICP-MS. Result was compared with statutory guideline values and evaluated using geochemical and, ecological and health risk assessment methods.

Cadmium concentration ranged from 1-73mg/kg. The cadmium concentration in all the wetland sediments was observed to be greater than statutory guideline levels as specified by the WHO/FAO (0.05-0.5mg/kg in food), UNEP (0.03-0.3mg/kg) and EU (0.05mg/kg). The calculated mean value for Cd (23 mg/kg) in the wetland sediments was greater than the Effect Range Median as proposed by USEPA (ERM, 9.6mg/kg) indicating a very high likelihood to cause adverse biological effects. Calculated Geo-accumulation and Contamination Factor revealed considerable to very high contamination for Cd while the calculated Pollution Load Index was >1 indicative of general deterioration of the sediment quality. Ecological assessment revealed high risk with mERM-Q (Effects Range-Median Quotient) values for Cd greater than 1.5mg/kg in the wetlands’ sediments indicating highly toxic sediments. The calculated Daily Intake values and Total Chronic Hazard Quotient Index (THI) was > 1 and showed that elevated ecological health risk.

The current Cd status of the wetlands’ sediments is of concern as portions of the wetlands are currently cultivated for vegetables. This could provide appropriate pathway for bio-transfer of Cd into the population that may result in debilitating health conditions.

Key words: Cadmium contamination, Wetland, Lagos metropolis, Geo-accumulation, Ecological risk
Potential Ecological Risk Assessment Model for Toxic Heavy metal Contamination Based on Environmental Bioavailability of Agricultural Soils in Mining Areas

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Abstract:

The aim of this work was to develop a potential ecological risk index to be used as a diagnostic tool for heavy metal contaminated agricultural soils control purposes in mining areas. Taking consideration that the pathway for ecological risk of heavy metal contamination of soil is soil-vegetation-man. The environmental bioavailability largely determines the environmental impact of metal contaminated soils. Using environmental bioavailability explain the environmental toxicity sensitivity of the heavy metals in the soil-vegetation-man ecological system. The model is following:, with . RI = the requested potential ecological risk index for soil; = the potential ecological risk factor for the given substance (i); = the degree of contamination, = the metal concentration in the soil, = the metal concentration for samples from referring area; = the element toxic-response factor for the given substance: Zn = 1, Pb = 4, Cd = 15, Cu = 2, Cr = 11, Ni = 3; = the environment bioavailability ratio factor, = [water soluble fraction + exchangeable fraction / total concentration of the metal in soil × 100%] for the samples of contaminated soil, = [water soluble fraction + exchangeable fraction / total concentration of the metal in soil ×100%] for samples from referring area.

Keywords: Potential ecological risk assessment; Environmental bioavailability ratio factor; Heavy metal contaminated soil; Mining environment
Geochemical evaluation of surface soils and a plant (Musa acuminata) in Ijero-Ekiti area, southwestern Nigeria, in relation to health problems

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Abstract:

This study investigated the trace elements geochemistry of samples of surface soils and a plant (Musa acuminata) in Ijero-Ekiti area, southwestern Nigeria, which has unique basement geology, with rare metal mineralisation and current mining activities. This is aimed at determining the distribution and abundance of toxic and carcinogenic metals in the samples, with a view to discovering whether there is any relationship between geology and the level of toxic /carcinogenic metals contamination, which may negatively impact the health of residents in the area. Samples collected were processed using standard laboratory procedures. They were then analysed for about 25 trace elements, while portions of the dried homogenized surface soil samples were tested for radioactivity. The resulting data were subjected to various treatments and compared with different standards to determine whether or not the samples are contaminated, while human health risk assessment based on consumption of fruits of Musa acuminata was carried out for adults and children inhabitants of the area, using the estimated daily intake of metals (DIM), health risk index (HRI) and carcinogenic risk method (RI). The results showed that some of the soils and Musa acuminata samples contained certain toxic and carcinogenic elements such as As, Be, Cd, Cr and Mo in elevated amounts above recommended standards. This implies that the toxic and carcinogenic elements which are results of both geogenic and anthropogenic contaminations in the soils have entered the food chain (i.e. Musa acuminata). Both adults and children in the area have risks of health problems due to ingestion of toxic elements through consumption of banana (Musa acuminata) grown in the area, with higher risk for adults, while both the adults and children have equal susceptibility to cancer risk.

Key words: Geochemical, Contamination, Soil, Plant, Radioactivity, Health
Sequestration of arsenic through formation of Fe(II, III) minerals in reducing groundwater: Interferences from manganese and phosphate

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Abstract:

Elevated arsenic (As) concentrations in groundwater due to geogenic sources have been found around the globe, threatening the health of over one hundred million people. Iron (Fe) oxides based materials are capable of arsenic removal in water and are widely used in water treatment. However, because most iron oxides are unstable under reducing conditions, they are not suitable for in situ remediation of groundwater As which frequently occurs in reducing aquifers. Recently, nano-particulate magnetite formed by single-stage injection of Fe(II)-nitrate solution has been shown to immobilize As in water through laboratory column experiments. The field implementation of in situ groundwater arsenic remediation, however, is complicated by other aqueous species such as manganese (Mn) and phosphate (PO\(_4^{3-}\)) that can affect mineralization or compete for sorption sites. Lot 86 in North Carolina is a typical contaminated Superfund site containing high concentration of phosphate and Mn in its groundwater. Here, a series of column experiments using saprolitic sediments from the site were reacted with artificial groundwater with 2M phosphate and 10 ppm Mn to mimic site conditions. Co-current with the injection of Fe(II) and nitrate and consistent with prior studies, As concentration in effluents of all experimental systems stayed below 10 µg/L, the WHO guideline value for drinking water arsenic, for more than 100 pore volumes (PVs). Most added iron formed iron(II/III) hydroxides or ferrihydrite, rather than magnetite. Arsenic breakthrough occurred 20-40 pore volumes after the cessation of iron and nitrate additions, and largely related to the saturation of surface sites with phosphate, which was retained much more extensively than was As (adsorbed P:As molar ratio of 200). Thus high concentration of phosphate in groundwater interfered with the sequestration of arsenic. Manganese increased As retention, by either influencing Fe mineralization or through coupled Mn redox processes. Taken together, As appears to be immobilized better possibly when mineral products incorporated impurities such as Mn, and under the influence of complex microbial communities including Mn cycling.

**Key words:** Groundwater arsenic; In situ remediation; Magnetite; Manganese; Phosphate
The effect of different management practices on soil’s physical-chemical parameters: A contribution to the sustainability of Douro vineyards

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Abstract:

Viticulture is an important economic activity and a cultural legacy in many regions of the world. Environmental issues, economic interests, consumer’s concerns, and food safety are awakening the interest of winegrowers to convert conventionally managed vineyards into organic farming. Nevertheless, the advantages of organic farming (both environmental and economic) are still controversial, and the adoption of sustainable practices (e.g.: minimize the use of pesticides), through the implementation of integrated production mode (IPM), can be a solution to improve and maintain soil functions and services, turning these agroecosystems resilient against disturbances. In the Douro Region, well known by the production of Porto wine, in addition to the growing number of vineyards in organic production mode (OPM), the IPM is widely implemented. Since the major difference between these two production modes relies on the type of agrochemicals allowed (synthetic fertilizers and pesticides in IPM; organic fertilizers, S and Cu-based fungicides in OPM), this study aims at evaluate influence of these soil management practices on soil physical-chemical parameters of Douro vineyards. To reach this aim, three areas with similar age vines, but where different practices are implemented, were selected: (i) inorganic fertilizers and synthetic pesticides used in a resistant grape variety; (ii) inorganic fertilizers and synthetic pesticides used in a less resistant grape variety; and (iii) organic fertilization, S and Cu-based fungicides in a resistant variety. The former two areas are under IPM, whereas the last one is under OPM. Several physical-chemical indicators of soil quality (bulk density; texture; water holding capacity; EC; pH; OM; total OC, N, H and S; pseudo-total content and solid phase distribution of inorganic elements) were analyzed in 44 composite soil samples distributed by the three vineyards. In order to evaluate the geological background inputs, reference soils
(forest soils without direct anthropogenic influence) were collected nearby each farm. Sampling took place prior to the pesticide application period (January).

For the indicators studied, differences were observed among the vineyard soils. The level of OM, OC and N were lower in soils under OPM than under IPM. Regarding the content of major elements, only K showed a lower concentration in the soils under OPM, while for the others no differences between areas were observed. For trace elements, the most significant differences were observed for Cu, Mn and As, all showing higher concentrations in the OPM soils. For Cu and Mn, the enrichment is related with the management practices used, whereas the high levels of As have a geogenic source. On the OPM, a considerable percentage of Cu is associated to more labile fractions. The nature of the soils and their geological origin play an important role, turning difficult to conclude which production mode is most beneficial for the maintenance of soil quality.

Key words: Soil Quality; Organic Farming; Integrated Production; Agrochemicals.

Acknowledgments: This research was supported by: the Strategic Funding UID/Multi/04423/2019 (CIIMAR), UID/GEO/04035/2013 (GEOBIOTEC), and UID/AMB/50017/2013 (CESAM), through national funds provided by FCT/MEC and ERDF (PT2020 Partnership Agreement); individual financing to A. Cachada (CEECIND/00058/2017) by FCT/MEC.
Chromium isotope composition of the upper continental crust

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Abstract:

The upper continental crust (UCC) is one of the main circles of human activities. Its average chemical composition is usually used as a basic geochemical parameter for estimating enrichment factor (EF) and geoaccumulation index (Igeo) to identify chromium (Cr) sources and assess soil contamination. The average concentration of Cr in UCC is approximately 35µg g⁻¹, but Cr pollution is widely spread in the surficial environment as Cr is extensively utilized in smelting, leather and dyeing industries. Cr pollution has attracted more attention from researchers because of Cr (VI)’s carcinogenicity. Currently, Cr isotopes have shown a great potential in tracing Cr pollution processes in groundwater. However, as one of the important reservoirs of Cr, the average Cr isotope composition of UCC is still poorly known. In this study, using a suite of samples including granite, loess, stream sediments and glacial diamictites, we constrained the Cr isotopes of the UCC.

The average δ⁵³Cr values of granites are -0.15±0.03‰ (2SD, n=10) for I-type, -0.06±0.02‰ (2SD, n=4) for S-type and -0.06±0.10‰ (2SD, n=3) for A-type. The average δ⁵³Cr values of loess, stream sediments and glacial diamictites are -0.13±0.04‰ (2SD, n=17), -0.17±0.07‰ (2SD, n=6) and -0.15±0.05‰ (2SD, n=4), respectively. The δ⁵³Cr values of samples range from -0.20‰ to 0.01‰, showing no obvious fractionation of Cr isotopes. This indicates that the Cr isotope composition of UCC is relatively homogeneous. Thus, the weighted average of these data, -0.14±0.09‰ (2SD, n=54) can represent the average Cr isotope composition of UCC. Since Cr is a typical redox sensitive element, its isotope fractionation can reach up to ~1‰ during the redox processes but almost no fractionation during Cr (VI) adsorption. This means, if the Cr isotope composition in samples deviates significantly from the average value of UCC, the sample is likely to be affected by redox processes. However, some rocks such as serpentinized ultramafic rocks were reported to have ~1‰ δ⁵³Cr. Therefore, both redox processes and local bedrock composition must be considered when interpreting Cr isotope data. This work was supported by the National Natural Science Foundation of China (41473028 and U1612441)

Key words: Cr isotopes; Upper continental crust; Isotope tracer; Reservoirs.
Antibiotics in soils of typical vegetable fields across an urban-suburban gradient in Guangzhou

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Abstract:

Agricultural soil is considered to be one of the most important destinations of antibiotics. In order to understand the distribution of antibiotics in the agricultural soil across the urban-suburban in Guangzhou, and their possible sources and the influencing factors, the concentration of antibiotics in soil of three kinds of vegetable field from Mangjiao in Haizhu distinct, Dongchong and Hengli in Nansha distinct along an urban - suburban gradient were identified using high-performance liquid chromatography-tandem mass spectrometry (HPLC-MS/MS). A total of 5 categories of 12 antibiotics including sulfonamides (sulfamidine), quinolones (norfloxacin, Pefloxacin, ofloxacin, enrofloxacin, ciprofloxacin), tetracycline (tetracycline, doxycycline, oxytetracycline, chlortetracycline), penicillins (novobiocin), macrolides (oleandomycin) were detected. Both the most antibiotic and the total antibiotic concentration were observed in Mangjiao, followed by Dongchong and Hengli, which was consistent with the gradient from the urban to suburban. Specifically, sulfamidine, doxycycline and oleandomycin were detected in all of the sites. The content of oleandomycin also decreased from the urban to suburb, and the content of sulfamidine varied considerably. However, the content of doxycycline increased from the urban to suburb. In addition, there were significant differences of the antibiotic contamination among different types of vegetable fields. In total, our results suggest that the amount and richness of the antibiotics in the soil of vegetable fields were generally reduced from the urban to suburb in Guangzhou City.

Key words: soil antibiotic, gradient, vegetable field
Geochemical fractionation of natural-occurring thallium pollution in soils of a large-scale Hg-Tl mineralized area

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Abstract:

The Lanmuchang Hg-Tl deposit in Guizhou Province, China is an uncommon large-scale independent Tl deposit in the world. Owing to the natural weathering of Tl-rich sulfides, local soils, rivers, sediments and crops have been highly enriched with Tl. Several Tl poisoning incidences occurred during the 1960s to 1970s, with over 20 people died from Tl poisoning. It is well-known that geochemical behavior and assessing the environmental hazard of Tl in the soil cannot be based only on total Tl content, but mainly on its geo-chemical forms (species) and its binding mode to the soil matrix, which determine mobility, toxicity and bioavailability of Tl. Pertinent studies have investigated Tl geochemical fractionations in the soils/sediments impacted by anthropogenic activities, such as mining, smelting of sulphide minerals, and coal burning. However, it remains largely unknown of the geochemical fractionations of Tl in naturally-occurring polluted soils. In this study, a modified IRMM sequential extraction procedure was applied on different soils from Lanmuchang Hg-Tl mine area to uncover the geochemical fractionations of Tl. The results revealed that the total Tl contents (68.8 - 367 mg/kg) in the soils were exceptionally high as compared to the background values of the Chinese soils. The sequential extraction uncovered that a significant portion of Tl was associated with the mobile fractions (i.e. the sum of reducible, weak-acid-exchangeable and oxidizable fraction). This highlights that the natural-occurring Tl pollution harbors significant environmental risks to local ecological system. Further analysis by STEM-EDS found that Tl is mainly enriched in mineral containing Fe (such as jarosite and hematites).

Key words: thallium, geochemical fractionation, Lanmuchang, soil

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Exploring the Extraction Effect of Four Extractants on the Bio-availability of Mercury in Paddy Soil

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Abstract:

This study was designed to assess the effect of different extracting reagent on bio-availability of Hg in paddy soil collected along the aozhai river in Wanshan mercury mining area. Milli-Q water (18.2 MΩ), 0.1M CaCl₂, 0.1 M HCl, and 0.01 M DTPA were used for extracting bio-availability Hg. THg concentrations in paddy soils decreased significantly with the distance increasing from to the mercury mine, and were positively correlated with the THg concentrations in the rice grain. The bio-availability Hg extracted by these 4 reagent were extremely low and only accounted 0.1‰-0.4‰ of THg in the paddy soils. While CaCl₂ and HCl extracted concentrations were relative higher. No significant correlation was found between bio-availability Hg extracted by these 4 reagent and THg concentrations in rice grains. However, significant correlations were found between bio-availability Hg extracted by these 4 reagent and THg concentrations in paddy soils. Bio-availability Hg extracted by Milli-Q water had the best correlation with THg concentrations in paddy soils, therefore, we proposed that Milli-Q water is the suitable extract used for evaluation of bio-availability Hg in paddy soils.

Key words: mercury mining, extracting reagent, bio-availability, paddy soils
Global change and forest fire: How the burning bush impacts upon environmental and human health

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Abstract:

Forest fire affects the terrestrial ecosystem by both natural disturbance and anthropogenic activities, mostly in the region where meteorological conditions are characterised by higher temperature and low relative humidity. More than 30% of terrestrial ecosystems are subjected to substantial occurrence of fire, specifically western and southwestern United States, Western South Africa, Chile, northern Spain and Australia and are significantly affected by climatic variability.

Fire activities are able to alter the physio-chemical, biogeochemical and hydrological properties of the forest soil and release variety of chemical constituents in the form of ash, charred materials and volatilised components. Many chemical constituents become very mobile due to the complex interaction between combustion of vegetation, heating and interaction of ash with underlying soil, which increase their potential bioavailability. Although many of these chemical constituents are essential nutrients for the sustainable growth of the forest ecosystem, many are hazardous to the environment and human health such as potentially toxic metals (As, Hg, Pb, Cd, Cr, Mn and Zn). Increased overland flow along the burned areas, coupled with an increase in erosion rate (of between 2 to 100%) and strong wind activity results in enhanced metal mobility. Leaching of mobilised contaminants through the soil profile can enhance the surface and groundwater contamination levels and pose significant health risks as forest catchments supply potable water to communities and major cities globally. In addition, human health impacts including hospitalization has increased during and immediately after fire in many regions.

Changing fire regimes directly link to change in climate, and specifically fire activity increases when the climate warms and dries and weather patterns are listed among the major controlling factor of global fire activity. Therefore, as forest fire activity increases in response to global climatic change, the impacts to human and ecosystem health must be evaluated prioritised.

Keywords: Fire, metal mobility, health impacts
Atmospheric Pollution and Human Health
Influential factors and spatial suitability of the method of limestone tablets in a karst carbon cycle study

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Abstract:

The method of limestone tablets (MLT) is an important means to evaluate the dissolution rate of regional carbonate rocks. In the karst carbon cycle, the MLT is often used to calculate the dissolution rate and carbon cycle strength of the regional carbonate rock. However, because of the sensitivity of limestone tablets to environmental factors such as precipitation and temperature, the MLT shows variation in spatial suitability. In this study, data were collected from 45 sites in China from north to south. The effects of rainfall and temperature on the dissolution rate of limestone tablets and the variation of the dissolution rate on the surface (150 cm above the ground surface and on the ground surface) to that beneath the surface (20 cm and 50 cm beneath the ground surface) were analyzed. The results show that rainfall is an important factor affecting dissolution; higher the precipitation, higher the dissolution rate. The effect of temperature on the dissolution rate on the surface is obviously stronger than that beneath the surface because the dissolution rate on the surface is mainly caused by physical weathering. It is more affected by a combination of hydrothermal conditions; the dissolution rate beneath the surface is not only affected by precipitation and temperature, but also related to the soil chemical field, soil microbes, and root activity of the buried point. From the north to south in China, with the increase in precipitation, there is a change in the dissolution rate on the surface and beneath the surface. In general, in southern China, the dissolution rate on the surface is less than that beneath the surface, while in northern China, the dissolution rate on the surface is greater than that beneath the surface. The areas where the dissolution rate on the surface is greater than that beneath the surface is approximately within the range of 300–600 mm of annual precipitation and the average annual precipitation in these areas is 594 mm. In the areas where the annual precipitation is 1100 mm, the dissolution rate on the surface and beneath the surface are similar. In the areas with an average annual rainfall of 1400 mm, the dissolution rate beneath the surface is greater than that of the surface. To further clarify the influential factors of carbonate dissolution and explore the suitability of the MLT in carbon sink research, further research was conducted in the Nanchuan River Basin in a karst area of northern China, Qingliangsigou basin in a
northern loess area, and middle and upper reaches of the Wujiang River of southern karst area. The results show that in addition to temperature and rainfall, the dissolution rate is also affected by lithology and soil chemical field. The effect of lithology on the dissolution rate is higher acid insolubles and a lower dissolution rate. Further investigation of the dissolution rate beneath the surface showed that there is a strong positive correlation between the dissolution rate beneath the surface with the soil CO2 (carbon dioxide) concentration in both the northern and southern karst areas of China. However, because of the high soil inorganic carbon content in the northern loess area, it shows the opposite characteristics of the karst area, resulting in a dissolution rate that is low or even negative. Because the loess area often contains high carbonate components he MLT is not suitable for carbon cycle research in the loess area. In the northwestern and northern China arid and semi-arid areas other than the loess area, carbon sink study using the MLT should avoid field test sites of high soil inorganic carbon content.

Keywords: karst carbon cycle; method of limestone tablets; influential factors; carbona
**Gridded emission inventory and atmospheric fate of lead from anthropogenic sources in China**

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**Abstract:**

Lead (Pb), a typical toxic heavy metal, has raised widespread concerns due to its adverse effects on the ecological environment and human health. In the present study, the atmospheric Pb air concentration and dry as well as wet deposition were simulated using an Euler atmospheric transport model CanMETOP (Canadian Model for Environmental Transport of Organochlorine Pesticides) based a gridded emission inventory of atmospheric Pb over China. The gridded emission inventory of contaminants is a critical stage for modeling atmospheric fate and evaluating regional or global emission characteristics as well as health risk. This study firstly developed a gridded Pb emission inventory from primary anthropogenic activities with a 1/4 longitude by 1/4 latitude resolution in China for 2016, which was generated based on provincial activities data and emission factors. The gridded atmospheric Pb emission inventory showed that total national Pb emission was 9774.91 tons for 2016, in which Shanxi province contributed the largest emission, followed by Shaanxi province. Coal consumption by industrial boilers was a major anthropogenic emission sources in China, contributing 6104.70 tons to the total atmospheric emissions of Pb for 2016, followed by coal consumptions by other sectors (1,158.26 tons) and liquid fuels combustion (1,083.71 tons). The higher anthropogenic emission densities were located along central Shaanxi, south-central Shanxi, southwestern Hebei, Yangtze River Delta and Pearl River Delta regions. The modeling results exhibited that higher annual average concentrations of atmospheric Pb were found in North China Plain, Sichuan Basin and Central and Eastern Henan. The areas with the highest dry deposition flux was mainly loaded at the regions covered large-scale forest including the Daxinganling, southeast coast regions and the Green Wall of China. The model caught that higher wet deposition fluxes mainly were occurred at central and eastern regions of China affected by precipitation. The good consistency between simulated and observed data was observed, supporting the reliability and credibility of the gridded Pb emission inventory that was established in the present study.

**Key words:** Lead; Atmospheric gridded emission inventory; CanMETOP model; Atmospheric concentration; Dry and wet deposition.
Geochemical Evaluation and Health Risk Assessment of Heavy Metals in Road Dust of an Urban City Southwestern Nigeria

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Abstract:

Emission of road dust, consequence of over-population and Industrialisation has become a major threat to public health especially in developing countries like Nigeria. The research work is therefore aimed at evaluating the geochemical impact of heavy metals and its eventual health risk consequences on an urban city of Southwestern Nigeria. Two 5 kg weight of soil samples were collected each along major roads within the metropolis, and all the samples were collected at the dry season. Samples collected were thoroughly mixed in a clean plastic container to obtain a representative sample, pulverised, sieved (65µ), digested and analysed using Atomic Absorption Spectrometer (AAS). Results when compared with USEPA (2002) permissible limits revealed Pb, Cd, Cr and As to be above the limits, while the others are below. Contamination factor showed uncontaminated to extremely contaminated by heavy metals. A high non-carcinogenic risk of disease was observed on adults and children through dermal and ingestion pathways while Cr contributes highly to major carcinogenic risk in the area. Heavy metal pollution of road dust is now eminent in the city and more sensitization of its effect has to be done.

Keywords: Geochemical, Heavy metal, Industrialisation, Public Health, Road Dust
Heavy metal assessment in classroom of dust of Abeokuta, Southwest, Nigeria

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Abstract:

Children the most sensitive target groups of exposure to heavy metals due to their small body size, developing nervous system, high absorption rate and behavioral pattern present during childhood are subjected to polluted soils in schools of most developing countries such as Nigeria mainly through inhalation. An assessment of the impact of heavy metals in dusts of Nursery Schools was done in the Abeokuta, Southwest, Nigeria. Twenty-one (21) classroom dust samples were obtained from a nursery and primary school in Abeokuta using plastic scoop, brush and a zip lock bag, samples were dried under normal room temperature and sieved into a fine fraction of 63µm. The samples were subjected to aqua regia microwave digestion and then analyzed. Result revealed all the metals to be within the USEPA (2010) permissible limits with the exception of Fe that was observed to be most polluted in the area. This could be due to the impact of surrounding dye industry, aluminum industries, and mechanic shops found around the school sampled. This result was confirmed by the contamination factor and geo-accumulation index (Igeo) which showed strongly to extremely polluted in the study area. In conclusion, the values obtained in this study are lower than expected and are of low ecological and health risk but it is still a source of concern since children are exposed to this environment daily and for appreciable period of time.

Key words: Children, Classroom, Polluted, Behavioral pattern, Heavy metals
Association between maternal exposure to moderate ambient sulfur dioxides and preeclampsia

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Abstract:

Previous studies have suggested that endogenous sulfur dioxides cause endothelium-dependent vasodilation and lowers blood pressure. However, few studies have examined the associations between ambient SO\textsubscript{2} exposure and the risk of preeclampsia. Current population based cohort study was conducted to examine the hypothesis that maternal exposure to ambient SO\textsubscript{2} may decrease the risk of preeclampsia. Air pollutants and obstetric data were obtained from a provincial air quality monitoring system and perinatal surveillance system, respectively, in Canada. Two datasets were linked by zip codes both for monitoring station and residence of pregnancy. Pregnancies with singleton live birth but without chronic hypertension from 2005 to 2009 were the study subjects. Logistic regression models were used to estimate the adjusted odds ratios (aORs) for SO\textsubscript{2} exposure on developing of preeclampsia. 290,101 pregnancies entered final analysis. Of which, 4,025 had a diagnosis of preeclampsia with an incidence of 1.39\%. The incidences of preeclampsia in women exposed (average exposure throughout pregnancy) to the lower (0~1ppb) and higher (1.25~4ppb) concentration of SO\textsubscript{2} were 1.66\% and 0.90\%, respectively. SO\textsubscript{2} exposure was negatively associated with preeclampsia (OR= 0.535 [95\% CI, 0.476, 0.601]). After adjustment for potential confounding factors, odds ratio (aOR= 0.600 [95\% CI, 0.527, 0.684]) has no substantial change. Similar effects were observed during different exposure windows. In conclusion, exposure to moderate level of ambient SO\textsubscript{2} during pregnancy was associated with a decreased risk of preeclampsia in this cohort study. SO\textsubscript{2} in moderate concentrations may be a protective factor for preeclampsia. The effect of SO\textsubscript{2} on preeclampsia warranted further studies.

Key words: Sulfur dioxides, Ambient air pollutants, Preeclampsia, Cohort study
Association between maternal exposure to moderate ambient carbon monoxide and risk of hypertensive disorder of pregnancy

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Abstract:
Hypertensive disorders of pregnancy (HDP), including gestational hypertension, preeclampsia and eclampsia, affect 3-10% pregnancies worldwide. Previous studies have reported the relationship between ambient carbon monoxide (CO) exposure and the risk of HDP/preeclampsia, with inconsistent results of null or slightly positive association. The aims of this study were to examine whether maternal exposure to ambient CO was associated with HDP. A provincial birth record system in Canada was used in the study. Pregnancies with singleton live birth but without chronic hypertension from 2005 to 2007 were the study subjects. The ambient CO database was linked to the perinatal database through the postal code of mother’s residence. Logistic regression models were used to estimate odds ratios (ORs) and 95% confidence intervals (CIs) for the associations between ambient CO and HDP. Among the eligible population of 188,681 subjects, 6,218 (3.3%) had a diagnosis of HDP. The incidence of HDP was 5.31% (877/16,504), 3.29% (549/16,705), 3.32% (620/18,648), and 2.68% (423/15,813) for CO quartiles 1 (0.06-0.24ppm), 2 (0.24-0.29ppm), 3 (0.29-0.31ppm), and 4 (0.31-0.50ppm), respectively. The entire gestational period and the trimester-specific CO-HDP associations were all similar. In the adjusted model, consistent results (OREntire=0.67, 95% CI: 0.63, 0.72; ORTrimester1=0.85, 95% CI: 0.81, 0.89; ORTrimester2=0.80, 95% CI: 0.84, 0.81; ORTrimester3=0.78, 95% CI: 0.74, 0.81) were observed after adjustment for potential confounding factors. In summary, our results suggested that maternal exposure to moderate level of ambient CO was independently associated with a decreased risk of HDP in the population based cohort. Further studies were warranted to replicate our findings and explore the underlying biological mechanisms.

Key words: Carbon monoxide, Ambient air pollutants, Hypertensive Disorder of Pregnancy, Cohort study
Distribution of Indoor Radon Levels in Azerbaijan and its Potential Health Effects
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Abstract:

According to the data of the World Health Organization, radon is one of the most cancer-inducing and radioactive gases. Lung cancer induced by radon exposure is the sixth leading cause of death from cancer. The radon problem has been long studied in different countries, including countries where the ecological situation is considered favorable. The radon level in residential premises had not been determined in Azerbaijan until 2010. The first studies of the indoor radon volume activity were performed in Azerbaijan in 2010-2011 with financial support from the Swiss national Science Foundation (SNSF) as a part of a grant (Development of Radon Survey and a Map of Radon Distribution in Azerbaijan Using Swiss Technology and Experience). These studies were carried out jointly by the Radon Competence Centre (RCC) of the University of Applied Sciences and Arts of Southern Switzerland (SUPSI) and the Institute of Geology and Geophysics of ANAS. In 2014-2015 the investigation of radon problem in Azerbaijan has been continued in the framework of Azerbaijan State Program (2014-2018). The measured indoor radon concentrations vary in a broad range. Based on the data the map of distribution of radon volume activity has been constructed. The map shows that regions with the enhanced levels of radon volume activity are attributed to fold-mountain massifs; lower values are typical for the Kurin Lowland composed of modern sediments. The results of measurements of radon volume activity in indoor air are in good agreement with data of radon content in the soil air. Higher concentrations of radon in the soil air were recorded mostly in the seismically active regions, where the enhanced values of radon volume activity were also observed indoors. During data comparison a definite correlation between high levels of radon concentration and lung cancer risk has been revealed.

Key words: indoor radon, radon exposure, radon volume activity
Nasopharyngeal microbiota diversity and community structure is associated with different ambient PM2.5 exposure

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Abstract:

Previous studies showed that high concentration of particulate matter (PM) 2.5 carried a large number of bacterial and archaeal species, including pathogens and opportunistic pathogens which have a serious impact on human microecological system and health. In this study, two nasopharyngeal (NP) swabs (PH sampled in March and UH sampled in September) were collected from each healthy volunteer enrolled in two consecutive visits (6 months apart). Any other environmental factors such as SO2, NOX or O3 had no significant difference (P > 0.05) between two different period of sampling except PM2.5 (P < 0.001). All of 16 nasopharyngeal swab samples corresponding to 8 health undergraduate students were collected for pyrosequencing by amplification of the 16S rRNA V3-V4 regions and bioinformatic analysis. About 724742 valid reads were obtained and clustered into 2902 modified operational taxonomic units (OTUs) at 97% identity, belonging to 28 phyla, 76 classes, 135 orders, 241 families, 389 genera and 432 species. Alpha diversity analysis based on Shannon-index and observed OTUs displayed no significant difference between group PH and UH. On the phylum level, the NP microbiota mainly contained Firmicutes (36.5%), Proteobacteria (34.7%), Bacteroidetes (14.1%), Actinobacteria (4.3%), Fusobacteria (3.9%) and Acidobacteria (2.4%). At the genus level, the NP microbiota was dominated by 16.0% Streptococcus, 11.8% Neisseria, 10.0% Symbiobacterium, 5.8% Prevotella, 5.2% Haemophilus, 4.5% Enhydrobacter, 3.6% Porphyromonas, 2.6% [Prevotella], and 2.4% Fusobacterium while 0.1% Staphylococcus, 0.1% Corynebacterium and 0.1% Moraxella were found out as rare genera (relative abundance < 1%). Beta diversity analysis showed that the bacterial composition and community structure altered markedly among two group (P=0.042). The LEfSe analysis found out 31 differential taxa. In the PH group, Nitrospirae and Armatimonadetes were relatively more abundant on the phylum level, while Symbiobacterium, Rhodoplanes and Nitrospira were enriched on the genus level. However, Streptococcus, Staphylococcus, Prevotella, Cloacibacterium and Enterococcus were significantly higher in the UH group which all of these taxon could be considered as potential biomarkers. Network analysis and function predictions were performed as well. So, we could conclude that exposure to comparatively high PM2.5 might altered the composition and structure of NP microbiota, which may introduce unexpected health risks, especially respiratory infections. Future, the mechanism and function of NP microbiota need to be further studied

Key words: Nasopharyngeal microbiota, bacterial diversity, PM2.5, 16S rRNA
Characterization of Fine Particulate Matter and Associated Health Burden in Nanjing

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Abstract:

Particulate matter (PM) air pollution has become a serious environmental problem in Nanjing and poses great health risks to local residents. In this study, characteristics of particulate matter with an aerodynamic diameter less than 2.5 μm (PM2.5) over Nanjing were analyzed using hourly and daily averaged PM2.5 concentrations and meteorological parameters collected from nine national monitoring sites during the period of March 2014 to February 2017. Then, the integrated exposure-response (IER) model was applied to assess premature mortality, years of life lost (YLL) attributable to PM2.5, and mortality benefits due to PM2.5 reductions. The concentrations of PM2.5 varied among hours, seasons and years, which can be explained by differences in emission sources, secondary formations and meteorological conditions. The decreased ratio of PM2.5 to CO suggested that secondary contributions decreased while the relative contributions of vehicle exhaust increased from increased CO data. According to the values of attributable fractions (AF), stroke was the major cause of death, followed by ischemic heart disease (IHD), lung cancer (LC) and chronic obstructive pulmonary disease (COPD). The estimated total deaths in Nanjing due to PM2.5 were 12,055 and 10,771, leading to 98,802 and 87,647 years of life lost in 2014 and 2015, respectively. The elderly and males had higher health risks than youngsters and females. When the PM2.5 concentrations meet the World Health Organization (WHO) Air Quality Guidelines (AQG) of 10 μg/m³, 84% of the premature deaths would be avoided, indicating that the Nanjing government needs to adopt more stringent measure to reduce PM pollution and enhance the health benefits.

Key words: fine particulate matter, health burden, integrated exposure-response model.
Heavy metal pollution in urban construction dust of China and human health risk assessment

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Abstract:

Environmental pollution caused by urban construction has been of great concern. Construction dust has been recognized as an important contributor to heavy metal exposure of human. In this study, we conducted a comprehensive study to investigate geographical variation, source and bioaccessibility of heavy metal in urban construction dusts from 7 cities in China, as well as human health risk assessment. Particle size in construction dust samples averaged between 30-70μm, in which fine particle dominated. The median concentrations of heavy metal in construction dusts from 7 cities ranged from 23.8 (Ganzhou)-143 mg/kg (Wuhan) for Cr, 6.14 (Ganzhou)-12.6 mg/kg (Shijiazhuang) for Co, 3.47 (Ganzhou)-28.9 (Wuhan) mg/kg for Ni, 24.4 (Ganzhou)-62.2 (Wuhan) mg/kg for Cu, 68.6 (Ganzhou)-261(Hanzhou) mg/kg for Zn, and 41.8 (Chongqing)-72.4 mg/kg (Wuhan) for Pb, respectively. Compared with other countries, Chinese construction dusts had higher concentrations of Pb, Ni, and Cr, but lower concentrations of Cu and Zn. The enrichment factors of heavy metal in construction dusts decreased in the order of Zn>Pb>Cu>Cr>Co>Ni, however, their bioaccessibility followed descending order: Zn>Cu>Pb>Co>Ni>Cr. Potential sources of heavy metal in construction dusts may be classified as: Cr and Ni related to soil weathering and alloy use, Cu, Zn, and Pb related to traffic activities (e.g. tractor, excavator, loader, and unloader), Co related to construction cement. Human health risk assessment showed that hazard index (HI) of Cr in Chinese construction dust exposure to children was higher than 1, indicating high non-carcinogenic risk of children exposure to construction dusts. The risks of carcinogenic exposure to heavy metal in construction dusts decreased in the order of Cr>Ni>Co. The overall risks of carcinogenic exposure to Cr in construction dusts from all cities (except Ganzhou) exceed 1×10⁻⁴, indicating adverse health effect to human exposure to construction dusts.
Emission reduction control on surface O3 in Lanzhou

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Abstract:

Located in the western part of the Loess plateau, Lanzhou is a typical industrial city in semi-arid northwest China. Lanzhou is also the first city in China to report the occurrence of photochemical smog which is associated with O3. Using the WRF-Chem model and MEIC emission inventory of atmospheric pollutants, we designed 11 modeling scenarios by increasing and decreasing the emission of O3 precursors VOCs and NOx to simulate and examine the relationship between surface O3 and changes in NOx and VOCs in summer 2016 in Lanzhou. The results revealed that the changes in surface O3 is more sensitive to VOCs. It was found that surface O3 in the downtown area of Lanzhou was controlled by VOCs and petrochemical-industrialized western suburb by NOx. Typical topography, geographical location, and climate of Lanzhou city plays an important role in the heavy O3 pollution and formation. Located in a mountain-valley terrain and semi-arid region, the calm winds, strong sunlight/radiation, and low humidity in Lanzhou favor particularly the O3 formation. In general, higher O3 levels were simulated in the west suburb of the city as compared with the downtown area, agreeing with measurements. Xinglong Mountain in the east of the city plays an important role in the atmospheric transport and growth of ozone in the urban area, which is likely related to the “downstream effect” and topographic forcing. The model experiments provided useful references to the reduction strategy of O3 precursors and the O3 mitigation in Lanzhou.

Keywords: ozone concentration, emission reduction control, WRF-Chem model, Lanzhou city
Transfer of Arsenic from Mother to Neonate in Relation to Pregnancy Complications

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Abstract:
Damage to placental barrier function during gestational diabetes mellitus (GDM) and gestational hypertension (HDCP), leads to a high risk of intrauterine exposure of arsenic (As). In this study, total Cd of maternal blood, placental and umbilical cord blood were measured in 29 healthy pregnant women and 14 pregnant women with GDM, 14 pregnant women with HDCP, 15 pregnant women with HDCP and GDM. Maternal blood and umbilical cord blood were collected during childbirth and the mother’s family social status was investigated. For As, the ratio of maternal blood to umbilical cord blood >1 in the case group were lower than that in the normal group. The role of placental barrier in the case group was weaker than that in the normal group, and placental accumulation was an important manifestation of the placental barrier. Placenta barrier effect weakened, resulting in fetal prenatal exposure to heavy metals, heavy metals from the mother is more likely to pass the fetus, resulting in prenatal exposure to intrauterine high risk to the fetus a high degree of health risks.

Key word: Gestational diabetes mellitus Gestational hypertension Arsenic Placental barrier Maternal blood Umbilical cord blood
Assessment of health risk from exposure to Cu, Zn, Cd and Pb pollution in urban street dust in China between 2006 and 2016

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Abstract:

Since heavy metal pollution is widespread in street dust in China, the effects of heavy metals in street dust on human health cannot be ignored. However, studies estimating heavy metal pollution in street dust nationwide are limited. In this study, the concentrations of Cu, Zn, Cd and Pb in street dust at 3,506 sites throughout China were obtained from the published scientific literature. Based on these data, the contamination levels, spatial distributions, sources and potential health risks of heavy metals in street dust were comprehensively estimated. The results revealed that Cu, Zn, Cd and Pb levels are generally higher in the southeast provinces than in northwest China. In addition, traffic emissions and industrial activities are determined to be the two main sources of heavy metal pollution in street dust. The spatial distribution of health risks suggested that the health risks are more serious in southeast China than in northwest China. The noncarcinogenic risks posed by Pb are relatively higher than those posed by the other three metals for both children and adults. Meanwhile, none of the hazard index (HI) values exceeded the safe level (1.0), with the exception of Pb in Daye city for children (HI=1.074). The HI values for children were higher than those for adults. Therefore, children should be prioritized for protection from heavy metal pollution.

Keywords: Street dust; heavy metal pollution; spatial distribution; health risk; China
Airborne particulates: a potential exposure pathway of Tl around a Tl mineralization area in Southwest Guizhou, China

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Abstract:
Thallium (Tl), as a typical dispersed element, usually presents in low concentration in nature, but some specific sulphide minerals (eg. Cinnabar, realgar, lorandite, orpiment and pyrite) might enrich high Tl concentration, and even Tl-rich deposit might be formed owing to epithermal metallogenesis. Lanmuchang, located in the southwest Guizhou, China, is a typical Tl mineralization area, it suffers from serious Tl pollution resulted from mining activities since early 1960s, and thallotoxicosis has ever bursted in 1960s, 1970s and 1990s. In past two decades, increasing researchers attempted to reveal the accumulation, migration and transformation of Tl in different environmental mediums (eg. soil, sediment, water and plant), and its human health impacts. However, there is few study on airborne particulates, which could be a potential migration pathway of Tl in Lanmuchang area. Thus, this study attempts to verify that, 1) whether might the airborne particulates accumulate elevated Tl? 2) and might it be another potential Tl exposure source for local inhabitants in Lanmuchang area? Fifteen airborne particulates were collected from window sill and/or roof of local dwellings within Lanmuchang area, Southwest Guizhou. Tl and other metals concentrations were analysed by ICP-MS. Results showed that, Tl concentrations in airborne particulates were 1.86-48 mg/kg in Lanmuchang mineralization area, and higher than the background value of Tl in China soil (0.29-1.2 mg/kg). Elevated As (29.7-248 mg/kg), Cd (0.4-2.39 mg/kg) and Sb (7.36-46.9 mg/kg) concentrations were also found. The Geo-accumulation indices showed that in airborne particulates, Tl, As and Sb were strong-extremely polluted meanwhile Cd was low-modestly polluted. Correlation analysis showed that Tl was significantly correlated with As, suggesting that Tl and As might be originated from same sources. In a word, it is confirmed that the inhalation of airborne particulates is a very important exposure pathway of Tl and other metals for local residents in study area.
Regional and seasonal variations of PM2.5 toxicity to A549 cells and the component contributions in a megacity of eastern China

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Abstract:

Atmospheric fine particulate matters (PM₂.₅) induce adverse human health effects through inhalation, and the harmful effects of PM₂.₅ are determined not only by its air concentrations, but also by the particle components varied spatially and temporally. To investigate these differences, both various components and their toxic effects on human alveolar basal epithelial cells (A549) were analyzed for PM₂.₅ samples collected from different functional areas of Nanjing city, eastern China during a whole year. Results showed that, regional and seasonal differences of toxicity effects of PM₂.₅ and its components differed significantly, and the PM₂.₅ samples from industrial area showed stronger toxicity. The transition metals in particles, water soluble ions and organic extracts are important contributors to the overall aerosol cell toxicity. Therefore, for reasonable health risk assessments of aerosol pollution, both the inorganic and organic components of PM₂.₅ should be considered.

Key words: Atmospheric particles; Compositions; Health effects; Cytotoxicity; Heavy metals
Isotopic composition of atmospheric total gaseous mercury and particulate bound mercury in remote areas of China

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Abstract:

China presently contributes the largest amount of anthropogenic mercury (Hg) emission into the atmosphere in the world. In this study, isotopic composition of atmospheric total gaseous Hg (TGM) and particulate bound Hg (PBM) were measured at Mt. Waliguan (MWLG), Mt. Changbai (MCB), Huaniao Island (HNI), Mt. Ailao (MAL), and Mt. Lulin (MLL) to investigate the sources and transport of atmospheric Hg in remote areas in China. δ²⁰²Hg of TGM at the monitoring sites varied significantly with mean values of 0.52±0.35‰ (1sd), -0.21±0.39‰ (1sd), 0.22±0.25‰ (1sd) and 0.04±0.21‰ (1sd) at MCB, HNI, MAL, and MLL, respectively. Mean values of ¹⁹⁹Hg of TGM at MCB, HNI, MAL, and MLL were -0.18±0.04‰ (1sd), -0.16±0.06‰ (1sd), -0.08±0.08‰ (1sd) and -0.22±0.04‰ (1sd), respectively. We suggest that the isotopic signatures of TGM were impacted by a combined effect of anthropogenic emission and vegetation uptake. At MCB and MLL, TGM δ²⁰²Hg were mainly controlled by the forest uptake of TGM, while at HNI and MAL, regional and long-range transport of TGM from anthropogenic sources regulated the variations of TGM δ²⁰²Hg. Mean δ²⁰²Hg of PBM were -0.83±0.39‰ (1sd), -1.45±0.45‰ (1sd), -0.84±0.29‰ (1sd) and -0.88±0.31‰ (1sd) at MWLG, MCB, MAL and HNI, respectively. ¹⁹⁹Hg of PBM varied significantly at the monitoring sites (mean = 0.07‰ to 0.10‰). PBM ¹⁹⁹Hg was relatively higher in cold than warm season at the sites in northwestern and southwestern China, whereas the opposite was found at the site in northeastern China. Our analysis indicates that the seasonal variations in PBM ¹⁹⁹Hg were influenced by the exposure of air masses to regional and long-range sources in the preceding several days, with the former characterized by lower PBM ¹⁹⁹Hg and latter characterized by more positive PBM ¹⁹⁹Hg due to sufficient atmospheric transformations. At MCB and HNI, elevated PBM concentrations were mostly associated with ¹⁹⁹Hg close to zero, suggesting anthropogenic sources contributed significantly to PBM pollution at the two sites. On the other hand, elevated PBM concentrations at MAL were mostly associated with significantly positive ¹⁹⁹Hg values, which were likely attributed to the long-range transport of PBM from South Asia.

Key words: Atmospheric mercury; Sources; Transport; Mercury isotope
Forecasting PM2.5 induced lung cancer mortality and morbidity at county level in China using satellite-derived PM2.5 data from 1998 to 2016 and spatial analysis

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Abstract:

Background: Evidence from previous studies has showed that ambient fine particulate matter (PM2.5) was one of key risk factors of lung cancer. Moreover, recent studies have indicated the impact of PM2.5 regional transport and internal migration on population health.

Objectives: In this study, we aim to predict the spatial distribution of lung cancer morbidity and mortality in China due to exposure to PM2.5 concentration in 2015 and 2016.

Methods: We used 1194 counties/cities lung cancer morbidity and mortality data from Chinese cancer registration from 2006 to 2014. The annual concentrations of global surface PM2.5 at 0.01°×0.01° spatial resolution from 1998 to 2016 were collected. A spatial autocorrelation method was used to investigate spatial clusters of lung cancer. Two group variables were used to establish the forecasting model, one contains local yearly mean PM2.5 concentration and previous 8 years while the other contains the yearly mean PM2.5 concentration of those neighbor counties of a certain county and previous 8 years. Ridge regression (RR), partial least squares regression (PLSR), model tree (MT), regression tree (RT) and the combined forecasting model (CFM) were alternative methods used to predict the lung cancer morbidity and mortality in 2015 and 2016. A kriging interpolation method was used to obtain the spatial distribution of lung cancer mortality and morbidity.

Results: A total of 720,563 and 595,002 lung cancer morbidity and mortality cases were reported in China from 2006 and 2014, of which 481,413 (66.8%) were male, 239,277 (33.2%) were female in morbidity, 404,679 (68.01%) were male, 190,323 (31.99%) were female in mortality. The morbidity and mortality of lung cancer showed an increasing trend from 2006 to 2014, as well as the yearly mean PM2.5
concentration. Spatial autocorrelation analysis indicated that the morbidity and mortality of lung cancer and PM2.5 concentration were significantly spatial autocorrelated for each year in China. The combined forecasting model showed the best performance through a 1000-loops simulation among five alternative models. Through the forecast estimated by CFM of 2408 counties in China, the morbidity and mortality of lung cancer rise steadily. Results from kriging method suggested a similar spatial distribution in morbidity and mortality of lung cancer in 2015 and 2016, and high morbidity and mortality of lung cancer areas were mainly located in central-east coast districts.

**Conclusions:** The spatial distribution of lung cancer morbidity and mortality were identical with the spatial pattern of PM2.5. These findings may help stakeholders implement a cross-regional PM2.5 control strategy for the areas characterized by the high risk of lung cancer.

**Key words:** Forecasting; Lung cancer; satellite-derived PM2.5 data; spatial analysis

**Highlight:** Long-term and high spatial resolution satellite-derived PM2.5 concentration data.
Long-term and national morbidity and mortality of lung cancer data.
Local and neighbor PM2.5 concentrations were taken into consideration simultaneously.
A forecast of PM2.5-related cancers mortality and morbidity on county level in China based on satellite-derived PM2.5 data from 1998 to 2016 and spatial analysis

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Abstract:

Air pollution, especially ambient fine particular matter (PM2.5), is becoming increasingly serious in China, but there are limited studies which analyze the relationship between PM2.5 and PM2.5-related cancers using satellite retrieved data and spatial analysis simultaneously on the county level. Thus, this study aims to predict spatial distribution of PM2.5-related cancers, namely breast cancer, pancreatic cancer, and all-cause cancer, and their mortalities and morbidities in 2015 and 2016 and draw a series of forecasting maps of those PM2.5-related cancers. A total of 1194 counties or cities morbidity and mortality data of breast cancer, pancreatic cancer, and all-cause cancer were included, we also collect the annual concentration of global surface PM2.5 concentration derived from satellite at 0.01°×0.01° spatial resolution. A spatial autocorrelation method was carried out to estimate the spatial relationship between those cancers morbidities and mortalities and satellite retrieved PM2.5 concentration from 2006 to 2014. 18 independent variables were used to establish the model, which consist of two group: one contains local annual mean PM2.5 concentrations in a specific year and previous 8 years while the other contains the annual mean PM2.5 concentrations of those neighbor counties of a certain county in this specific year and previous 8 years. After that, a 1000-loops simulation was conducted to choose the optimal one between five alternative models, namely ridge regression (RR), partial least square regression (PLSR), regression tree (RT), model tree (MT), and the combined forecasting model (CFM) for every cancer. Then, we chose the optimal models to forecast the mortalities and morbidities at county level,
2408 sites, in China. A kriging interpolation method was used to draw the distribution maps in 2015 and 2016. The trend showed a gradual increase in the mortality and morbidity of those cancers. Forecasted results of 2408 counties in China showed a constant growth in mortality and morbidity of all cancers, and the kriging method suggested a similar spatial distribution, it can also be found that high morbidity and mortality areas were mainly in central-east and south-east of China. Through those analysis and making of forecasting maps, we found the similar distribution pattern between PM2.5 concentration and PM2.5-related cancers mortality and morbidity, which can give a valuable reference to develop the effective politics.

**Key words:** PM2.5-related cancer; satellite-derived PM2.5 data; forecast; spatial analysis
Association between maternal exposure to ambient air pollution and newborn telomere length

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Abstract:
Background: Telomere length (TL) is considered a marker of biological aging and has been associated with aging-related diseases. The initial setting of newborn TL has important implications for telomere dynamics over the lifespan, and is influenced by the intrauterine environment. However, little know about the effect of maternal air pollution exposure on this initial setting.

Objectives: We aimed to explore the trimester-specific associations between maternal air pollution exposure and newborn TL.

Methods: Between November 2013 and March 2015, a total of 762 mother-newborn pairs were enrolled in a birth cohort study in Wuhan, China. Relative cord blood TL was measured using the quantitative real-time polymerase chain reaction. A spatial-temporal land use regression model was used to estimate the concentrations of PM2.5, PM10, SO2, NO2, and CO for three trimesters of pregnancy. Multiple informant models with were used to explore the trimester-specific associations between maternal air pollution exposure and cord blood TL. To further explore the nonlinear dose-response relationship between maternal air pollution exposure and cord blood TL, we carried out a restricted cubic spline analysis. The results in our study are shown as percent change and 95% confidence intervals (CI).

Results: After adjustment for maternal age, educational level, pre-pregnancy BMI, passive smoking during pregnancy, parity, hypertensive disorders of pregnancy, gestational diabetes, birth weight, gestational age, infant sex, and season at delivery, a 10 μg/m³ increase in PM2.5, PM10, SO2, and a 100 μg/m³ increase in CO during the third trimester were associated with 3.71% (95% CI: -6.06%, -1.30%), 3.24% (95% CI: -5.29%, -1.14%), 11.07% (95% CI: -18.86%, -2.53%), and 3.67% (95% CI: -6.27%, -1.00%) shorter cord blood TL, respectively. The spline analysis showed linear associations between cord blood TL and maternal exposure to PM10, SO2, and CO during the third trimester, while a reverse J-shaped relationship for maternal PM2.5 exposure. In the stratified analysis, maternal exposure to PM2.5, PM10, SO2, and CO during the third trimester was inversely associated with cord blood TL in male infants, but not in female infants.

Conclusion: Our findings suggested that maternal exposures to PM2.5, PM10, SO2, and CO during the third trimester were related to shorter TL in newborns, which may help us to understand the “programming” effect of the adverse intrauterine environment on the newborn telomere and highlights the importance of improving air quality in favor of subsequent health of newborns.

Keywords: Air pollution; telomere length; maternal exposure; newborns, trimester-specific
Personal air pollution exposure in New York City bicycle commuters:

Evidence from the Biking & Breathing study

Qiang Yang, Cara Smith, Darby Jack, Jonathan Thornburg, Patrick Kinney, Xinhua Liu & Steven Chillrud

Abstract:

Highly resolved data offer novel insights into where and when urban residents inhale air pollution, and have the potential to inform both individual behavior and urban planning policy. Drawing on a novel high resolution dataset collected by repeat measurements by volunteer bicycle commuters in New York City, we quantify spatial and temporal heterogeneity in air pollution exposures, and relate these exposures to cardiovascular risk factors, including blood pressure (BP) and heart rate variability (HRV). Personal black carbon (BC) and fine particulate matter (PM2.5) monitors were used to assess exposure. Minute ventilation (MV) and HRV were assessed using a biometric shirt. An ambulatory blood pressure monitor logged BP automatically. GPS locations during cycling were logged through a smartphone app. BP and HRV in the hours post exposure were compared to pre-exposure baseline readings. Utilizing potential inhaled dose (product of minute ventilation and pollutant concentration in the breathing zone) of PM2.5 and BC may capture risk more accurately.

Pilot results (n = 43) showed 2-times higher PM2.5 concentrations, 4-times higher BC concentrations, and 4-times higher minute ventilation rates during biking. Biking periods accounted for only ~ 7% of 24-hr period, but for 55% of total 24-hr BC dose and 35% of total 24-hr PM2.5 dose. Results showed positive correlations between inhaled BC dose and systolic blood pressure change following exposure (R = 0.12 to 0.41), with strongest correlations on a 2-hour lag (R = 0.38 to 0.41). Results also showed negative correlations between inhaled BC dose and HRV change following exposure (R= -0.13 to -0.48), with strongest correlations on a 4-hour lag (R = 0.42 to 0.48). Based on these results, we assess the potential health benefits that could be obtained both by changes in individual behavior (modifying routes and time of commute) and by redesigning cycling infrastructure to minimize air pollution exposures.

Key words: black carbon, PM2.5, bicycle commuters, blood pressure, heart rate variability
A comparative study on the adult respiratory health of indoor air pollution between winter and summer

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Abstract:
Background: Indoor environmental quality significantly influences the occurrence of asthma attack. This study aimed to examine the correlation of indoor exposure with adult respiratory health, as well as the disparities in effect between winter and summer. Methods: A cross-sectional epidemiological study was conducted among adult residents in Zunyi, Guizhou Province of Southwest China during winter and summer. Data on health variables related to asthma and home environmental factors were collected using a modified European Community Respiratory Health Survey II questionnaire. Result: the relative PM2.5 concentrations (cpm) in the kitchen (z=-5.583, p<0.001) and sleeping area (z=-5.587, p<0.001) were significantly higher in winter than in summer. However, the outdoor relative PM2.5 concentration (z=-5.420, p<0.001) was significantly higher in summer than in winter. Significant difference in pulmonary function (FVC, FEV1, FEV1/FVC and PEFR) was observed between summer and winter (p<0.001). A negative relationship between lung function and relative PM2.5 concentration in the indoor kitchen and sleeping area was also determined in winter rather than summer (P<0.001). The effect of exposure to indoor risk factors on lung function among the residents was greater in winter than in summer (P<0.001). Conclusion: The effect of indoor air pollution on respiratory health among adults with such exposure was greater in winter than in summer.

Keywords: Asthma; Asthma-related symptoms; Adult; indoor, seaso
Figure 1. Comparison of relative PM2.5 concentrations among 20 selected houses in winter and in summer. Mann-Whitney U test, *** significant at p<0.001.

Figure 2. Pared comparisons of pulmonary function (FVC, FEV1, FEV1/FVC and PEFR) in 46 adults in winter and in summer

Nonparametric test (Wilcoxon Signed Ranks Test); *significant at p<0.001

Table 1. The correlation of pulmonary function levels with the PM2.5 exposure of the kitchen and sleeping area in winter and in summer.

<table>
<thead>
<tr>
<th></th>
<th>kitchen</th>
<th>sleeping area</th>
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<tbody>
<tr>
<td></td>
<td>Winter</td>
<td>Summer</td>
</tr>
<tr>
<td></td>
<td>r</td>
<td>P value</td>
</tr>
<tr>
<td>FVC in litres (L)</td>
<td>0.250</td>
<td>0.020*</td>
</tr>
<tr>
<td>FEV1 in litres (L)</td>
<td>0.267</td>
<td>0.013*</td>
</tr>
<tr>
<td>FEV1/FVC in percentage</td>
<td>0.422</td>
<td>P&lt;0.00</td>
</tr>
<tr>
<td>PEFR in litres/min</td>
<td>0.257</td>
<td>0.017*</td>
</tr>
</tbody>
</table>

Spearman correlation, r: Correlation coefficient. *significant at p<0.05.
Hypertension Risk from Iron Brake Particulate Matter

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Abstract:

Of 12 moon walkers, James Irwin on the day after return from Apollo 15 mission, showed extraordinary bicycle (B) stress test (ST) hypertension (275/125) after 3 minutes exercise; supervising > 5000 maximum treadmill ST, the author never witnessed ST - blood pressure approaching this level. Symptom-limited maximum B stress test showed “cyanotic fingernails”; possibly venous blood trapped peripherally, supporting author’s “Apollo 15 Space Syndrome,” postulating that severe fingertip pain during space walks, triggered by plasma fluid, trapped distally; mechanism could be related to endothelial dysfunction, providing “silent ischemia” warning. Neil Armstrong returned to Earth with severe diastolic hypertension (160/135), consistent with ischemic left ventricular dysfunction; 50 mm increase in comparison with resting BP 110/85. With inhalation of lunar dust, brought into habitat on space suit, with high lunar iron (I) this dust inhalation, along with reduced (R) space flight- transferrin, R antioxidant, calcium (Ca) blocker - magnesium, conducive to severe oxidative stress, Ca overload with potential endothelial injuries. Using moon walker studies as an example, our recent editorials show that I dust released from brakes, with over 90% of brakes made of I, is a major hypertension factor and may contribute to myocardial infarctions.

Key words: Hypertension Risk, Lunar dust, moon walkers, cyanotic fingernails
Lead in Environment and Public Health
Simultaneous Microcystis Algicidal and Microcystin Synthesis Inhibition by Prodigiosin from an indigenous Serratia marcescens.

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Abstract:

Microcystis blooms and their secondary metabolites Microcystins (MCs) occurred all over the world, which have damaged aquatic ecosystems and threatened the public health. Techniques to reduce the Microcystis blooms and MCs are urgently needed. This study aimed to investigate the inhibitory effects of prodigiosin (PG) against the growth and microcystin-producing abilities of Microcystis. The algicidal activity was observed under the microscope. The expression of microcystin synthase B gene (mcyB) was determined by quantitative real-time polymerase chain reaction (qRT-PCR). The concentrations of MCs were detected by enzyme linked immunosorbent assay (ELISA) method. The algicidal activity against Microcystis aeruginosa (M. aeruginosa) FACHB 905 with 50% lethal dose (LD₅₀) at 24 hr was 0.25 μg/mL, when the concentration of Microcystis was 5×10⁷/mL. The expression of mcyB of M. aeruginosa was down-regulated 4.3, 8.1, 18.5 times lower than that of the control. Moreover, the concentration of the intracellular MC (IMC) were 1.6, 2.3 and 3.0 times lower than the control. PG had high algicidal activities against M. aeruginosa, with the activities of SOD decline, the contents of MDA increase, the expression of mcyB gene down-regulation, and MCs synthetise inhibitation. These results showed the PG has a great potential for controlling Microcystis blooms and reducing the synthesis of MCs in environment.

Key words: Microcystis blooms; Algicidal activity; mcyB; MCs;
Identification and characterization of a novel algicidal bacterium against Microcystis aeruginosa

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Abstract:

Harmful Microcystis blooms have occurred frequently in many eutrophic lakes and rivers and have caused much serious environmental pollution worldwide. Algicidal bacteria may play an important role and is considered as an effective method to control the Harmful Microcystis blooms. Isolating and characterizing some indigenous algicidal bacteria has become vital. In this study, algicidal bacteria were isolated by serial dilution and identified according to their 16S rDNA sequence analysis following the development of phylogenetic tree. The algae-lysing activities on different conditions including temperature, pH, and different concentrations of algicidal bacteria as well as Microcystis aeruginosa were observed under light microscopy. A novel algicidal bacterium designated as YFA1 was successfully isolated and identified as Chryseobacterium species from Hunan Province, China. The stain showed strong algae-lysing activities against Microcystis aeruginosa strain FACHB 905 where the highest activity reached 80.0% within 72 hr. In addition, the algae-lysing activities of the bacterial cells were observed to be much higher than those in the supernatant. The algicidal bacterium YFA1 is able to lyse Microcystis aeruginosa effectively, which is potentially useful for managing harmful Microcystis blooms.

Key words: Algicidal bacteria; Microcystis aeruginosa; Cyanobacterial harmful blooms (CyanoHABs); Chryseobacterium.
The inflammatory damage of chronic exposure to MC-LR on testis of C57BL/6 mice

Xingde Du, Haohao Liu, Le Yuan, Jinxia Wu, Yueqin Wang, Phelisters Wegesa Marwa, Rui Wang, Ya Ma, Huizhen Zhang

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Abstract:
Objective: To explore the effects of Microcystins-LR (MC-LR) on the testicular tissue of C57BL/6 mice and the expression of proto-oncogenes and inflammatory cytokines after chronic exposure.

Methods: Forty 8-week-old SPF C57BL/6 male mice were randomly divided into 4 groups (n=10), including control group, low-dose group (MC-LR, 30μg/L), medium-dose group (MC-LR, 60μg/L), and high-dose group (MC-LR, 120μg/L). The testes were isolated from mice for the subsequent experiments after drink containing MC-LR water freely for 3 months. The pathological changes of the testicular tissue were observed by HE staining. The protooncogenes c-myc, c-fos, c-jun and the expression levels of inflammatory factors IL-6 and TNF-α were detected by qRT-PCR.

Results: The results of HE staining showed that the spermatogenic cells in the testicular seminiferous tubules were detached from the base and move to the lumen. Furthermore, the spermatogenic cells and mature sperm were reduced and the exfoliated spermatogenic cells can be seen in the lumen, but no inflammatory cell infiltration was visible. Compared with the control group, the expression of c-myc, c-fos, c-jun, IL-6 and TNF-α were significantly increased after exposure to MC-LR (p<0.05).

Conclusions: MC-LR can damage to testicular tissue and induce the expression of protooncogenes and inflammatory cytokines in testis tissue of C57BL/6 mice after chronic exposure.

Key words: Microcystin-LR; testis; proto-oncogenes; inflammatory cytokines
The role of miR-122 in the imbalance of iron homeostasis in LO2 cells induced by MC-LR

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Abstract:
Objective To explore the mechanism and the role of liver-specific micro-RNA-122 (miR-122) in the imbalance of iron homeostasis in LO2 cells induced by microcystins-LR (MC-LR). Methods After exposed to MC-LR for 24h, the cell proliferation inhibition rate of LO2 cells was determined by CCK-8 kit and the half-inhibitory concentration (IC50) of MC-LR to LO2 cells was determined. The concentration of 0, 1/4 IC50, 1/2 IC50, IC50 were selected for the subsequent experiments. Negative control mimic+1/2 IC50 MC-LR, miR-122 mimic+1/2 IC50 MC-LR, negative control mimic group and miR-122 mimic group were used to analyze the role of miR-122. Lip3000 was used for the transfection carrier. The expressions of Smad1, p-Smad1/5/8, Stat3, p-Stat3 in protein level were detected by Western Blot and the genes of HAMP, Hjv, Hfe, Stat3, BMP6, IL-6, Tmprss6 and HIF-1α were determined by RT-PCR. Results The IC50 of MC-LR to LO2 cells was 28 μg/ml, and 1/4 IC50 (7 μg/ml), 1/2 IC50 (14 μg/ml), IC50 (28 μg/ml) were selected for the subsequence experiments. Compared with Smad1 and Stat3 respectively, the expression of p-Smad1/5/8 and p-Stat3 was increased significantly with the increasing concentration of MC-LR. The expression of p-Smad1/5/8 and p-Stat3 was lower than that in the control group after transfection of miR-122 mimic, and those proteins also reduced in miR-122 mimic+1/2 IC50 MC-LR group compared with that in the 1/2 IC50 MC-LR group. The expressions of HAMP, Hjv, Hfe, Stat3, BMP6, IL-6 and Tmprss6 were increased in a dose-dependent manner, but decreased on the expression of HIF-1α. Hfe, Hjv, BMP6, IL-6, Stat3, and Tmprss6 have a slight increase trend in the miR-122 mimic group. However, HAMP showed a downward trend. Compared with the 1/2 IC50 MC-LR group, Hfe, BMP6, IL-6, Stat3 were increased, but HAMP was down-regulated in the miR-122 mimic+1/2 IC50 MC-LR group. Conclusion MiR-122 plays a salvation role in the MC-LR-induced dysfunction of iron homeostasis and it may be mediated by direct acting on HAMP.

Keywords: microcystin-LR; micro-RNA-122; iron homeostasis; LO2 cells; HAMP
Regulation of ATF6/CHOP pathway on autophagy and apoptosis of mouse ovarian granulosa cells induced by MC-LR

Xingde Du, Haohao Liu, Le Yuan, Jinxia Wu, Yueqin Wang, Phelisters Wegesa Marwa, Rui Wang, Ya Ma, Huizhen Zhang

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Abstract:

Objective To investigate the regulation of ATF6/CHOP pathway in autophagy and apoptosis of ovarian granulosa cells (KK-1) induced by Microcystin-LR (MC-LR). Methods The ovarian granulosa cells of mice were cultured under conventional culture conditions. The KK-1 were exposed to different concentrations of MC-LR for 24 h. After that, the activity of KK-1 cells was determined by CCK8 kit, and 8.5 μg/mL, 17 μg/mL and 34 μg/mL were selected for the subsequent experimental concentrations. The autophagy and apoptosis-related factors were detected by RT-qPCR. The ATF6-silenced and CHOP-silenced KK-1 cell lines were construct by SiATF6 and SiCHOP respectively and Lip3000 was used for its transfection carrier. The apoptosis rate of KK-1 cells was determined by Annexin V-FITC/PI apoptosis detection Kit. Results Compared with control group, the expressions of endoplasmic reticulum stress and autophagy related genes of ATF6, GRP78, CHOP, Beclin1 and apoptosis-related factors such as bax, caspase-9 and caspase-3 were significantly increased with the increase of MC-LR concentration. Furthermore, the apoptosis rate was also significantly increased (p<0.05). No significant changes were observed of apoptosis-related factors and apoptosis rates in ATF6-silenced KK-1 cells. However, the autophagy-related factors CHOP and Beclin1 were significantly reduced. In addition, the apoptosis-related factors and apoptosis rate were significantly reduced in CHOP-silenced KK-1 cells. Conclusions MC-LR can induce the autophagy and apoptosis of KK-1 cells. ATF6 can ameliorate MC-LR-induced ER stress and autophagy, and silencing CHOP can also alleviate the MC-LR-induced apoptosis of KK-1 cells.

Key words: Microcystin-LR; autophagy; apoptosis; KK-1
The role of miR-122 in the induction of hepatic cell apoptosis by MC-LR

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Abstract:

Objective To explore the mechanisms and the role of liver-specific micro-RNA-122 (miR-122) in the hepatic damage of C57BL/6 mice induced by microcystins-LR (MC-LR). Methods Male C57BL/6 mice were injected intraperitoneally with 25μg/kg body weight (BW) and 40μg/kg BW MC-LR for two weeks, and the control group were injected with normal saline for 10ml/kg BW. H&E staining were used to detect the pathological damage of liver. The expression of miR-122, caspase 3, caspase 8 and bcl-2 in mRNA levels were determined by q-PCR. The proteins of caspase 3, caspase 9, cleaved caspase 9, caspase 8 and bax were detected by western blot. Immunofluorescence co-localization analysis was used to examine the cytoplasmic cytochrome c (Cyt-c) released from mitochondria. Results The study found that no obvious hepatic damage was observed in the control group, however, MC-LR induced dose-dependent increase damage to liver. Hepatocyte swelling, loose cytoplasm, spotted necrosis of hepatocytes, disintegration of nuclear fragments was observed in 25μg/kg MC-LR group. Hepatocyte necrosis and necrosis hepatocyte nucleus pyknosis dark stained or disintegrated were discovered in 40μg/kg MC-LR group. The expression of bax, caspase 9 was increased but caspase 3 and caspase 8 was decreased in MC-LR-treatment group compared that in the control group. Furthermore, the expression of miR-122, Bcl-2, caspase 8, and caspase 3 in mRNA levels in liver were down-regulated after exposure to MC-LR, which was consistent with the trend of the protein. The immunohistochemically cumulative optical density (IOD) analysis results showed that the content of Cyt-c in the cytoplasm was significantly increased compared to the control group in a manner. Conclusion miR-122 mediates MC-LR-induced hepatic damage and the hepatocellular apoptosis induced by MC-LR may be mediated by miR-122/mitochondrial-dependent pathway.

Keywords: microcystin-LR; micro-RNA-122; apoptosis; mitochondria
Effect of histone acetylation on MC-LR-induced apoptosis in testicular germ cells of SD rats

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Abstract:

Microcystin-leucine arginine (MC-LR) is an isomer of microcystins (MCs), which is seriously pollutional and widely contacted by People. It is closely correlated to reproductive toxicity. It is closely correlated to reproductive toxicity. Histone acetylation modification regulates the expression of apoptosis-related genes and may have a vital function in MC-LR-induced male reproductive toxicity. Objective It is to investigate the change of histone acetylation induced by MC-LR and molecular mechanism in apoptosis of male germ cells. Methods MC-LR was used to treat testicular Sertoli-Germ cells of SD rats SD rats. Histone acetylase (HAT), deacetylase (HDAC) activity and histone (H3, H4) acetylation were detected. Histopathological damage, apoptosis were observed. Apoptosis-related genes expression profiles were analyzed by RT-qPCR. Apoptosis-related proteins expressions were detected by Western blotting. Results The results of experiments in vitro and vivo showed that MC-LR could enhance the activity of HDAC, decrease the activity of HAT, up-regulate the expression of HDAC1 and down-regulate the expression of Ac-H3 and Ac-H4. Meanwhile, MC-LR could induce tissue injury, cells apoptosis rate and increased the expression of apoptosis-related genes and proteins of Bax, Caspase3 and Caspase8 in testicular tissues. Furthermore, MC-LR-induced cells apoptosis rate and the expression of apoptosis-related proteins and genes were decreased by pretreated with the HDAC inhibitor TSA in cells and tissues. These results indicated that MC-LR can enhance HDAC activity and reducing the level of histone acetylation and activate the mitochondrial Caspase pathway to lead to the cells apoptosis in normal testicular germ cells of SD rats. Conclusion In conclusion, histone acetylation plays an important role in MC-LR-induced apoptosis in male germ cells, which provides a new insight for the study of the male reproductive toxicity.

Key words: Microcystin-leucine arginine (MC-LR); Histone deacetylase(HDAC); Histone acetylase(HAT); Apoptosis
The role of NAC in germ cells injury of SD rats induced by MC-LR in vitro and in vivo

Le Yuan, Haohao Liu, Yueqin Wang, Xingde Du, Phelisters Wegesa Marwa, Rui Wang, Ya Ma, Huizhen Zhang*

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Abstract:

Objective To explore the protective of N-acetyl-cysteine (NAC) on microcystin-LR-induced (MC-LR) testicular reproductive toxicity in vivo or in vitro. Methods The co-cultured Sertoli-germ cells were extracted and purified from the testis of SD rats, and then exposed to 36 μg/mL MC-LR, 36 μg/mL MC-LR+NAC and NAC respectively. The contents of ROS, SOD, MDA, apoptosis rate, mitochondrial membrane potential and apoptosis-related proteins Caspase 9, bcl-2 and Bax were detected. SPF male SD (48) rats were randomly divided into 8 groups and then intraperitoneal injection of 0.9% saline, 10 μg/kg.bw, 20 μg/kg.bw, 40 μg/kg.bw, and those doses+ NAC for two weeks. The dose of NAC was 150 mg/kg.bw. The testicular tissue was isolated after exposed to MC-LR alone or MC-LR after pretreatment with NAC. The effect of MC-LR on the histopathological morphology of rat testis was observed by HE and TUNEL staining. Meanwhile, the contents of Caspase 9, bcl-2 and Bax were detected. Results 1. Compared with control group, the levels of ROS, apoptotic rate and MDA content in co-cultured Sertoli-germ cells increased in a dose dependent, but decreased after pretreatment with NAC. However, the activity of SOD was decreased after exposed to MC-LR, but increased after pretreatment with NAC. 2. MC-LR can aggravate the damage to testicular tissue of SD rats with the increase exposure dose of MC-LR, but the damage was ameliorated after pretreatment with NAC. The expressions of apoptosis-related proteins were increased after exposed to MC-LR, but NAC can effectively inhibit the effect of MC-LR. Conclusions NAC can effectively ameliorate MC-LR-induced the apoptosis of reproductive cells in vivo or vitro.

Keywords: Microcystin-LR, Apoptosis, N-acetyl-cysteine (NAC)
The role of H3K4me3 in apoptosis of germ cells induced by MC-LR in SD rats
Le Yuan, Haohao Liu, Yueqin Wang, Xingde Du, Phelisters Wegesa Marwa, Rui Wang, Ya Ma, Huizhen Zhang*
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Abstract:
Objective To explore the role of trimethylation of histone H3 at lysine 4 (H3K4me3) on Microcystin-LR-induced (MC-LR) testicular reproductive toxicity from the perspective of epigenetics.

Methods 1. The co-cultured Sertoli-germ cells were extracted and purified from the testis of SD rats, and then exposed to 0, 9, 18, 36 (μg/ml) MC-LR respectively. Afterwards, the mRNA levels of H3K4me3 were detected by RT-qPCR. 2. The protein of H3K4me3 was used as the target protein for Chromatin Immunoprecipitation with high-throughput sequencing (Chip-seq) to screen differential genes related to apoptosis between control group and exposure group. And then, these genes were further verified by RT-qPCR after exposed to (0, 36μg/mL) MC-LR, 36 μg/ml MC-LR+1mmol/L MTA (the inhibitor of H3K4me3) and 1mmol/LMTA repectively.

Results Compared with control group, MC-LR induced the expression level of H3K4me3 in a dose dependent manner. The GO enrichment analysis results showed that the target genes of H3K4me3 were mainly involved in ion binding, cytoplasmic membrane development and transcriptional regulation. KEGG enrichment analysis results demonstrate those target genes mainly focus on cancer and mitogen-activated protein kinase (MAPK) signaling pathways. The expressions of apoptosis-related genes as Fas，Dffa，Atg7，Irak3，Eif3c，Rps24，Birc3，IL1r1，Pik3r1，Lzts1 increased after exposed to MC-LR, but the expression of those genes decreased after pretreatment with MTA.

Conclusions H3K4me3 plays an important role in Microcystin-LR-induced (MC-LR) testicular reproductive toxicity.

Key words: Microcystin-LR, Apoptosis, H3K4me3
Genetic diversity, structure and forensic characteristics of Hmong-Mien-speaking Miao revealed by autosomal insertion/deletion markers

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Abstract:

Insertion/deletion (Indel) genetic markers play an indispensable role in the forensic and population genetics, molecular bioanthropology and evolutionary biology. However, the genetic diversity, allelic frequency, forensic parameters and population genetic characteristics of the Indel markers in Guizhou Miao, one Hmong-Mien-speaking population, remain unclear. Thus, we genotyped 30 forensic related Indel markers in 311 unrelated healthy Miao individuals (149 females and 161 males) residing in the Guizhou Province (Southwest China) using the Investigator DIPplex amplification system. All 30 Indels are in accordance with the no-departures of HWE and LE. The combined probability of discrimination (CPD) and the probability of exclusion (CPE) in Guizhou Miao population are 0.999999999948 and 0.9843, respectively. This observed ideal forensic parameter estimates indicate that this di-allelic Indel panel can be used as a supplementary tool in forensic retinue personal identification and complemented for autosomal STRs in the parentage testing in Miao population, especially used as a tool in the old or high-degraded samples in the disaster victim identification (DVI). Eleven Indels show a high allele frequency difference between different continental population and could be used as ancestry-informative markers in forensic ancestry inference. Phylogenetic relationships between Guizhou Miao and 68 worldwide populations based on the genetic polymorphisms of Indels are investigated via three different pairwise genetic distances, principal component analysis, multidimensional scaling analysis and phylogenetic relationship reconstructions. Our results demonstrate Guizhou Miao people are genetically closer related to geographically adjacent populations, especially with Liangshan Yi, Guangxi Miao and Dong, while they are distantly related to Turkic-speaking and Tibeto-Burman-speaking populations. The comprehensive and precise geneti admixture and divergence history between Guizhou Miao and neighboring populations are needed to further investigate via high-density marker panel or whole-genome sequencing modern or ancient Miao people.
Population genetics, diversity and forensic characteristics of Tai-Kadai-speaking Bouyei revealed by Insertion/Deletions markers

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Abstract:

China, inhabited by over 1.3 billion people and known for its genetic, cultural and linguistic diversity, is considered to be indispensable for understanding the association between language families and genetic diversity, utilization of forensic-related markers and process of human population history. We report a comprehensive population genetic relationship investigation among 14,303 individuals from 84 worldwide populations based on allele frequency correlation and 4,907 genotypes of 30 Insertions/Deletions (InDels) markers from 36 populations which distributed in all continental or major subregions and seven linguistic phyla in China. Forensic parameters observed show high polymorphic and informative features for Asians although it developed focused on Europeans, and indicate this amplification system is appropriated to forensic personal identification and parentage testing. Patterns of Indel variations revealed by principle components analysis, multidimensional scaling plots, phylogenetic relationship exploration, model-based clustering as well as four pairwise genetic distances (Fst, Nei, Cavalli-Sforza and Reynold) demonstrate significant genetic differentiation at the continental scale and genetic uniformity in Asia except for Tibeto-Burman and Turkic speaking populations. Additionally, Tai-Kadai speakers share more genomic ancestry components than with other language speakers and totally are genetically very similar to Hmong-Mien-speaking populations (Zhuang and Dong). More fine-scale maps of human dispersal and genetic structure, and even ancient gene flows and admixture are needed to carry out more whole genome sequencing or high-density genotype data for East Asians.
Genetic structure and forensic characterization of 19 X-chromosomal STR loci in Guizhou Sui population

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Abstract:

Background: Guizhou Sui people are an officially recognized ethnic group living in southwest China, but have seldom been studied genetically.

Aim: To investigate the polymorphisms of 19 X-chromosome STR loci in typical Sui population, with the aim of enriching the East Asian X-STR reference database for forensic DNA analysis.

Subjects and methods: We genotyped a total of 400 individuals (195 males and 205 females) of Sui at 19 X-STR loci using the AGCU X19 STR Kit. We calculated and illustrated the allele frequencies, forensic parameters, Nei's and Reynolds' genetic distances between Sui and other 18 East Asian populations to explore genetic polymorphisms and population relationships.

Results: We observed a total of 215 alleles with corresponding frequencies ranging from 0.0017 to 0.6512 in Sui using male and female pooled allele frequencies. The combined power of discrimination of Sui males and females are 0.9999999999975 and 0.9999999999999999999937, respectively, and the mean paternity exclusion chances (MECs) are larger than 0.999999964. The genetic distance and neighbor-joining tree among 19 populations presented that Sui has close genetic affinities with other Tai-Kadai populations, as well as the Sinitic populations living in southern China.

Conclusions: The AGCU X-19 STRs are highly polymorphic and informative in Guizhou Sui people. The genetic relationships between Sui and other populations in China are generally consistent with the language classification and geographical distance.

Keywords: 19 X-STRs; Guizhou Sui population; genetic structure; forensic characterization
In vitro bioaccessibility and geochemistry of toxic trace metal Pb in urban soil and street dust in northwestern China

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Abstract:

To quantificationally assess the health risk of children exposure to the heavy metal lead from urban soil and dust in the valley-city, a total of 243 analytical samples composited from 3-5 subsamples according to classical cone and quarter technique were collected from the 0-20 cm top soil and 1-1.5 m high building balcony dust in Baoji, Xi’an, Weinan, Tongchuan industrial areas. The concentrations of heavy metal lead including of its chemical fractionations and health risks exposure to children were investigated by XRF, BCR and USEPA health risk assessment methods respectively. The results showed that the concentrations of lead in urban soil and dust in Baoji, Xi’an, Weinan, Tongchuan were (409.2 ± 52.54) and (624.70 ± 66.15) mg·kg⁻¹, (357.47 ± 41.37) and (592.60 ± 36.78) mg·kg⁻¹, (61.4 ± 13.31) and (78.42 ± 14.89) mg·kg⁻¹, (46.71 ± 12.11) and (64.7 ± 13.76) mg·kg⁻¹ respectively, which was much beyond the background value of lead in Shaanxi Province. The corresponding pollution levels divided by background value decreased as the order of Baoji > Tongchuan > Xi’an > Weinan. The BCR analysis suggested that the mobility tendency of lead in urban soil and dust decreased as the following order: urban dust of Baoji (90.71% ) > urban dust of Xi’an (84.74% ) ≥ urban soil of Baoji (83.12% ) > urban dust of Weinan (74.89% ) ≥ urban soil of Xi’an (74.50% ) > urban dust of Tongchuan (72.49% ) ≥ urban soil of Tongchuan (57.50% ) > urban soil of Weinan (53.79% ). The migration trend of lead in urban dust was much larger than corresponding urban soil. On the other hand, the hazard indexes (HI) of lead in urban soil and dust between Baoji and Tongchuan city were higher than 1, indicating that lead posed a higher non-carcinogenic risk to children in two cities. However, the carcinogenic risk of lead exposure to four urban children obtained in this study had a considerable level, and the risk degree decreased as Baoji > Tongchuan > Xi’an > Weinan. The non-carcinogenic and carcinogenic risk degrees of lead exposure to children show the similar trend with the oxidizable fractionation distributing in four
corresponding urban soil and dust, which indicated that the oxidizable fractionations of lead might be the main speciation and factor causing to children’s blood lead poisoning. The highest bioaccessibility (46.9%) of lead in industrial areas simulated by in vitro SBET and the lead chemical compounds of Pb, PbSO₄ and Pb₃O₄ (PbO 2PbO₂) identified by XPS confirmed the above observations. The higher frequency anthropic activities including the industrial discharge and coal combustion would be increased the geochemical mobility of lead. A comprehensive environmental management strategy should be concerned by the local government to address lead pollution in urban areas.

**Keywords:** lead; children; exposure risk; in vitro bioaccessibility; urban soil; urban du
A fast method for nanocomposite PbS synthesis: Preparation and characterization

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Abstract:

PbS nanoparticles (Nps) were synthesized by a chemical route at room temperature. Lead acetate and Thiourea were employed as sources of Pb^{2+} and S^{2–} ions respectively. The elemental composition of synthesized nanoparticles was evaluated by using dispersive energy analysis of X-rays (EDS). The EDS spectra show the peaks of Pb and S elements. The X-ray diffraction (XRD) pattern shows the cubic phase of PbS NPs. The broadening of the XRD peaks indicates the nanocrystalline nature of the synthesized sample. The crystallite size calculated from the Scherrer formula and it is 16.81nm. The SEM and TEM conform the morphological characteristics of the PbS NPs. The nanoparticles have been also investigated by X-ray photoelectron spectroscopy (XPS).

Keywords: PbS Nanoparticles, XRD, SEM, XPS, TEM, EDS
Contemporary blood lead levels of children aged 0-84 months in China–A national cross-sectional study

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Abstract:

Despite the global abundance of studies on children’s lead (Pb) exposure, the magnitude of Pb exposure among children in China remains unclear at the national level following the removal of Pb from petrol in 2000. Regarding no safe level for Pb exposure, in order to develop strategies of further reducing children’s Pb exposure in the era of unleaded petrol, we conducted a national blood Pb survey from May 2013 to March 2015, with 31,373 children (0-84 months old) from 88 sampling sites of 15 provinces across China (31 provinces in total) involved in. Blood lead levels (BLLs) were tested using graphite furnace atomic absorption spectrometry with detection limit of 1 µg/L. The results showed the contemporary geometric mean (GM) BLL of China was 26.7 µg/L, with 8.6% of BLLs exceeding 5 µg/dL. That indicates China made great achievements on the prevention of environmental Pb exposure after prohibition of leaded petrol. However, it is worth noting that children in China still have higher BLLs compared to those of countries with very high Human Development Index (HDI). Within China, BLLs showed an apparent regional disparity. Generally, BLLs of investigated provinces were negatively associated with their HDIs. Given applying dose-response relationship between BLLs and intellectual impairments of US children to this study, we estimated approximately 173 million IQ points could be denuded from Chinese children. China was suffering more losses of intelligence resource even after adjusting the population of children aged 0-6 years old. Policy responses need to be developed to further mitigate Pb exposure in China.

Key words: lead exposure, spatial distribution, human development index, intellectual impairments, China
Environmental and geochemical analysis of lead contamination: its sources and pathways of exposure
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Abstract:
Resolving the source of environmental contamination is the critical first step in remediation and exposure prevention. Australia’s oldest silver-zinc-lead mine at Broken Hill (>130 years old) has generated a legacy of contamination and is associated with persistent elevated childhood blood lead (Pb) levels. However, the source of environmental Pb and children’s blood Pb remains in dispute: current mine emissions; remobilized mine-legacy lead in soils and dusts; and natural lead from geological weathering of the gossan ore body. Multiple lines of evidence used to resolve this conundrum at Broken Hill include environmental, geochemical and epidemiological analyses. The results demonstrated that Broken Hill contemporary dust Pb deposits were primarily sourced from current mining emissions as opposed to naturally weathered or legacy sources held in soil and dust around the city. Children living closest to the mining operations were found to be at an increased risk of Pb exposure due to higher dust Pb loading (mean 255 μg/m2/day) and its high bioaccessibility (75% of total Pb). Pb isotopic compositions showed that dust adjacent to the mine (208Pb/207Pb: 2.3197; 206Pb/207Pb: 1.0406) had a close match (99%) to the ore body, with values slightly lower (94%) at the edge of the city. The effects of current mining emissions on the contemporary dust Pb loading were quantitatively estimated. The analysis showed that a 1% increase in distance away from the current mining operations was associated with -0.501% (95% CI: -0.728, -0.275) reduction in dust Pb loading, while a 1% increase in production intensity at the mine increased the expected amount of dust Pb loading by 1.487% (95% CI: 0.537, 2.437%).
Consistent with the dust Pb decreasing with distance away from current active mining operations, contemporary blood Pb concentrations (2011–2015) also decreased with distance (i.e. 1% increase in distance was associated with a 0.173% reduction in blood Pb concentration). In addition, children living within the prevailing wind direction were at the greatest risk of elevated blood Pb compared to those living in a non-prevailing wind direction, even after adjusting for other potential factors. The role of current emissions on driving exposures was further corroborated by the fact that children’s blood Pb shifted systematically with mine Pb production volumes irrespective of remedial interventions. Considering geochemical and statistical evidence, dust emitted by contemporary mining activities is a significant driver of childhood Pb exposure in Broken Hill.
The application of a multiple lines of evidence as used in this research to establish more precisely the source(s) of exposure in mining and smelting communities could be applied to other locations. Such an approach would help to address unequivocally extant disputes over the sources, causes and impacts of environmental Pb contamination in order to better target remediation and prevention strategies.
Key words: blood lead, dust, Pb isotopes, ore production, wind
Fabrication of the spongy microbe-based biosorbents and their application in removing Pb(II) from waters

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Abstract:

Lead is a widespread and lethal heavy metal ion, and it can give rise to many serious disorders and dysfunctions, especially those concerning children’s learning abilities as well as behavioral and mental development. The WHO, USEPA and many government environmental protection agencies have strictly regulated the maximum acceptable concentration of Pb(II) in drinking water and industrial effluent discharge. It is extremely urgent to develop effective technologies and materials to extract Pb(II) from waters. Due to the environmentally benign nature and lack of secondary pollution, the application of biotechnology as an alternative or complementary method for sequestering heavy metals from wastewater is rapidly growing. However, the dead biomass with a small particle size is difficult to separate from solutions, and only those biosorbents with a significantly high adsorption capacity and selectivity for heavy metals have promising application potential in a full-scale treatment process due to the complexity of contaminated water. In our study, we focused on developing a one-step synthesis method to transform different nonliving microbes into sponge-like biosorbents with a high removal efficiency of Pb(II). Herein, gram-negative bacteria Pseudomonas putida I3, gram-positive bacteria Microbacterium sp. OLJ1 and mycelial fungus Talaromyces amestolkiae Pb served as raw materials to facilely synthesize spongy biosorbents. SEM, EDS, FTIR, 13C NMR, XRD and XPS were used for investigating the morphology and surface properties of these three biosorbents. The obtained biosorbents possessed the same three-dimensional porous structure but different productivities and mechanical strengths due to the similar chemical compositions and different cell structures of their microorganisms. Pb(II) adsorption on X-PI3, X-OLJ1 and X-TPb was fast and pH dependent, with maximal adsorption capacities of 345.02, 237.02 and 199.02 mg/g, respectively. These biosorbents had a high selectivity for Pb(II), while Pb(II) remarkably suppressed the adsorption of co-existing heavy metal ions. The results indicated that Pb(II) removal was mainly achieved by ion exchange reactions, surface complexation with heteroatom-containing functional groups and microprecipitation. The treatment effects of synthetic and real wastewater revealed that the as-prepared biosorbents are promising for Pb(II) removal.

Keywords: microorganism, lead, adsorption, mechanism, selectivity
Preliminary study on the Changes of miRNA expression profiles in hippocampus of the 2nd offspring’s rats exposed to the fluorine combined with aluminum and its relationship with learning and memory

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Abstract:
Objective: To investigate the changes of miRNA expression profiles in hippocampi of the 2nd offspring’s rats exposed to the fluorine combined with aluminum and their relationship with learning and memory. Methods: Sixteen healthy adult SD pregnant rats of clean grade were randomly divided into control group (0, 0) mg/L, low fluorine + aluminum group (60,600) mg/L, medium fluorine + aluminum group (120,600) mg/L, and high fluorine + aluminum group (240,600) mg/L, four in each group. Six offspring (male to female ratio: 2:1) were randomly selected from each group to mate in PND90 (sexual maturity). After the birth of the 2nd offspring’s rats, 8 rats (half male and half female) were randomly selected from each group. The rats were treated from pregnant day zero to postnatal day 60(PND60) of the 2nd offspring’s rats, rats were poisoned by drinking water freely and weighed every other week. Before killed, the learning and memory ability was tested by the Morris water maze experiment and light and dark box experiment, and 12 hour urine was collected. After anesthesia with isoflurane, blood was taken from the heart and the brain was retained. The brain tissue is separated on ice and the left brain is used for HE staining and the transmission electron microscope. The hippocampus of the 2nd offspring’s rats separated and kept the -80 °C until analysis. The changes of hippocampal structure were observed by light microscopy and electron microscopy. The contents of fluorine in serum, brain and urine were tested by fluorine ion selective electrode method, and aluminum in serum, brain and urine level were tested by graphite furnace atomic absorption spectrometry. High-throughput sequencing was utilized to analyze the microRNA (miRNA) profile of the hippocampi in the 2nd offspring’s rats. It was made that Fold change>1.5 and P<0.05 as standard to screen differentially expressed miRNAs. The target genes of differentially expressed miRNAs were predicted by the miRDB, miRanda and Targetscan. The Gene ontology category and Kyoto Encyclopedia of Genes and Genomes (KEGG) pathway were used to analyze the function and pathways of target genes. Real-time fluorescence quantitative polymerase chain reaction (qRT-PCR) was used to verify the screened miRNAs with differential expressions. Results: 1. Body weight: At the PNDO, compared with control group, body weight of exposure groups in the 2nd offspring’s rats was lower (P>0.05). Born 2 ~ 8 weeks, compared with control group, except for 2th, 4th weeks of low fluorine except + aluminum group, body weight of exposed group in the 2nd offspring’s rats was decreased (P<0.05). 2. Compared with control group, the concentration of fluorine and aluminum in urine of the 2nd offspring’s rats from the all exposed groups was increased (P<0.05). 2. Compared with control group, the concentration of fluorine and aluminum in brain of the 2nd offspring’s rats from the all exposed groups was increased (P<0.05). (3) Compared with control group, the
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concentration of fluorine and aluminum in serum of the 2nd offspring’s rats from the all exposed groups was increased (P<0.05). 3. HE staining result: the hippocampus of the 2nd offspring’s rats in the control group was clear and neurons were arranged neatly. Compared with control group, the hippocampal neurons showed pathological changes such as different sizes, disordered arrangement, volume reduction, deep cytoplasmic staining, nuclear pyknosis, and fuzzy structure in the exposure group. 4. Transmission electron microscopy results: Compared with the control group, the hippocampal neuron mitochondria of the 2nd offspring’s rats were swollen, the golgi complex was dilated, the synapses were decreased, and the synaptic structure was slightly swollen. 5. Black and white box experiment: Compared with the control group, the retention time of the black box in the middle fluoride + aluminum group and the high fluoride + aluminum group was extended, the number of piercing times was reduced, the percentage of the white box stay time was reduced, and the percentage of the black box stay time was increased (P<0.05). 6. The Morris water maze experiment: Compared with the control group, the escape latency of the 2nd offspring’s rats in each exposure group was prolonged in the first to fourth days of training. Except the middle fluoride + aluminum group on the third and fourth days, the escape latency of 2nd from the other groups was significantly prolonged (P<0.05). Compared with the control group, the first time of arrival and the time of crossing the platform were increased in the 2nd offspring’s rats in each exposed group (P<0.05). 7. Analysis of differential miRNA expression profile: According to the screening criteria, 253 differential miRNAs were screened. Compared with the control group, 24.5% of miRNAs were differentially expressed. Compared with the low fluoride + aluminum group, 8.7% of miRNAs were differentially expressed. Compared with the fluorine + aluminum group, the miRNAs with differential expressions accounted for 0.4%. Among them, undifferentiated miRNAs in any two groups accounted for 66.4%. (2): The result of Real-time PCR verification: miR-122-5p, miR-450a-3p, miR-183-5p, miR-130a-5p and miR-547-3p were selected for intensive analysis by Real-time PCR. The results show that the candidate miRNAs are consistent with the sequencing results. (3) Prediction and functional analysis of target genes: 5,200, 1,866 and 6,118 target genes were predicted respectively by miRanda, miRDB and TargetScan, which had 152 common target genes. GO gene functional analysis showed that the predicted target genes had different functions, and learning and memory functions were involved in cell components, biological processes and molecular functions. Pathway analysis of target genes predicted by partial differential miRNAs by KEGG revealed that Cholinergic synapse, Long-term potentiation, Dopaminergic synapse, and long-term depression were the major pathways associated with neural behavior and learning and memory. Conclusion: 1. Under the experimental conditions, the fluorine combined with aluminum can reduce the learning and memory ability of the 2nd offspring’s rats. 2. The learning and memory impairment induced by the fluorine combined with aluminum in the 2nd offspring’s rats is closely related to the coordinated regulation of miRNA and its target genes.

**Key Words:** Fluorine, Aluminum, Hippocampus, miRNA expression profiles, learning and memory
RyRs mediated calcium dependent CaMKIIα/CERB signaling pathway in lead exposure induced neurotoxicity in vivo and in vitro

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Abstract:

Lead (Pb) causes neurodevelopmental disorders and neurodegenerative diseases, which might be related to intracellular calcium ion (Ca^{2+}) imbalance along with Ca^{2+}-dependent biological processes. However, the mechanism underlying Pb exposure induces Ca^{2+} imbalance has not been clarified. Ryanodine receptors (RyRs) are currently the largest known ion channels which maintain intracellular Ca^{2+} homeostasis. The purpose of this study was to explore whether the RyRs / calcium signaling pathway acts in Pb causes cognitive impairment. Sprague Dawley rats were exposed to different doses of Pb through drinking water during pregnancy and after birth until 52 weeks of age. The results showed that Pb impaired the cognitive function of the rats, increased the neuronal intracellular free Ca^{2+} concentration ([Ca^{2+}]_i), and significantly up-regulated RyRs and decreased the calcium dependent Ca^{2+}/calmodulin-dependent protein kinase IIα (CaMKIIα) and cyclic adenosine 3’,5’-monophosphate response element binding protein (CREB) phosphorylation in rat hippocampus during developmental and neurodegeneration stages. Furthermore, knockdown RyR3 in PC12 cells decreased [Ca^{2+}]_i, increased the CaMKIIα and CREB phosphorylation, and elongated the cognitive function related neurite length under Pb exposure. In addition, RyRs was found involved in Pb impaired Long-Term Potentiation (LTP) using RyRs agonist in rat brain hippocampal slices detected with electrophysiology. Our results suggest that Pb exposure causes cognitive impairments, which is related to RyRs-mediated high levels of free calcium as well as calcium dependent CaMKIIα/CERB pathway in neurons. Thus, RyRs could serve as a significant therapeutic target of heavy metal Pb induced central nervous system disorders characterized by calcium disorders.

Key words: Lead exposure; cognitive impairment; ryanodine receptors; calcium disorder; CaMKIIα/CERB signaling pathway

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Mercury Contamination and Human Health
Mercury, microcystins and omega-3 polyunsaturate fatty acids of farmed-raised fish in eutrophic reservoir: risk and benefit assessment

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Abstract:
Fish as traditional nutrient are rich of physiologically required omega-3 polyunsaturate fatty acids (n-3 PUFA), including eicosapentaenoic (EPA, 20:5n−3) and docosahexaenoic acids (DHA, 22:6n−3) for human health. However, fish are also the major route of methylmercury (MeHg) exposure. Artificial feeding can alter the fatty acids profiles as well as MeHg in fish. Moreover, exacerbating eutrophication caused by aquaculture lead to growth of toxin-producing cyanobacteria, most of which are microcystins (MC) that can be accumulated in fish. In order to improve understanding of risks and benefits of consuming farmed-raised fish, total mercury (THg), MeHg, Microcystins-LR (MC-LR), Microcystins-RR (MC-RR) and n-3 PUFA were determined in 11 species, 205 fish samples in eutrophic Wujiangdu Reservoir. The results showed that THg content in fish ranged from 3.0 to 185.1 ng/g ww, with average of 22.9 ± 22.8 ng/g ww, MeHg content ranged from 0.2 to 49.1 ng/g ww, with average of 6.0 ± 6.6 ng/g ww. Both THg and MeHg contents were highest in planktivorous fish and lowest in herbivorous fish, all well below the MeHg recommendation of fish consumption for human health 500 ng/g ww. The MC-LR concentration in water was 0.07 ± 0.05 μg/L, lower than the national maximum allowable concentration 1.0 μg/L. MC has been detected in 110 fish samples, the detection rate of MC-RR and MC-LR were 53.6% and 51.7%, respectively, and their ranges were 0.02-0.13 μg/g and 0.01-0.08 μg/g, respectively. MC content in fish was highest in the planktivorous fish and lowest in the carnivorous fish. Assessed by Environmental Protection Agency's recommended model, Hg and MC in fish in this study didn’t represent health risk for human health at present. The ranges of n-3PUFA and EPA+DHA contents in fish were 81.9-369.8 mg/100g dw and 60.0-331.2 mg/100g dw, respectively. Both n-3PUFA and EPA+DHA contents were highest in carnivorous and lowest in herbivorous fish. We concluded that the catfish contained high EPA+DHA and relatively low Hg and MC contents. Based on mercury levels and recommended intake levels of omega-3 PUFA, recommend fish consumption for normal adults’ healthy and cardiovascular condition were 74.6 g of catfish or 417.0g of grass carp.

Key words: Mercury; Microcystins; Omega-3 polyunsaturate fatty acids; eutrophic; farmed-raised fish
Effect of low-dose Mercury exposure via Rice consumption on Children's Intelligence Quotient

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Abstract:

Rice consumption can be the main pathway of methylmercury (MeHg) exposure for local populations living in Hg mining area. However, effects of Hg exposure on children's intelligence quotient (IQ) were based on data from fish-consuming populations. This study was designed to evaluate the effects of Hg exposure on children's IQ in rice-consuming populations from Wanshan Hg mining area in China. 9-year-old primary school students (n=100) from Daping primary school and Aozhai primary school in mercury mining area were studied. The total mercury (THg) concentration in hair is used as the indicator of exposure to Hg. In our study, the average of THg concentrations in children's hair samples was 1.08±0.79 μg/g, and 38% exceeded the USEPA recommended value (1 μg/g). Children's IQ tends to decrease with the increasing of hair THg concentration, but no significant negative correlation was observed (p>0.05). The study population were divided into four groups based on hair THg concentrations. The group with highest hair THg concentration (1.22-7.26 μg/g) showed lower IQ scores than the group with lowest hair THg concentration (0.33-0.70 μg/g). The results showed that IQ score decreased by 3.54 with increasing of hair THg of 1 μg/g. According to the results of the fish-consuming populations, the average fetal IQ decreased by about 0.18 for every 1 μg/g increase in maternal mercury exposure. Since fish contains nutrients that are beneficial for brain development, it may underestimate the health risks of fish MeHg exposure. Therefore, it is necessary to determine the effects of low-dose mercury exposure via rice consumption on children's IQ, and more work are needed to track the relationship between the IQ changes and Hg exposure in children.

Keyword: low-dose Mercury exposure, intelligence quotient, Rice consumption
Mercury isotope fractionations in different form of mercury in paddy ecosystems and environmental implications

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Abstract:

Rice consumption is the main pathway of methylmercury (MeHg) exposure for residents that rice as the stable food in inland areas of Southwestern China. However, the mechanism of MeHg bioaccumulation in rice grain is still unclear. Stable isotope is a powerful tool to track the sources and processes of migration and transformation of Hg in the environment. In this study, new methods were applied to extract MeHg from soils and rice plant tissues as well as total mercury (THg) for Hg isotope analysis, which aimed to understand the pattern of MeHg isotope fractionation in paddy ecosystem during whole rice growing seasons. We calculated Hg isotope values in inorganic mercury (IHg) according to its proportion of THg. The results suggested that MeHg and IHg in rice plants showed different characters of mass dependent fractionation and mass independent fractionation. In rice plants, the $\delta^{202}\text{Hg}$ values in MeHg showed no fractionation in roots, stalks, leaves, and grains, and gradually decreased with the growing season of rice. However, the $\delta^{202}\text{Hg}$ values in IHg of stalks were the mixing of signal in roots and leaves. In paddy ecosystem, the $^{199}\text{Hg}$ values showed that irrigation water was the original source of MeHg to soil and rice plants, but IHg in rice plant simultaneously affected by the irrigation water and atmosphere. Our study spatially and temporally demonstrated the sources of MeHg and IHg in rice plant by Hg stable isotope approach, which can help us to better understand the mechanism of bioaccumulation of MeHg and IHg in rice plant and to provide scientific advice for risk controls.

Keywords: MeHg, IHg, stable mercury isotope, paddy ecosystem, rice growing season.
Total mercury distribution in different crops at a historically Hg-polluted site in China: implication for regional Hg risk management

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Abstract:

Soil surrounding mercury (Hg) mining areas (MMAs) has posed high level risk on Hg exposure for the inhabitants, thus the management for safety crops production at MMAs is necessary to protect the human health. This study aimed to screen the crops with low Hg accumulative, then crops planting structural adjustment scheme is developed, which can largely ensure the original agricultural use of farmland and the benefits to farmers by encouraging them to grow these low Hg-accumulative crops at Wanshan Hg mining area in Guizhou province, China. Total 640 couple of soil and crops samples were collected. Mercury (Hg) content in soil range from 0.6 to 789.6 mg kg\textsuperscript{-1}. The total Hg (THg) content in the edible parts of 43 types of crops vary greatly from 2.4 to 1075 μg kg\textsuperscript{-1}. The edible part of four of the crops (radish (Raphanus sativus L.), strawberries (Fragaria ananassa Duch.), corn (Zea mays L.) and potato (Solanum tuberosum L.)), which were grown within respective soil Hg content, had Hg content significantly lower than the Chinese National Food Quality Standard. We plant these four category crops into two Hg-contaminated farmlands in the second year, had the Hg content lower, too. These crops are deemed low Hg accumulative crops. Based on the result and the database of land use. One of the expected best crops planting structural adjustment scheme is that the strawberry is planted in the farmland of tier I and II, and planting potato in the tier III area. The maximum agricultural output of the scheme will be obtained, 787 million CNY (117 million USD). Compare to values before (170 million CNY), there is great potential for income increase. The net Hg contained in the annual agricultural products in the Wanshan Hg mining area turn to be 0.21±0.089 kg (Table 5). The annual net mass of Hg in all agricultural products reduce 1.55-1.62 kg compare to values before, thus by reducing percentage range of 88.1%-92.0%. By adapting to this scheme, the Hg exposure in local inhabitants in MMAs could be significantly reduced.

Key words: low-Hg crops, soil contamination, land use
Evaluation of low-level mercury exposure effects on human health

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Abstract:

This study focused on the evaluation of low level mercury exposure effects on main parameters of the human body with biomonitoring of hair mercury content in Simferopol population (72 high schoolers, 14-15 year old; 79 students, 18-20 year old). Mercury content in students – residents of Simferopol was compared to age-matched individuals (n = 46) living in other districts of Crimea. Some of the preliminary results on mercury content in human hair were published (Evstafeva E.V. et al. Environmental and biomonitoring mercury research in the Crimean region, 2017). Mercury content in hair was determined by atomic absorption spectrometry (analyzer PA-915M, National Research Tomsk Polytechnic University). Parameters of central and autonomic nervous system and cardiovascular system were examined by the methods of electroencephalography (EEG), electrocardiography (ECG) and heart rate variability (HRV). HRV measurement was performed by five-minute three-lead ECG recordings in supine position and during active tilt test followed by analyzes of standard time and frequency domain HRV parameters. Higher mental functions were assessed by 2 standard tests: Schulte tables to assess the characteristics of voluntary attention and Eysenck test for personality evaluation.

Mercury hair concentrations in high schoolers (0,13 ± 0,07 (min = 0,06, max = 0,3) mkg/g) and students (0,15 ± 0,14 (min = 0,02, max = 0,95) mkg/g) were within normal ranges (0,5–1 mkg/g) with no significant gender difference. Negative associations were determined between mercury concentration and total power of low- and average EEG frequencies (0,35<r<0,65; p<0,05) accompanied by prolonged latency of the N1 and P300 event related potentials. Individuals with higher mercury levels showed higher hostility (r = 0,41) and neuroticism (r = 0,37) and were less mentally stable (r = -0,41) and felt insecure (r = -0,39). Correlation analyses revealed significant associations between parameters of voluntary attention and temperament.
characteristics with mercury content in high schoolers. Identified associations between stress index and mercury levels (r = 0.51) were suggestive for increased sympathetic activity in high schoolers. In students low level mercury exposure effects on HRV may have been mediated by reduced central influences and were associated with reduced sympathetic activity especially in female group. Statistically significant negative associations between mercury and amplitude of R in II and III standard leads and in AVF and also negative for the amplitude of T in III standard lead and AVF (0.16<r<0.20; p<0.05) were observed suggesting that mercury exposure may be one of multiple factors that might influence cardiac activity. These results provide evidence that mercury exposure might play a role in pathogenesis of altered nervous and cardiac activity. This study was funded by RFBR research projects № 18-29-24212\18 (mercury analysis in Simferopol), № 18-45-920042 (mercury analysis in Sevastopol).

**Key words:** cardiovascular system, nervous system, mental functions, mercury, Crimea.
Mercury concentration and speciation in mine wastes in Tongren mercury mining area, southwest China and environmental effects

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Abstract:

Mercury mines are considered typical mercury (Hg) contaminated areas. Huge quantities of mine wastes were produced during long history of large scale Hg mining activities. This study investigated Hg concentrations and speciation in mine wastes collected from Tongren Hg mine and their impacts on the surrounding environment with different remediation measures. Total Hg (THg) concentrations in the mine wastes varied widely from 4.15 to 825 mg/kg, and Hg\textsubscript{0} was the dominant form in the wastes. No obvious deformations were observed in mineral boundaries of mine wastes by TEM analysis, indicating that the smelting processes were insufficient. Additionally, nanometer scale Hg compounds were observed in the mine wastes coupled with EDS microtopography analysis, which may pose potential risks to the local environment. Total soluble Hg (TSHg) concentrations in leachates of mine wastes averaged at 11.27 μg/L. THg concentrations in surrounding surface waters varied from 0.038 to 10.6 μg/L, and 21.1% of THg concentrations exceeded the level V of national standard (1 μg/L). The THg concentrations and pH in the surface water were significantly negatively correlated, indicating that Hg was more active under acidic conditions. Total gaseous mercury (TGM) concentrations above the mine waste heaps ranged from 13.5 to 309 ng/m\textsuperscript{3}, which were significantly lower than previous studies. These data demonstrated the effects from restoration projects and proper treatment methods were needed in different mine waste heaps.

Keywords: mercury; speciation; mine waste; surface water; atmosphere
Delineation of mercury-binding proteins by using immobilized metal ion affinity chromatography

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Abstract:

Mercury binding proteins play important roles in mercury-induced toxicity. However, only a few high abundant proteins that bind mercury have been characterized. Less abundant proteins capable of binding mercury may be also crucial for underlying the toxicity mechanisms of mercury. Nevertheless, separation and identification of these less abundant proteins are faced with interference from high abundant proteins. Immobilized metal affinity chromatography (IMAC) has been widely used for characterization of metal-binding proteins in various cells and bacteria. Proteins with zinc-, copper-, arsenic-, bismuth-, and cobalt-binding ability were successfully identified by IMAC. In this study, a mercury affinity chromatography method was developed for the separation and identification of putative mercury-binding proteins. No proteins were kept on the column without Hg affiliated on the column, while a number of proteins were captured by the Hg-chelated column. The developed technique was applied to delineate mercury-binding proteins in human neuroblastoma SK-N-SH cells. Among the mercury-binding proteins 38 of them were identified, and most of the identified proteins were not reported to bind metals previously. These identified proteins were mainly proteins with binding ability, catalytic activity, and molecular structure activity, which involved in protein folding, cell redox homeostasis, and cellular localization. These identified proteins provided useful information on the possible molecular mechanisms of Hg neurotoxicity and protein candidates for mercury transport and toxicity.

Keywords: immobilized metal ion affinity chromatography, mercury-binding proteins, SK-N-SH cells, mechanisms of Hg toxicity
Mercury Geochemistry over Western China and Its Potential Environmental Impacts

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Abstract:

Mercury (Hg) is a global pollutant as it has significant adverse impacts on human health, which is among the most highly bioaccumulated toxic trace metals in the global environment. Western China, defined herein as the Tibetan Plateau and the Xinjiang Uyghur Autonomous Region, is the highest mountainous region on earth. On top of the world's highest mountain ranges and peaks is the largest aggregate of cryospheric environments outside the polar regions. Anthropogenic Hg emissions from the surrounding regions such as the South Asia can be transported over long distances and deposited into the cryosphere of the Tibetan Plateau. This review synthesizes research progresses on the Hg geochemistry from different cryospheric environments (e.g., glacier, snow/ice, permafrost). Impacts of cryospheric processes to the biogeochemical Hg cycling and their potential environmental feedbacks to the related socioeconomic development are addressed in the context of climate warming at regional/global scales.
Abstract:
Mercury is considered as a global pollutant and had high toxicity which can adversely affect human health. Coal combustion, Pb/Zn smelter and large-scale gold production are most important anthropogenic mercury emission source in China, which maybe resulted in serious Hg pollution to local environment. However, human health risks of Hg exposure in these contaminated areas are unclear. In this study, we collected staple food (rice, fish etc.) and human hair samples at the three typical Hg polluted areas for total mercury (THg) and methylmercury (MeHg) analysis. Around coal-fired power plant, the geometric averages of THg and MeHg concentration in human hair samples are 0.235 μg/g (0.081~1.09 μg/g, n=155) and 0.123 μg/g (0.027~0.747 μg/g, n=36), respectively, and THg concentrations in rice samples averaged at 3.63 ng/g (1.05~11.4 ng/g, n=126). Around Pb/Zn smelting area, the geometric average of THg and MeHg concentrations in human hair are 0.596 μg/g (0.132~1.82 μg/g, n=125) and 0.203 μg/g (0.045~1.139 μg/g, n=42), respectively, while 17% of hair THg concentrations exceed 1 μg/g set by USEPA; THg concentration in rice samples averaged at 5.99 ng/g (3.02~30.7ng/g, n=70). At the surroundings of large-scale gold production, the geometric averages of THg and MeHg concentrations in human hair samples are 0.333μg/g (0.096~2.92 μg/g, n=144) and 0.183 μg/g(0.056~0.920 μg/g, n=41), respectively, while 3.5% of hair THg concentrations exceed 1 μg/g set by USEPA; THg concentrations in rice samples averaged at 4.46 ng/g(3.13~8.67 ng/g, n=65). Rice rather than fish consumption is the primary pathway of mercury exposure for local residents at the study region, which contributed 71.4%, 77.2% and 70.8% of total probable daily intake (PDI) on average, respectively, which is similar to mercury mining area. Hair THg and MeHg concentrations in Pb/Zn smelting area were significantly elevated compared with other two areas, which indicated potential health risks for the local residents. Therefore, effective techniques should be conducted on Pb/Zn smelting to reduce Hg emission from this sector and to reduce human health risks of Hg exposure.

Keyword: mercury contaminated area; human exposure; health risk; rice
Mercury isotope fractionation during aqueous-phase reduction of HgII by low molecular weight organic compounds

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Abstract:
Mercury (Hg) is a global contaminant due to the volatility and chemical inertness of its elemental form (Hg⁰) towards oxidation that renders atmospheric long-distance transport viable. In the atmospheric environment, oxidized Hg (HgII) existing as gaseous or particle-aggregated molecules comparatively displays many times higher rates of dry and wet deposition and subsequently transient lifetime in the lower troposphere. Red-ox transformations of Hg in the atmosphere occur both by homogeneous and heterogeneous reactions in the gas phase, and also in the aqueous phase and heterogeneous phases and at atmospheric interfaces. Evidence for surface-enhanced and complex atmospherically-relevant reactions are numerous from laboratory studies. However, the extent of photolytical reduction of atmospheric HgII is debated given the lack of a systematic understanding of reduction pathways. Nonetheless, there are field studies and global chemical transport models suggesting the general occurrence of atmospheric HgII reduction. In this experimental study, we have investigated the kinetics, mechanisms and stable Hg isotope fractionation during aqueous-phase photo-reduction of HgII by a series of semi-volatile aliphatic and aromatic organic compounds that are potential components of secondary organic aerosols (SOA) making up a prominent fraction of tropospheric particulate matter. Yielding considerably contrasting mass-dependent fractionation (MDF, δ²⁰²Hg) and mass-independent fractionation (MIF, Δ¹⁹⁹Hg and Δ²⁰¹Hg) signatures, the isotopic characterization of the individual HgII - organics photo-reactions provide a unique fingerprint for each of the classes of reactions.
We have established the equipment for aqueous phase reduction, and have found HgII by C₂O₄²⁻ preceded by the lighter Hg isotopes were preferentially reduced to the product Hg⁰, which in addition displays (-) odd-MIF.

Keywords: Hg, isotope fractionation, reduction, aqueous-phase
Transportation and Mobility of Mercury in Typical Karst Catchment of Guizhou, China

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Abstract:
Mercury (Hg) has unique geochemical behavioural characteristics in karst areas, but in-depth systematic research on Hg in karst areas is lacking. Guizhou province is located in the heart of karst, south western of China. Therefore, research on transportation and mobility of Hg in typical karst catchment can provide scientific basis for prevention and control of Hg pollution in Karst areas. Through this study, we want to assess the role of soil in Karst area whether as a sink or source in Hg cycling, and characterize soil parameters that may affect Hg mobility in these soils. For this reason, two small typical Karst catchments (Huilong and Chenqi catchment) are studied. The difference of spatial and temporal distribution of Hg in rainfall and surface runoff in Huilong catchment (mining area) and Chenqi catchment (farmland) is obviously. The Hg concentrations of rainfall varied between 5.3 and 91 ng l\textsuperscript{-1} in Huilong, and between 3.9 and 73 ng l\textsuperscript{-1} in Chenqi. For runoff waters, Hg concentrations varied between 31 and 98 ng l\textsuperscript{-1} in Huilong, and between 1.5 and 30 ng l\textsuperscript{-1} in Chenqi. The rainfall Hg concentration in the dry season (Oct-Apr) is almost 2 times higher than rainy season (May-Sep). The next step is to combine the rainfall and runoff data to calculate the annual Hg input and output fluxes for the two catchments. The distribution of Hg in soil profiles is quite different, which may be related to parent rock background, soil formation process and external input. The relationship of Hg mobility with other parameters (multi-element concentrations in soils, SOM, CEC, pH and redox potential) will be discussed.

Key words: mercury, karst catchment, input and output flux
Mercury Risk in Poultry in the Wanshan Mercury Mine, China

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Abstract:

Mercury (Hg), a toxic metal pollutant, is released to the environment via natural and anthropogenic sources. Hg can be methylated via microbial processes, especially in aquatic ecosystems. Methylmercury (MeHg) is the most toxic form of Hg, which can be easily bioaccumulated and biomagnified in food chains. Bioaccumulation of MeHg results in high MeHg levels in fish, and fish consumption is regarded as the major exposure pathway of Hg to humans. Due to limited fish consumption by locals in inland populations of China, rice has recently been identified as the major exposure pathway of Hg. Wanshan Mercury Mine (WMM) is China’s largest and the world’s third largest Hg mine, long-term mining activities have resulted in serious Hg contamination to the surrounding environment. In recent years, due to the awareness of Hg contamination, local residents in WMM started to buy imported food supplies. Local crops were used more extensively to feed poultry and the awareness of Hg pollution in crops, led to a concern over Hg contamination in poultry. In this study, total Hg (THg) and MeHg burdens in muscles (leg and breast), organs (intestine, heart, stomach, liver) and blood were investigated for chickens, ducks and geese in the WMM. Elevated THg and MeHg levels, especially in livers and blood, were observed in WMM poultry. The liver may serve as a filter of blood Hg, and may be a site of MeHg demethylation. Elevated THg and MeHg burdens were observed in chickens (THg: 15.3 to 238.1 μg; MeHg: 2.2 to 15.6 μg), ducks (THg: 15.3 to 238.1 μg; MeHg: 3.5 to 14.7 μg) and geese (THg: 83.8 to 93.4 μg; MeHg: 15.4 to 29.7 μg). Organs and blood constitute more than 50% of total burdens of THg and MeHg in poultry. This study demonstrated poultry can be a new important Hg exposure source for the WMM residents, and identified a high risk of Hg exposure for the local population.

Key words: Mercury Methylmercury Poultry Mercury mine Human exposure
NPP-VIIRS DNB-based reallocating intra-urban populations to mercury
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Abstract:
Accurate and update assignment of population-related environmental matters onto fine grid cells in a sparse monitoring network remains challenging. We present the approach based on Suomi National Polar-orbiting Partnership (S-NPP)-Visible Infrared Imaging Radiometer Suite (VIIRS) Day/Night Band (DNB) to reallocate population onto a regular finer surface. Urumqi city cluster as an example, the number of potential population to the mercury were reallocated onto 0.1x0.1 km reference grid. The result of Monte Carlo modelling indicated that the range of 0.5 to 2.4 million people was reliable. The study highlights that the NPP-VIIRS DNB-based multi-layered, dasymetric, spatial method enhances our abilities to remotely estimate the distribution and size of target population at the street-level scale and has the potential to transform control strategies for epidemiology, public policy and other socioeconomic fields.

Key words: NPP-VIIRS DNB; Subpopulation reallocating; Sparse monitoring network
The role of soil microbial communities in predicting methylmercury production

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Abstract:

Rice ingestion has been recognized as an important route of dietary exposure to neurotoxic methylmercury (MeHg) that is usually synthesized in rice paddy soils. Although Hg methylators have been linked to MeHg formation in soil, it remains unclear whether non-Hg methylating communities are also important for MeHg production. Here, we collected 141 paddy soil samples from main rice-producing areas across China to identify associations between bacterial community composition (including both Hg and non-Hg methylators), and methylation efficiency (proxy as %MeHg). Results showed that %MeHg in the paddy soils varied from 0.005 to 2.838% at a national spatial scale, which can be explained by the variations of soil microbial community composition across different areas. Our structure equation modeling suggested a much stronger link between bacterial community composition and %MeHg, compared to the abundance of methylating gene (hgcA) and edaphic properties. More importantly, random forest models suggested a more important role of non-Hg methylators than Hg methylators in predicting variations of soil %MeHg. The non-Hg methylators such as unclassified Saccharibacteria and Deltaprobacteria NB1_j could be used as bioindicators of %MeHg, which have strong co-occurrence patterns with Hg methylators in the paddy soils. Our findings highlight an overlooked role of non-Hg methylating communities in predicting MeHg production in paddy fields.

Key words: microbial community, paddy soil, methylmercury.
Selenium modulated gut flora and promoted decomposition of methylmercury in methylmercury-poisoned rats

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Abstract:

Methylmercury (MeHg) is one of the most toxic environmental pollutants, which can magnify through food chains and cause potent neurological problems like Minamata disease. Gut flora has been found to transform MeHg while MeHg exposure may destroy the diversity of gut flora and decrease their capability to transform MeHg. Our previous study found that selenium (Se) could promote weight gain, decrease hepatic damage and increase serum mercury (Hg) levels in MeHg-poisoned rats. In this study, the effects of Se on the profile of gut flora and the transformation of MeHg in MeHg-poisoned rats were investigated. MeHg-poisoned rats were treated with sodium selenite every other day for 90 days. Fecal samples were collected on Day 8, 30, 60 and 90. Gut flora in feces was determined using 16S rRNA gene profiling, and concentrations of Se, total mercury (THg) and MeHg were measured using ICP-MS and CVAFS. It was found that gut flora at both the phylum and genus rank in the MeHg-poisoned rats after Se treatment was modulated towards that in the blank group, suggesting the restoration of the profile of gut flora. Increased THg was found in fecal samples after Se treatment on day 30. The percentage of MeHg (of total mercury) in the control group (MeHg-poisoned rats) was in the range of 81-105% while it was 65-84% in the Se treatment group on different days, suggesting the increased decomposition of MeHg in MeHg-poisoned rats after Se treatment. In all, this study suggests that MeHg poisoning damaged the abundance of gut flora and decreased their capacity for the decomposition of MeHg. After Se treatment, the abundance of gut flora was partially restored and the decomposition and excretion of MeHg was enhanced. These findings suggest that the modulation of gut flora may be one way to promote the health status in MeHg-poisoned rats and possibly in human beings.
Mixed exposure to low dose heavy metals impaired spatial cognitive function and the related mechanisms

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Abstract:
Human exposure to toxic heavy metals is a global challenge. The toxic effect of individual heavy metals, such as lead, cadmium and mercury, which were also representative neurotoxicological contaminants, is well documented. However, there is limited information on neurobehavior and neuronal injury of these heavy metal mixtures (MM), making it unclear and essential. Pregnant female rats were administered heavy metal mixtures containing lead, cadmium and mercury with 3 different concentrations (1× MM, 5× MM and 10× MM) in drinking water until weaning (postnatal days 21, PND 21). Controls were supplied with drinking deionized water. Morris water maze was used to measure spatial cognitive function and search strategies, and thionine staining were evaluated to measure neuronal density. Golgi-Cox staining was used to analyze morphology of dendritic spines in hippocampal CA1, CA3, and DG regions. Confocal laser scanning microscope and immunofluorescence double labeling were applied to detect the protein expression of PSD95 and GluR1 co-localization, as well as MAP2 and GluR1 co-localization. Morris water maze testing revealed that the offspring in MM-exposed groups used more nonspatial search strategy including thigmotaxis, passivity, and took more latency to get the hidden platform than control groups. A significant decrease in the neuronal density was detected in hippocampus CA1 region in rats of 1× MM, 5× MM and 10× MM groups, and CA3 and DG region in 5× MM and 10× MM groups. Consistent with the results of neuronal density, Golgi-Cox staining showed that density of dendritic spines declined in dose-dependent manner after MM exposure, and the spine showed an immature form in MM-exposed rats. In addition, the expressions of synaptic functional plasticity related PSD95-GluR1 co-localization as well as MAP2-GluR1 co-localization were decreased in dose-dependent manner after MM exposure. These results suggested that low dose heavy metals exposure in rats is associated with alterations in synaptic structural and functional plasticity abnormal in rat, thereby leading to spatial cognitive function impairment.

Key words: Heavy metal mixtures; spatial cognitive function; synaptic spine; PSD-95; GluR1; MAP2

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Mercury and the environment: A case history from the goldfield of Victoria, Australia.

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Abstract:

The environmental fate of mercury in the goldfields of Victoria, Australia is largely uninvestigated. As the principle ingredient of gold extraction from the processing of both alluvial and hard rock gold sources across the goldfield, mercury-gold amalgamation resulted in significant volumes of mercury entering waterways and soils surrounding numerous processing facilities, from the mid 1850’s through until much of the mining ceased in the first half of the 20th century. The distribution and concentration of mercury at these sites, and further afield, may be more problematic than previously acknowledged. We investigate the gold mining and stamp battery operation in the Mt Egerton historical mining area, which represents a highly disturbed landscape. The site contains high concentrations of potentially toxic elements including mercury (Hg), arsenic (As) and antimony (Sb). Stream sediment and soil sample data analysis shows elevated concentrations of contaminants throughout the zone both proximal and distal (more than 1km from the battery) to source being the Government Stamp Battery hosted on the site. Concentrations of Hg ranged from 0.08-17.85mg/kg, As ranged from 13.3-1745mg/kg and Sb from 0.27-6.07mg/kg. Concentrations of both Hg and As exceed health and ecological investigation levels for acceptable concentrations of contaminants in recreational areas. The need to evaluate potential health risks persist despite previous rehabilitation works on the site.

In this study, we examine the distribution and concentration of mercury at a single, arguably representative Battery Site to highlight the need for detailed evaluation of Hg distribution across the historic gold mining region.

Keywords: Mercury, mining, gold, disturbed landscapes.
Numerical and Statistical Modeling and its Applications in Medical Geology
Geologic structure forms flow barrier to increase resilience of Qingduo groundwater supply aquifer in Jiyuan basin, Henan Province, China

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Abstract:
Qingduo groundwater supply, located in the northern alluvial plain of Mang River, is essential for Jiyuan Basin. The supply wells (n=16) extract water from the lower karst aquifer of Ordovician (O) fissured limestone (depth 80~150m) at Qingduo. The upper Quaternary (Q) unconsolidated sedimentary aquifer is also exploited for local usage. A lead smelting plant located within a kilometer from the Qingduo groundwater supply wells has contaminated nearby soils with heavy metals such as Pb (300 mg/kg to 2500 mg/kg) and As (25 mg/kg to 170 mg/kg). The plant is adjacent to Zhulong river that also receives discharges from the battery and sulfuric acid factories, resulting in contamination of surface water. Concerned with the safety of the Qingduo groundwater supply given the severe surface water and soil pollution, this study seeks to illustrate how geological structure influences groundwater flow regimes and contaminant transport for the Qingduo groundwater supply aquifer.

The alluvial plain in northwestern Jiyuan Basin was chosen as the model domain (~45km$^2$), encompassing Qingduo groundwater supply well field (0.36 km$^2$) and the known industrial pollution sources. To depict geological features including the topographic relief, stratigraphic structure, predominant fault and so forth, a 3D geological-based grid for the model domain was generated using spatial analysis by Geographic Information System (GIS). It is hypothesized that geological structures, such as faults, alter the groundwater flow path either as an impedance or as a conductor, thus divert the groundwater flow from the expected regional hydraulic gradient. To test this hypothesis, a steady-state 3D groundwater flow numerical model is set up using Groundwater Modeling System (GMS) to analyze the flow regimes in annual mean state, or the stable flow field under current pumping scenario. The contaminant transport was then simulated using a particle-tracking method based on the calibrated flow model. Results show that a major fault in the study area acts as a discharge conduit of the well-developed karst system to the shallow alluvial groundwater. This fault is essentially a “flow barrier” to the surface-derived industrial pollution through forming a “water mound” around Qingduo. Because of this, the infiltration of industrial pollution is minimal, reducing the risk of pollution. Based on the mass balance and calibrated hydraulic property, the conduit flow capacity of the fault has been estimated, the long-term effect of increased pumping by the supply wells on this flow barrier’s protective effect is further discussed.

Key words: Geological setting; Groundwater flow regime; Numerical modeling; GIS; Groundwater pollution risks
Seasonal variations and trend prediction of water quality of Hongfeng Reservoir in Guizhou Plateau

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Abstract:
Temporal and spatial patterns of water quality from Hongfeng Reservoir located in Southwestern China Plateau were investigated using chemometric techniques. Integrated research on the evaluation, prediction, and protection of water quality is the key to protecting the safety of water supply. Water samples were collected at 8 monitoring sites of the reservoir between January 2004 and December 2018, and analyzed for dissolved oxygen (DO), pH, permanganate index (COD$_{Mn}$), ammonia nitrogen (NH$_3$-N), total phosphorus (TP), total nitrogen (TN), five-day biochemical oxygen demand (BOD$_5$), fluoride, selenium, arsenic, mercury, cadmium, lead, cyanide, total and faecal coliforms, and volatile phenol. Concentrations of DO, COD$_{Mn}$, NH$_3$-N, TP, fluoride and total and faecal coliforms did reach the specified standard levels in a large proportion of the water samples. To evaluate the current status of water quality and predict the spatial and temporal trends from the tributaries, the Seasonal Mann-Kendall tests and two-dimensional water quality numerical model was conducted on the basis of the water quality monitoring data in Hongfeng Reservoir. TN and TP concentrations are taken as the major indicators for water quality. The TN concentration shows a highly significant increasing trend in Hongfeng Reservoir according to Seasonal Mann-Kendall tests. The two-dimensional water quality numerical model provided the best picture to showed that the sphere of influence from the tributaries can spread across the Baihua Reservoir if the pollutants are not controlled.

Keywords: Water quality; Trend prediction; Mann-Kendall test; Numerical modeling; Hongfeng Reservoir
Assessment of groundwater As risks in Mekong Delta through machine learning methods

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Abstract:

Elevated concentrations of geogenic arsenic in groundwater have been detected in > 70 countries to exceed 10 μg/L, the WHO’s guideline value for drinking water. A common yet unexplained characteristic of groundwater arsenic spatial distribution is the extensive variability at various spatial scales. Chronic exposure to drinking water As, a known carcinogen, has been demonstrated to negatively impact human health through drinking water exposure. The Mekong Delta encompassing Cambodia and Vietnam exhibits significant groundwater arsenic risks, with tube well arsenic level among the highest in the world. Furthermore, rapid expansion of groundwater-irrigated land threatens food security and safety when used for rice cultivation.

Machine learning methods, including boosted regression tree and random forest, were used to fit data set including groundwater quality data, and other raster data such as digital elevation model (DEM), temperature and precipitation. Boosted regression tree is a prediction model in the form of boosting decision trees. The model is built in a stagewise fashion, starting at a single tree fitting the whole training dataset. Then it generates new trees serially along the steepest descent. Random forest is a prediction model in the form of bagging decision trees. The model comprises numerous decision trees. It generates each tree concurrently and independently fitting a random bootstrap-resampling set of training data with random subset of the features, and combine by the majority vote to give a representative output of all individual trees.

The precited distribution of groundwater As through modelling can be used to provide an estimate of population exposure to groundwater As, and to evaluate food security risks. Furthermore, the model is useful to reveal hydrogeochemical processes controlling spatial patterns of groundwater As occurrence of groundwater in Mekong data. The results have implications for arsenic mitigation.

Key words: Machine learning, Arsenic, Cambodia, Vietnam, Mekong Delta
Predicting the mobility of lead and other metal ions in groundwater by using site-specific sorption models

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Abstract:

Centuries of human activities have dispersed lead (Pb) all over the Earth. Mining, pesticide manufacturing and application, and spent ammunition at shooting ranges are major contemporary point sources of lead to drinking water supplies. Lead poses such serious health problems that, in the United States, the target concentration in drinking water is 0 and concentrations exceeding 72 nanomole/L (15 ug Pb/L) require remedial action. This study seeks to understand the processes that promote the mobility of Pb in a shallow, unconfined, quartzitic, sand and gravel aquifer on Cape Cod, Massachusetts, USA, where shooting ranges are distributed across the landscape, through laboratory experiments, field-scale transport experiments, and reactive transport modeling.

Laboratory experiments conducted with sediments from the study area examined the influence of pH and concentrations of the major cations observed in ambient groundwater (sodium, calcium, magnesium, and potassium) on sorption of the major cations, Pb(II), zinc(II) (Zn), and nickel(II) (Ni). Sorption of Pb was much more extensive than sorption of Zn or Ni. Sorption of Pb increased steeply with increasing pH and exhibited minimal change with increasing dissolved-salt concentrations. Nickel and Zn sorption also increased sharply with increasing pH but decreased significantly with increasing dissolved-salt concentrations. The experimental data were well-described using a sorption model that included pH-dependent sorption of major cations and metal ions.

Field-scale transport experiments were conducted in which groundwater amended with 20 micromole/L (uM) Pb, Zn, and Ni, and 1000 uM bromide (Br-), (added as a conservative tracer) was injected into one region with low dissolved-salt concentrations and one region with moderate dissolved-salt concentrations. Groundwater pH in both regions was 5.8-6.0. Reactive transport model simulations using the site-specific sorption model for the major cations and metal ions captured the principal trends in the observations: 1) Ni was transported faster than Zn in both regions; 2) Ni and Zn exhibited much lower mobility in the region with lower dissolved salt concentrations; 3) no lead was detected 1.4 m downgradient up to one year after completing the injection; and 4) injection of ethylenediaminetetraacetic acid (EDTA) one year after injection of the metal ions mobilized Pb.

Additional reactive transport simulations examined chemical conditions that could mobilize Ni, Zn, and Pb. Metal ions were equilibrated with sediments at pH 5.8 and low concentrations of dissolved salt. A subsequent 10-fold increase in dissolved salt concentrations or decrease in pH to 4.8 mobilized Ni and Zn but resulted in minimal mobilization of Pb. Lead could be mobilized by introduction of an organic complexing agents represented by EDTA. Findings suggest that, under mildly acidic conditions, the most likely mechanism by which Pb can be mobilized is the introduction of compounds that form strong aqueous complexes with Pb.

Keywords: lead, sorption, groundwater, transport, modeling
Modeling the challenge of moving toward a lower drinking water maximum contaminant level for arsenic on domestic-well population in the conterminous United States

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Abstract:
Domestic wells serve as the dominant drinking water source for approximately 44 million rural people in the United States. Geogenic arsenic (As) in domestic well water has adverse health effects on these rural residents. Approximately 2.1 million, or 4.8% of rural population were estimated under exposure to [As] > 10 µg/L, the current US drinking water maximum contaminant level (MCL) and World Health Organization (WHO) drinking water guideline. Multiple lines of evidence have showed the health effects of As exposure at lower levels, and US Environmental Protection Agency (EPA) is assessing the health risk of exposure to lower As including 3 and 5 µg/L. States of New Jersey and New Hampshire have adopted a lower As standard of 5 µg/L. This study investigates the spatial heterogeneity of groundwater with 5-10 µg/L As at national, regional and local scales, and develops prediction models to estimate the domestic well population exposed to > 5 µg/L As in the conterminous US. Preliminary results from logistic regression models have showed more than doubled population will be exposed to higher [As] if the MCL is changed to 5 µg/L, consistent with a typically quasi-lognormal distribution of groundwater [As] in US. Some states with lower median [As] could face bigger challenge as the population exposed to 5-10 µg/L [As] would exceed the current population exposed to [As] > 10 µg/L. At regional and local scales, the spatial pattern of As exceedance area and population could dramatically change, with newly emerging exceedance areas and population that are not identified under the current MCL. Specific rock types, arsenic concentrations in soil and stream sediments, groundwater geochemistry such as pH and redox index that influence As dissolution and sorption, and hydrological processes related to groundwater residence time are among the major factors regulating As occurrence in domestic wells. Advanced models, such as boosted regression tree and random forest, will be developed to improve As exceedance prediction and exposure population estimate.

Key words: domestic well, arsenic, 5 µg/L, spatial heterogeneity, regression model
Numerical modeling of arsenic adsorption and oxidation on manganese oxides

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Abstract:

Manganese (Mn) oxides commonly occur as coatings and fine-grained aggregates of poorly-crystalline mineral phases in the natural environment and are known to play a crucial role in the redox cycling of many contaminants in groundwater, including arsenic (As). Groundwater As contamination poses serious environmental and human health risks. The oxidation of arsenite (AsIII), into less mobile and less toxic arsenate (AsV) enhance As sequestration from groundwater and reduces the risk. As(III) can be oxidized on the Mn oxide mineral edge; however, little is known about the factors that control the overall oxidation rate. An improved understanding of the reaction process, and its intermediate products, is essential to quantify this rate.

Here we developed a process-based numerical framework to rigorously analyze the observations from previous relevant experiments. These experiments were carried out over the duration of up to two days using birnessite, a type of Mn(IV) oxide similar to those found in sediments and soils, and at circumneutral pH relevant to groundwater systems. Our model identified three phases of oxidation that differed in the rate of As(III) oxidation based on the characteristic changes in the accessibility of Mn(IV) and Mn(III) edge sites to As(III). The first phase is short and governed by fast As(III) oxidation on Mn(IV) edge sites. During the second phase, oxidation gradually shifts to Mn(III) edge sites, decreasing the rate significantly. In the third phase oxidation proceeds at a steady rate with Mn(IV) and Mn(III) sites contributing equally. Also, As(III) may remain adsorbed on Mn(III) sites for extended periods before getting oxidized.

These new model-derived insights provide an important contribution towards a better understanding of the reactivity of Mn oxides and their significance on the cycling of redox sensitive metalloid(s) in the environment.

Key words: manganese oxide, arsenic, geochemical modeling, surface complexation, oxidation.
Quantifying Uncertainty in Arsenopyrite Oxidation due to Re-Injection of Unconventional Gas Co-Produced Water using Heuristic Multi-objective Optimization

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Abstract:

Water resources management often involves models that simulate physical/chemical processes to make predictions of future system behavior. These predictions often contain uncertainty that must be considered in order to make robust decisions. The quantification of this uncertainty is often not conducted in practice due to computational limitations and a lack of flexible software capabilities. To bridge this gap, we have developed a heuristic, multi-objective, model-independent optimization methodology using TCP/IP network communications for parallel run management on high-performance computing systems. The proposed optimization methodology is based on Particle Swarm Optimization (PSO), where the memory-like nature of PSO makes it ideal for tracing a Pareto front that graphically illustrates the trade-off between competing objective functions. The resulting Pareto front can be used during decision-making to assess, e.g., the practicality of a series of potential management solutions, the best calibration parameter sets, the likelihood of hypothesized model outcomes, etc. The algorithm can also handle inequality constraints that reflect additional conditions that must be met along the Pareto front. We have demonstrated the algorithm on an important real-world case study where the trade-off between (1) the calibration of a field-scale reactive transport model, and (2) a contested simulated model outcome was evaluated. This study considered the re-injection of coal seam gas co-produced water into deep aquifers in the Surat Basin, Queensland, Australia, where the potential impact of an undesired observed mobilization of arsenic concentrations needed to be understood and managed. The likelihood that arsenic release was caused in part by arsenopyrite oxidation was addressed; therefore, the total quantity of oxidized arsenopyrite was considered to be the primary prediction of the model. An inequality constraint was also necessary to maintain consistency with a laboratory experiment and its associated geochemical model. The results resoundingly indicate that arsenopyrite oxidation was a highly likely, and significant, contributor to the observed arsenic mobilization at the site.

Keywords: Uncertainty quantification; Groundwater arsenic; Reactive transport modeling; Multi-objective optimization; Managed aquifer recharge
Model-based analysis of reactive transport processes governing fluoride and phosphate release and attenuation during managed aquifer recharge

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Abstract:

During a large scale field experiment where 3.9GL of highly treated, deionised wastewater (average TDS 33 mg/L) was injected into a low fluoride (<16 μM) siliciclastic aquifer over a four year period, pulses of elevated fluoride (up to 58 μM) and filterable reactive phosphorus (FRP) (up to 55 μM) were observed. A process-based reactive transport model has been developed and applied to better understand the interacting hydro-geochemical processes affecting these pulses, and assess whether fluoride concentrations may eventually exceed drinking water limits (1.5 mg/L = ~79 μM) with continued large scale injection. Based on previous experimental work, elevated fluoride and phosphate concentrations were attributed to dissolution of the fluoride-bearing calcium phosphate mineral carbonate-rich fluorapatite (CFA: Ca₁₀(PO₄)₅(CO₃)F₂). The reactive transport model incorporates the incongruent dissolution of (i) proton exchange, that primarily releases fluoride and calcium, and (ii) equilibrium with a mineral-water interface layer of hydrated di-basic calcium phosphate (DCPsurface: CaHPO₄) that forms on CFA. Model simulations identified that calcium initially increased on aquifer exchanger sites under the low ionic strength conditions post breakthrough of the deionized injectate. Elevated pulses of fluoride and phosphate concentration occurred when calcium concentrations in solution remained low. However, the fraction of calcium on the sediment exchanger sites was found to slowly increase with continued injection until an equilibrium was reached under the prevailing geochemical conditions post breakthrough of the deionised injectate. After calcium exchange equilibrium was reached, continued injection induced increasing aqueous calcium concentrations. This resulted in declining concentrations of fluoride and phosphate due to due re-equilibration with CFA. Eventually, with continued injection, fluoride and phosphate concentrations decreased below the concentrations in the native groundwater. Phosphate was found to attenuate much more quickly than fluoride due to surface complexation with aquifer sediments. Maximum fluoride concentrations were inferred to be controlled by equilibrium with the composition of CFA in the target aquifer and are not expected to exceed the elevated concentrations that were observed under post breakthrough low calcium conditions. A mitigation strategy involving the amendment of CaCl₂ in the injectate to further reduce fluoride and phosphate mobilization during managed aquifer recharge was assessed. Insights from this study may be broadly applicable to understanding natural fluoride release and mobilization from fluoride-bearing calcium phosphate minerals in other aquifers worldwide.

Key words: fluoride, phosphate, managed aquifer recharge, modeling
The utility of models to predict contaminants in groundwater

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Abstract:

Contaminant occurrence, controls on mobility, and fate and transport, have long been a part of hydrologic investigation in groundwater hydrology. Prediction of contaminants in groundwater has until recently, been largely avoided. Pitfalls in prediction may be part of the reason for this. For example, not having good information in three dimensions or attempting to predict a contaminant’s presence in areas of high well-to-well variability, can be daunting. Also, temporal variability can erode confidence in predictions when data sets span many years or decades. However, one of the biggest impediments to making good predictive models is the inability to start. Not developing a model because of a perceived lack of sufficient information slows the progress of the science of prediction and prolongs the inevitable: most predictive models of contaminants in groundwater are varyingly informative but suffer from varying degrees of uncertainty.

Recent developments in modeling methods and available computing power have helped spur an upsurge of modeling efforts worldwide: in particular, the use of several machine learning methods have made modeling somewhat easier, although, at the same time, these methods have been described as adding an element of “black box” to the efforts. One benefit of these new methods is the ability to directly compare the results to those from traditional predictive model methods. For example, the predictive accuracy of a logistic regression model can be compared to that of a random forest or boosted regression tree model and the differences in the predictions can be assessed. One model is not necessarily better than another but rather the goals of the predictive modeling and the model outcomes can be simultaneously considered and evaluated, adding to the understanding obtained from the modeling effort.

It is one aim of this presentation to illustrate the benefits of developing models at all stages of understanding so that we as scientists can logically develop newer and better models on the heels of the older models. This will be done by describing examples of the development of national models for nitrate in groundwater models in...
the United States (U.S.) as well as regional and national models for arsenic in groundwater in the U.S. In each of these efforts, new understanding was gained but the desire to improve upon each successive model was apparent and has led to the development of improved models more quickly than would have been the case without the original efforts.

Another aim is to illustrate how models – however accurate – may be the only path forward for some of our collaborators and partners. One example in the U.S. is modeling to predict arsenic in groundwater from private wells. Much work has been done across the U.S. to describe where arsenic occurs and what controls are most important in an area. Predictive models also have been developed for specific areas (New England, Southwest). Despite this, the need for a predictive model for the entire U.S. remained. When one was recently developed, collaborators in human health began to design studies that could use this information to inform the onset of disease and other human health concerns, such as adverse birth outcomes. For this last part, a new study to assess human health outcomes as they relate to arsenic in private wells in the U.S. will be discussed.

**Key words:** Statistical models, prediction, geogenic contaminants, arsenic.
Assessing drought impacts on arsenic exposure from domestic-supply groundwater in the conterminous United States

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Abstract:

Arsenic is a widespread geologic contaminant in groundwater with a maximum contaminant level (MCL) of 10 g/L for public drinking-water supplies set by the United States (US) Environmental Protection Agency. Domestic water supplies, however, are largely unregulated and do not require testing. Long term, high level exposure to arsenic in drinking water can cause a range of adverse health effects including skin lesions, cancers, and cardiovascular diseases. Exposure to arsenic has also been found to impact human development in utero and during early childhood.

In cooperation with the US Centers for Disease Control and Prevention, the US Geological Survey developed a statistical model using logistic regression (LR) to predict the probability of elevated arsenic levels (>10 g/L) in water from domestic wells located in the conterminous US (CONUS). The arsenic model uses geologic, geochemical, hydrologic, and physical landscape features, available as national scale GIS coverages, to predict the probability of high arsenic. Thirty year average annual precipitation and groundwater recharge are important predictor variables in the model, which suggests that drought conditions may affect the likelihood of elevated arsenic concentrations.

The objectives of this study are 1) to assess the potential impact of drought on the probability of elevated arsenic concentrations in domestic wells at a CONUS scale using an existing model that contains drought-related variables and 2) to estimate changes in the population of domestic well users exposed to elevated arsenic because of drought. We took a two-pronged approach for estimating the impact of drought on arsenic concentrations in domestic wells. First, we ran the original model using systematically reduced precipitation and recharge values to simulate drought conditions. Second, we ran the original model using total annual precipitation and
groundwater recharge values from the year 2012 when drought conditions existed over a large extent of the CONUS. The first approach facilitated estimation of the changes in the population exposed to elevated arsenic throughout the CONUS. The second approach provided a method for comparing the duration of drought to changes in the predicted probability of high arsenic in domestic wells.

The model simulations with systematically reduced precipitation and recharge values representative of drought conditions resulted in higher probabilities of exposure to elevated arsenic. The population exposed to elevated arsenic from domestic wells was estimated to increase from about 2.6 million to 4.0 million people, during drought conditions. Our findings also suggest that the probability of exposure to arsenic concentrations greater than 10 g/L increases with increasing drought duration. Our findings indicate that drought has an adverse impact on the arsenic hazard from domestic wells throughout the CONUS. This information supports public health agency efforts to implement interventions and build resiliency to climate variations.

**Key words:** Arsenic, arsenic exposure, drought, domestic drinking water, statistical model
Mineralogical Signatures of Iron Reduction and Arsenic Transport in Pleistocene Aquifers of the Red River Delta, Vietnam

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Abstract:

Aqueous arsenic contamination affects more than 100 million people globally. The reduction of arsenic-bearing iron(III) oxides is a key process in the generation of that dissolved arsenic. In most cases, arsenic is released from young Holocene sediments, which are often gray to black color due to this reduction. There are considerable questions about the extent to which As-contaminated Holocene aquifers are undergoing active reduction in situ, or whether most of the arsenic is released in shallow areas and then transported relatively conservatively through a reduced aquifer. Pleistocene sediments are usually orange and much more oxidized, however, recent evidence suggests that groundwater flow from reduced As-bearing aquifers can induce reduction of these Pleistocene aquifers. Since these low-As Pleistocene aquifers are used as drinking water sources, it is important to identify aquifers undergoing reduction prior to the advent of groundwater contamination. Here, we examine iron and As mineralogies using X-ray absorption spectroscopy (XAS) in an extensive series of core sections crossing Holocene-Pleistocene transitions that are being altered by groundwater flow to address these questions about the potential migration of As groundwater contamination. Iron mineralogies in Pleistocene and Holocene sediments differed considerably, in both oxidation state and overall mineralogy. Orange Pleistocene sediments were most oxidized (>70% Fe(III)), and contained Fe(II) primarily in mixed Fe(II)/Fe(III) silicates. Holocene sediments were more reduced, but still contained 20-40% Fe(III), mostly as goethite and hematite, and also contained abundant biotite. Transitional Pleistocene sediments fell directly in between pristine and contaminated sediments in oxidation state but with complex mineralogies reflecting enhanced weathering and the formation of metastable minerals indicative of active iron cycling. A range of unsupervised, standardless
statistical methods were invaluable in more clearly differentiating Pleistocene and Holocene sediments. These methods indicated that transitional areas appeared to more expansive than expected based on field interpreted colors and inferred ages—many seemingly orange Pleistocene sands and gray Holocene sands were actually transitional—indicating that a larger portion of the aquifer could be subject to future groundwater As contamination than previously realized. Significantly, these classifications revealed significant differences in the speciation of arsenic in the solid phase, in different reduced sediments that affected aqueous As levels.

**Key words:** arsenic contamination; iron mineralogy; green rust, siderite, sulfide minerals, EXAFS.
Arsenic immobilized \textit{in situ} through magnetite formation under field conditions

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Abstract:

Geogenic arsenic (As) contamination in groundwater has been found in many countries including China and is a major threat to public health. Most of the exposed population are affected by low to moderate levels of As (<100 µg/L) with low occurrence rate (<10%). Unfortunately, existing technologies are largely ineffective at reducing exposure to As in the dispersed rural areas. Communal water supply is too expensive to be practical, and household treatment units also have many problems including frequent treatment failures. Recently, nano-particulate magnetite, formed following simultaneous addition of ferrous iron (Fe) and nitrate, has been shown to immobilize As in laboratory studies. If successful under in situ field conditions, this magnetite-based method represents a potential breakthrough of in situ As remediation that is cost effective with high remediation efficiency and low re-contamination risks.

Here, we present data and modeling results from our recent field study, in which the magnetite-based method is tested in Yinchuan Plain, China. The field experiments were conducted in the shallow aquifer (< 40m), where elevated As levels are found in the groundwater and primarily attributed to microbial reduction of As-bearing Fe oxides. The experiments contained multiple push then pull phases. Ferrous Fe, nitrate and bromide were amended into groundwater and re-injected during the push phase, while residual chemicals and large volume of treated local groundwater were pumped out during the pull phase. We collected detailed hydrochemical and mineralogical data from the field experiments, and used a reactive transport modeling approach to integrate and quantitatively evaluate the observations. The bromide tracer data was used as constraints in the model to assess the physical transport characteristics of the shallow aquifer in terms of mixing and dispersion/dilution effects. The hydrochemical
data on reactive species as well as solid-phase data were used to extract thermodynamic and kinetic information on the observed Fe mineral (trans)formation and concomitant As partitioning dynamics. Preliminary modeling results support the application of this method at the field scale. Based on insights gained from modeling these experiments, predictive modeling approach will be used to upscale and optimize the efficiency and longevity of the magnetite-based method by comparing different model variants of operational modes, and to investigate how successfully the variants work at As immobilization under the impact of hydrogeological and biogeochemical heterogeneity that are hallmarks of As contaminated aquifers.

Key words: Groundwater arsenic; In situ remediation; Magnetite; Reactive transport modeling; Yinchuan Plain.
Development and Applications of Reactive Transport Modeling Approaches for Arsenic across Multiple Spatial and Temporal Scales

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Abstract:

Over the last two decades reactive transport modeling has become an integral tool for interpreting biogeochemical data and processes in groundwater systems. Spatial scales of model applications span now from pore-scale to the regional scale and investigated time-scales that may vary from minutes to 1000's of years for both pristine and contaminated systems. This presentation will focus on the ongoing research activities in developing and applying reactive transport models to better understand and quantify the fate of arsenic during controlled laboratory and small-scale field experiments. Analysis of controlled experiments is shown to be an important prerequisite for the subsequent analysis of larger-scale field data and an important milestone towards the goal of providing predictive capabilities for the often heavily arsenic-polluted aquifers in South and Southeast Asia. The presentation will illustrate how (i) reactive transport modeling was used to elucidate the role of iron mineral transformations and associated changes in sediment sorption capacity on arsenic mobility in laboratory experiments under varying redox conditions; (ii) the application and modifications of the developed numerical model helped to explain the field observations from a sucrose injection experiment in the West Bengal Plain; (iii) the simulation of environmental tracer data helped to constrain groundwater flow and solute migration rates at an arsenic-contaminated field site at Van Phuc near Hanoi, Vietnam; and (iv) how modeling supported the development of a new, magnetite-based in situ remediation technology for arsenic.

Key words: Groundwater arsenic; Reactive transport modeling; Redox transformations.
Bioaccumulation and Health Risk Assessment of Selenium and Associated Heavy Metals in the Soil–Rice System in a Typical Seleniferous Area in Central China

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Abstract:

Rice is an important source of selenium (Se) and heavy metal exposure; however, the transformation and translocation of Se and associated heavy metals in the shale-soil-rice system remain poorly understood, given the fact that Selenium is a double-edged sword for human and Se can inhibit the phytotoxicity and bioavailability of many heavy metals. The soil Se fractions, which include water-soluble Se (0.2 to 3.4%), ligand-exchangeable Se (4.5 to 15.0%), organically bound Se (57.8 to 80.0%) and residual Se (6.1 to 32.9%), are largely controlled by soil organic matter (SOM) levels. Decomposition of SOM promotes the transformation of organically bound Se to water-soluble Se and ligand-exchangeable Se, thereby increasing the bioavailability of Se. We also demonstrated that soils in Enshi are contaminated by Mo, Cu, As, Sb, Zn, Cd, Tl and Hg, with their concentrations 1 to 3 magnitudes higher than the abundances in the Earth’s crust. Soil mainly receives heavy metals from the weathering of Se-rich shales. Among these heavy metals, Cd and Mo have the highest bioavailability in soils. The bioavailable fractions of Cd and Mo account for 41.84% and 10.75% of the total Cd and Mo in soils, respectively. The probable daily intake (PDI) of Se, Cd, Mo, Zn and Cu through consumption of local rice was 252 ± 184 μg/day, 314 ± 301 μg/day, 1774 ± 1326 μg/day, 7.4 ± 1.68 mg/day, and 0.87 ± 0.35 mg/day, respectively. A high risk of Cd and Mo through consumption of local rice deserve extensive attention for Enshi residents.

Key words: selenium; heavy metals; bioavailability; bioaccumulation; risk assessment
Alterations of Arsenic Level and Awareness of Its Risk Factors: A population-based Study in a Unique Coal-borne arsenicosis County in Guizhou, China

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Abstract:

Currently, most arsenic (As) studies in populations are concerned with water-borne arsenicosis. However, residents in Xingren County of Guizhou Province, Southwest of China, represent a unique case of arsenicosis which is related to indoor combustion of high As-containing coal. In recent years, potential effects and mechanisms of As-contaminated coal on health are of concern, but the understanding of the risk factors for coal-borne arsenicosis remains limited. This study aimed to assess the alterations of As level in external environment medium and human body, and to conduct a systematic comparative analysis of risk factors for coal-borne arsenicosis. Four follow-up epidemiologic investigations in Xingren County of Guizhou Province were conducted during the years 1998 to 2017, a total of 245, 272, 584, and 309 residents were involved in the four investigations, respectively. Environmental samples (coal, soil, water, air, rice, corn and chili pepper) and biological samples (urine, hair) were collected at each time of investigation for total As analysis according to corresponding national standards. Sociodemographics and lifestyle variables were extracted from the questionnare interview. Both single factor and multivariate factor non-conditional logistic regression model were used to analyze the variation of risk factors for coal-borne arsenicosis. The present study observed a substantial reduction of total As level both in external environmental medium (coal, soil, drinking water, air, and corn and chili pepper) and biological samples (urine and hair) in the unique coal-borne arsenicosis region, especially in the latest 10 years. In addition, age, duration of consuming high As-containing coal and smoking status were found to be the most significant risk factors for coal-borne arsenicosis during the past 20 years by both single factor and multivariate factor non-conditional logistic regression analysis. Room ventilation and grain drying modes
were no longer to be risk factors since 1998 survey. Annual household income had always been an important influence factor for coal-borne arsenicosis in recent 20 years by both two different regression analysis. Grain storage mode had became significant influence factor in 2014 and 2017 survey. A certain correlation between sex, education and coal-borne arsenicosis was observed by single factor non-conditional logistic regression analysis but no clear link between them analyzed by multivariate factor non-conditional logistic regression. In summary, considerable efforts to blocking As exposure from burning coal and As contaminated foods in this region are observed over the study period. Further practical health education programs may need to target individuals with long-term of As exposure, lower socioeconomic status and smoking in order to better prevent and control the occurrence and development of coal-borne arsenicosis.

**Key words:** coal, Guizhou, arsenic, arsenicosis, risk factors.

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The effect of E2F7/E2F1 on inorganic arsenic-induced hepatocellular apoptosis and ginkgo biloba extract intervention study

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Abstract:

[Purpose] Arsenic is a common environmental poison. It can cause multi-organ and multi-system damage of our body and liver is one of the main target organs of arsenic. Previous findings of our research team indicated that arsenic can induce hepatocyte apoptosis and Ginkgo biloba extract can effectively antagonize arsenic-induced hepatocyte apoptosis. However, the exact mechanism is unclear. Studies have shown that Cell cycle transcription factor E2F family member E2F7 and its downstream molecule E2F1 can regulate cell apoptosis. The aim of this study was to establish a arsenism model. On the basis of that, to discuss the effect of E2F7/E2F1 on the apoptosis of liver L-02 cells induced by sodium arsenite (NaAsO₂) and the intervention mechanism of ginkgo biloba extract. [Methods] Different dose of NaAsO₂ [0 (control), 2.5, 5, 10, 20, 40µM] were exposed to L-02 cells for 24 hours. Western blot tested the protein expression of Bcl-2, Bax and Caspase-3. qRT-PCR was used to test the mRNA level of E2F7 and E2F1. After transfection of exogenous E2F7 interfering plasmid or E2F1 overexpressing plasmid for 24 hours, Western blot tested the influence of arsenic on the expression of E2F7, E2F1 and apoptosis-related proteins. Exposure to arsenic, L-02 cells were treated with 100 g/mL ginkgo biloba extract for 24 hours. Then, qRT-PCR was used to test the mRNA level of E2F7 and E2F1 and western blot was used to test the expression of E2F7, E2F1 and apoptosis-related protein. [Results] Compare with the control group, the mRNA and protein expression of E2F7, Bax/Bcl-2 ratio and caspase-3 level were upregulated with the increase of NaAsO₂ concentration. However, the expression of E2F1 was downregulated with the increase of NaAsO₂ concentration. Inhibition of E2F7 significantly promoted the expression of E2F1. Under 20µM NaAsO₂ exposure, transfection of exogenous E2F7 interfering plasmid or E2F1 overexpressing plasmid could restore Bax/ bcl-2 ratio and caspase-3 level. In addition, Ginkgo biloba extract significantly increased E2F1 expression and inhibited E2F7 expression, Bax/ bcl-2
ratio and caspase-3 level. [Conclusion] E2F7/E2F1 may mediate the apoptosis induced by NaAsO2. Ginkgo biloba extract may exert antagonistic effects of hepatoprotective activity injured by NaAsO2. This study was expected to provide a new intervention target for arsenic-induced liver damage.

**Key words:** E2F7/E2F1; NaAsO2; hepatocyte; apoptosis; ginkgo biloba extract

This study was supported by the Key Program of National Natural Science Foundation of China (81430077) and National Natural Science Foundation of China (81602887)
Assessment of the influence on pH of intense exploitation of the deep confined Tertiary aquifer of the Duero Basin (SE sector) and the consequent effect on arsenic HydroGeoToxicity in groundwater

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Abstract:

Natural waters play a fundamental role in the transfer of trace elements from the physical environment into the biosphere; thus, they are critical to the dynamic interrelationship between the natural environment and human health. Within the field of Medical Geology it is important to consider natural groundwater quality, which is closely linked to the geological setting. In this context, special attention needs to be paid to Potentially Toxic Geogenic Trace Elements (PTGTEs) (such as arsenic, As) in groundwater and HydroGeoToxic anomalies (e.g., HGTAs) due to high concentrations of these trace elements.

In the study area, located along the SE border of the Duero Basin, groundwaters with higher concentrations of As (plus V, Cr and sometimes U) are associated with the deep confined detritic aquifer, which is in contact with the fissured crystalline basement. The maximum concentrations of PTGTEs are usually associated with high pH. The deep level of Tertiary detrital aquifer has been intensively exploited; over time, a steady decrease in the piezometric level has been observed, as well as an overall parallel rise in pH as the water becomes increasingly alkaline.

For this study, 13 boreholes of $\geq$ 200 m depth were selected (this depth guarantees that groundwater samples come from the deep level of the aquifer in the study area). The time period studied corresponds to the initial epoch of pumped abstractions from the deep waters of the Tertiary aquifer, dating from the 1970s to the beginning of the 21st century. The highest exploitation rates of the deep aquifer were recorded during this period. Piezometric level data over this period are mostly annual, indicating decreases of more than 1 metre per year between 1972 and 2001 (29 years), with the most marked changes occurring between 1972 and 1995. After 1995, average levels stabilized, oscillating annually between a maximum and minimum values, but around the same mean.

Chemical data for the major ions were recorded in 5 boreholes from 1980 to 2000. In four of these boreholes, piezometric level and pH were logged at the same time. An increase in mean pH can be traced from close to neutral pHs, through slightly alkaline, to markedly alkaline pHs of 8 or 9 (at present, there are even cases of pHs close to 10).

The increase in pH can be related to changes in the physico-chemistry of the deep confined aquifer as it was subject to high rates of exploitation. As a consequence, it has been possible to establish the relationship between overabstraction from the deep aquifer, the rise in pH of the abstracted water and the increase of HGTAs.

Key words: Arsenic, HydroGeoToxicity, pH, overabstraction
Toxicity evaluation on human cells Caco-2 of Arsenic rich water samples from an abandoned gold mine (Portugal NE)

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Abstract:
This is a follow-up study of previous water monitoring data in the abandoned Freixeda gold mine area NE Portugal, where in contrast to gradual decrease in general heavy metals in water, arsenic (As) remains above the limit for drinking, for more than 50 years. Toxicological potential of As containing water on human cell lines was evaluated, as indicator of potential human health risk.

The main objective was to evaluate hydrochemical composition of surface and groundwater and to perform toxicological evaluation of selected water samples (with more than 10 μgL⁻¹ of As) in the in vitro system of human cell line Caco-2.

Six water samples were collected in February 2018 and the concentration of major anions was determined by ion chromatography, cations and trace elements by inductively coupled plasma mass spectrometry. Arsenic speciation was determined by cathodic stripping voltammetry, using a hanging mercury drop electrode. Cell experiments were done on human gastrointestinal cell line Caco-2 grown in 75 cm² flasks for adherent cell cultures in a cell incubator at incubation conditions of 37°C, 5% CO₂ and 100% humidity.

Groundwater samples contain higher amounts of dissolved minerals than surface waters. Higher mineralization is related to higher SO₄²⁻ (237 mgL⁻¹), Fe (6.5 mgL⁻¹) and HCO₃⁻ (180 mgL⁻¹) concentrations, and also higher As(III), reaching 336 μgL⁻¹ (As(T) = 607 μgL⁻¹). Sulphide minerals are an important source of As and the presence of bicarbonate as a competitor could be a reason for As desorption in the reductive underground conditions. In surface waters, As concentration decreased, reaching 150 μgL⁻¹ mostly as As(V), because in oxidizing conditions As adsorbs on Fe and Mn hydroxides that precipitates.

Results of toxicity evaluation of real water samples on human cells Caco-2 show that genotoxicity is only modestly affected by a short-term exposure to As-contaminated water samples. On the other hand, higher concentrations of As in real samples generally lead to higher level of oxidative stress (ROS formation) and reduced cell viability even after short exposure. We assume that longer exposure, which is common in areas of contaminated waters, would have more harmful effects. Exposure of Caco-2 cell line to different concentrations of pure As(III) solution show clear concentration dependent decrease in cell metabolism and viability, with no cell viability detected at 25 μgml⁻¹ of As(III). We observed also a strong increase in ROS generation and genotoxicity, additionally confirming harmful effects of As on human cells. We should mention here that concentration of As(III) in pure solution were...
higher than concentrations of As in real water samples. We concluded that the degree of cytotoxicity and ROS production in real water samples would be higher than in samples exposed to pure As(III) solution, if matched for the As concentrations. In this way we confirm the prediction that mixture of different chemicals together with As in water samples could have synergistic effect in reducing cell viability and in higher ROS formation.

**Key words:** Water quality, Arsenic, Hydrogeochemistry, Toxicity, Caco-2 cell line
Tekran2600-IVS 全自动总汞分析仪
- 检测方法：全汞结合冷原子荧光法，超高灵敏度。
- 进样方法：直接样品瓶内吹扫分离，防止样品和样品交叉污染。
- 方法标准：EPA3051A（液样样品），ASTM D5964-98 和 10-5（气样样品）。
- 检出限：>0.02 mg/L
- 检测范围：0.02-700 mg/L
- 进样量：<30 ml
- 分析时间：3 min（时间可自行设定）。
- 扩展应用：ICP-MS 联用测量总汞量：手动大容量（自行设定）选样。

Tekran 2700 全自动烷基汞分析仪
- 检测方法：全汞结合冷原子荧光法，超高灵敏度。
- 进样方法：直接样品瓶内吹扫分离，防止样品和样品交叉污染。
- 方法标准：EPA 1630
- 检出限：>0.002 mg/L
- 检测范围：0.002-100 mg/L
- 进样量：<30 ml。200-300 ml（可选超低液样样品）。
- 分析时间：5 min（时间可自行设定）。
- 适配柱：毛细柱（标准）可选填充柱。
- 扩展应用：ICP-MS 联用测量烷基汞量：手动大容量（自行设定）选样。
- 软件：全自动控温装置。
- 样品数：30 个

Tekran 2537Xi-NG 天然气汞在线分析系统
- 检测方法：全汞结合冷原子荧光法，超高灵敏度。
- 测样方法：高分辨率在线连续测样。
- 方法标准：ASTM D5350 和 ISO 6978
- 检出限：1 ng/m³
- 检测范围：1 ng/m³-3000 pg/m³
- 脱样流量：0.1-0.5 L/min
- 测样时间：2-60 min
- 控制：可远程控制软件和自存储数据。
- 校准：内部自动校准。

Tekran 3300 烟气汞在线分析系统
- 检测方法：全汞结合冷原子荧光法，超高灵敏度。
- 测样方法：高分辨率在线连续测样，包括单质汞 (Hg) 和活性汞 (Hg²⁺)。
- 检出限：0.1 mg/m³
- 检测范围：0.003-15 mg/m³（稀释法系统测定范围）：0.05～450 pg/m³
- 取样流量：0.2-0.5 L/min
- 测样时间：2-60 min
- 采样器输出流量：0.5~1000 μg/m³
- 控制：可远程控制软件和自存储数据。
- 校准：内部自动校准自动校准连续汞发生器自动校准。

Tekran 2537-1130-1135 大气汞在线分析系统
- 检测方法：全汞结合冷原子荧光法，超高灵敏度。
- 测样方法：高分辨率在线连续测样，包括单质汞 (Hg)、单质汞 (GEM)、单质汞 (OM) 、单质汞 (PbM)，用户可根据监测要求设置测定组分。
- 检出限：0.1 ng/m³（GEM）、1.25 pg/m³（GOM 和 PbM）
- 检测范围：0.1-2000 mg/m³
- 取样流量：0.5-1.5 L/min
- 测样时间：2.5-60 min
- 控制：可远程控制软件和自存储数据。
- 校准：内部自动校准自动校准。
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