
INTERNATIONAL STUDENT CONFERENCE ON MEDICAL GEOLOGY AND ENVIRONMENTAL HEALTH:
LATIN AMERICA EDITION
Please join us for the first in a series of conferences that will highlight student research on medical geology and environmental health issues:initial focus will be on Latin America
Conference: October 18 to 20 @ 9am Brasilia Standard Time
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# The International Student Conference on Medical Geology and Environmental Health: Latin America Edition

Compilers

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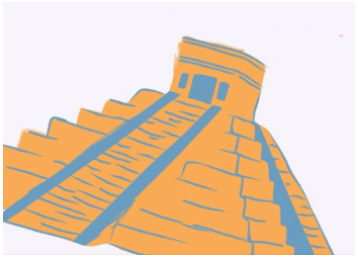
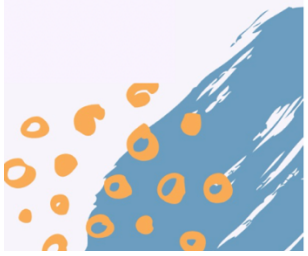
The **International Student Conferences on Medical Geology and Environmental Health** got off to a good start with the Latin America Edition on 18-20 October 2021. Fifteen students participated with more than 100 attendees. These student researchers examined the impacts of the environment from both natural and anthropogenic influences on human, animal, and plant health. These are increasingly important fields of study that will help minimize adverse impacts of both modern industrial society and the natural environment on living organisms.

This series of virtual conferences is designed to provide students with a number of benefits including:

- Providing students with a convenient opportunity to showcase their research.
- Offering a comfortable venue to practice writing and speaking English; essential skills for professional development.
- Allowing students, faculty, and others to learn of complimentary research being conducted within their region and to foster future collaborations.
- Receiving constructive feedback on their research projects from knowledgeable attendees.
- Fostering networking with other students and with established researchers in the region.
- Providing tangible encouragement and awards for outstanding student research projects.
- Posting their abstracts on several accessible, respected organizational platforms.

The cooperating organizations will benefit by stimulating interest and membership in their organization and increased awareness of regional medical geology/environmental health issues. In short, the **International Student Conferences on Medical Geology and Environmental Health** presents a win-win-win opportunity for all who participate.





## Table of Contents

# Program at a glance

| | 18th October | 19th October | 20th October |
|---|---|---|---|
| 09:00 | Openning Ceremony | Prof. María Aurora Armienta Hernández<br>**Medical geology and groundwater in Mexico: experiences and challenges** | Dr. Maria Del Carmen Gastañaga Ruiz<br>**Peru: Heavy Metals and Health** |
| 09:05 | | | |
| 09:10 | | | |
| 09:15 | Dr. Syed E. Hasan<br>**History and Evolution of Medical Geology** | | |
| 09:20 | | | |
| 09:25 | | | |
| 09:30 | | | |
| 09:35 | | | |
| 09:40 | | Cristian Salazar **Assessment of the effluent of Pedro Vicente Maldonado canton main drinking water treatment plant along with water quality index and health risk assessment** | Erick Márcio de Oliveira Pereira **Application of geochemical mapping in the Iron Quadrangle in Minas Gerais for the evaluation of contaminations and their possible effects in the health** |
| 09:45 | | | |
| 09:50 | | | |
| 09:55 | Viviana Bortagaray **Quantitative Microbial Risk Assessment (QMRA) for swimming and fishing activities in Las Cañas beach, Uruguay** | Mariano E. Cáceres Happel **Geoenvironmental Risk Study Due To The Arsenic Presence In The Main Aquifers Of The Southwest Of Uruguay And Its Possible Impact On Human Health From A Geomedical Approach** | Jessica Ramos **Mercury exposure assessment in a Brazilian ASGM Community and estimated chronic Hg levels in the atmosphere** |
| 10:00 | | | |
| 10:05 | | | |
| 10:10 | Dayani Davilla **Nutrient Pollution Impacts of Tourism in Cenotes from the Northern Yucatan Peninsula** | Paulina Pizzorno **Human Health Risk Assessment by exposure to arsenic through groundwater in a rural area of Uruguay** | María Soledad Gualde **Analysis of the heterogeneity of the Pampeano Aquifer sediments: towards a better understanding of the behavior of arsenic and fluoride in the Pampean Plain** |
| 10:15 | | | |
| 10:20 | | | |
| 10:25 | Líllian M. Domingos **Particle deposition estimative in the lung by inhalation exposure after iron failure dam using MPPD Multiple-Path Particle Dosimetry Model** | Paulo Roberto Penalva dos Santos **Has COVID 19 impacted the groundwater of public supply by psychopharmaceuticals? A bibliographic review in the period 2020/2021** | Maria Tereza de Godoy Cordeiro **Soil Geochemistry from Tailings Deposits in Barra Longa City, MG - BR** |
| 10:30 | | | |
| 10:35 | | | |
| 10:40 | Rebeca Y. Pérez-Rodríguez **Source Apportionment of Lead in Children's Blood Living in a Metallurgical Site, Using Lead Isotopic Ratio Analysis** | Joyce Shantala Fernandes de Oliveira Sousa **Study of the effects of polluting sources in aquifers and their effects on population quality of life in Russas-CE** | Sofía Navarro-Espinoza **Identification of refractory nano and microparticles from catalytic converters in dust: An emerging pollutant in urban environments** |
| 10:45 | | | |
| 10:50 | | | |
| 10:55 | Valeria M. Paz-Aparicio **Association between Environmental Pollution by PM2.5 Exposure and Childhood Overweight/Obesity in Children from 6 to 59 months in Lima and Callao, Peru** | Prof. Pablo Gamazo<br>**Contributions from Uruguay in the study of Human Viral Pathogens and other pollutants in the environment** | Dr. Zuleica C. Castilhos<br>**Mercury in the Brazilian Amazon: a glance** |
| 11:00 | | | |
| 11:05 | | | |
| 11:10 | Dr. Katarzyna Kordas<br>**Toxic elements and neurobehavioral development of children in an urban context** | | |
| 11:15 | | | |
| 11:20 | | | |
| 11:25 | | | |
| 11:30 | | | |
| 11:35 | | | **Closing Ceremony** |
| 11:40 | | | |
| 11:45 | | | |

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# KEYNOTE SPEAKER ABSTRACTS

# History and Evolution of Medical Geology

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## Abstract

Although the term 'Medical geology' was used by an anonymous British physician in 1834, it took nearly 150 years for medical geology to be recognized as a distinct field of study and research. Physicians in Europe, during the 18th century were using maps to monitor spread of contagious diseases and plan remedial actions.

Medical geology, as it is known now did not evolve until after the World War II. The advent of powerful computers and precise chemical analyses capabilities, triggered focused studies on the geochemical nature of earth materials. Several reports and articles were published during the 1960s and 1970s in Europe and the United States linking the geochemistry of an area to the health of the population (Cannon and Hopps, 1971). Early investigations by the Geological Survey of Sweden and the United States Geological Survey prompted the International Union of Geological Sciences in the late 1990s to endorse inclusion of medical geology as a special project under the International Geological Correlation Program that resulted in organizing a number of meetings and courses in medical geology at selected locations worldwide. Creation of an International Medical Geology Association (IMGA) was approved at the 32nd International Geological Congress, held in 2004 at Florence, Italy. During the past two decades degree programs and courses in medical geology have been established at many universities, and meetings and conferences in medical geology are being organized on a regular basis across the globe.

The presentation reviews use of earth materials in ancient cultures, discusses the history and evolution of medical geology, its future prospects, and offers tips to graduate students for career opportunities.

## References

Cannon, H.L., and Hopps, H.C. (eds.) (1971). Environmental Geochemistry in Health and Disease: Geological Society of America Memoir 123, 230 p.

# Toxic chemicals and neurobehavioral development of children in an urban context

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Ensuring optimal child health and development is underpinned by understanding the factors that detract from or promote these outcomes. Myriad environmental factors are associated with cognitive ability, behavior and learning in children, as well as quantifiable economic costs. The field of environmental epidemiology is shifting from investigating the health effects of single environmental factors to considering the effects of mixtures, that humans experience along the lifecycle. In the context of the Salud Ambiental Montevideo research program conducted in 2009-2019, our interdisciplinary team has been asking: 1) what chemical exposures and other environmental factors are experienced by schoolchildren and 2) how do those exposures affect child health? Among children enrolled in first grade of school (~7 years of age), we found exposure to multiple toxic metals as well as organic chemicals, including pesticides and flame retardants. These exposures occur in the context of varying degrees of neighborhood disadvantage. Exposure to individual toxicants such as lead and exposure to metal mixtures is related to cognitive deficits in this sample of low-income urban children.

# Medical Geology and Groundwater in Mexico. Experiences and Challenges

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Groundwater provides more than 60% drinking water of Mexico. The health safety of this water source is therefore of utmost importance in the country. In many of the areas, arsenic and fluoride occur at toxic levels. About 1.5 million people are exposed to arsenic and 20 million to fluoride concentrations above the Mexican drinking water standards of 0.025 mg/L and 1.5 mg/L respectively. Besides, other toxic elements like chromium and manganese occur in groundwater of various zones. Identifying their sources is necessary to give adequate alternatives to the health risk that implies tainted water consumption. Most of this contamination is related to geogenic processes. Medical geology studies are thus relevant in Mexico. An overview of the main geological and geochemical processes resulting in groundwater contamination will be provided in this presentation. Arsenic and fluoride occurrence is related mainly to the presence of As-bearing minerals in mining zones, geochemical processes releasing As in alluvial aquifers, water interaction with igneous rocks, and thermalism. These processes take place in diverse hydrogeologic and geological settings. Examples of studies carried out in various Mexican locations with the participation of students from many educational institutions will be exposed. At Zimapán, a historical mining town, the population asked for a scientific study to identify the source and give an alternative to the arsenic presence in groundwater. The studies included hydrogeochemistry, mineralogy, hydrogeology, and epidemiology developed in a context of limited funding. Achieving a solution faced other difficulties like the interaction with the authorities to convince them of the importance of developing actions to solve the problem. Another example was related to chromium presence in an industrial area. A detailed hydrogeochemistry study and the interpretation of chromium geochemistry with the hydrogeology of the valley led to actions to avoid the increase and dispersion of groundwater contamination.

# Contributions from Uruguay in the study of Human Viral Pathogens and other pollutants in the environment

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In Uruguay, as in many countries worldwide, groundwater microbiological quality is evaluated only according to bacteriological standards and virological analyses are not mentioned in the legislation. In this work, the incidence of human viral and bacterial contamination in groundwater in the Salto district, Uruguay, as well as the possible correlation between these groups of microorganisms, was studied. We also studied the transport mechanism of human viruses through column experiments in standardized and natural soil matrix-water systems (MWS).

For the Salto Aquifer, a total of 134 samples were taken for viral and bacteriological analysis[1]. For the column experiments, two pore volume of water containing Rotavirus and Norovirus were injected, followed by "clean water" injection, and samples were taken for PCR analysis[2].

From a total of 134 groundwater samples on the Salto aquifer, 42 were positive for Rotavirus, only 1 for both Rotavirus and Adenovirus, and 96 samples were positive for bacterial indicators. Bacteriological indicators were not adequate to predict the presence of viruses in individual groundwater samples (well scale), but a deeper spatial– temporal analysis showed that they are promising candidates to assess the viral contamination degree at aquifer scale. For the column experiments, in the standardized MWS, Rotavirus and Norovirus showed very similar breakthrough curves (BTCs), showing a removal rate of 2 and 1.7 log10, respectively. On the other hand, in the natural MWS, the two viruses show very different BTCs. The Norovirus transport model showed significant changes; BTC showed a removal rate of 4 log10, while Rotavirus showed a removal rate of 2.6 log10 similar to the 2 log10 observed on the standardized MWS. One possible explanation for this differential behavior is the difference in the isoelectric point value of these two viruses and the increase of the ionic strength on the natural MWS.

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# Mining Activity in Peru, Heavy Metals and Public Health

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Perú is among the main mining countries due to the presence of varios minerals in its soils. Though the years it has remained the main producer of: Copper (second producer), Lead (fourth producer), Zinc (second producer), Gold (6th producer), and Silver (first producer). Throughout the national territory it presents Mining Units in Production and Exploration programs, we have some examples

Mining in Peru is an important activity for the country's economy, the presence of minerals in its soil has led to a series of mining projects underway and several under exploration. This in turn has caused the change from agricultural activity to mining, now having several populated centers dedicated to artisanal, informal and illegal mining; Both the formal mining that does not comply with the regulations and this informality added to the increase in environmental liabilities are the main sources of exposure to heavy metals of the adjacent populations using water, air, food and soil as routes, causing damage to public health, especially of vulnerable groups (children and pregnant women) and socio-environmental conflicts with a negative impact on the development of the country. In addition, some investigations are presented in different regions of the country with the presence of socio-environmental conflicts, prioritizing heavy metals: lead, cadmium, ercury and arsenic; the Surveillance System of Risk Factors for exposure to heavy metals in charge of Epidemiology and the Notification model they use.

# Mercury in the Brazilian Amazon: a glance

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Much of the knowledge of the human health risks due to environmental exposure to methylmercury (MeHg) comes from epidemiological studies, in particular, of Minamata disease and also from acute exposures to MeHg. No matter the chemical form that mercury (Hg) is released, it is a persistent contaminant in the environment and can be converted in MeHg. Reaching the atmosphere, Hg can be interconverted into inorganic and vapor mercury and it can be transported over long distances, characterizing itself as a global pollutant. MeHg is formed mainly in the aquatic systems and it bioaccumulates at the base of the aquatic trophic chain and is transferred via food attaining the highest levels in carnivorous/piscivorous fish. Fish consumption is the main pathway of MeHg human exposure, as well as to wild animals that consume fish (alligators, birds, and others). However, the prediction of Hg in fish is not a trivial task. The observed nonlinearity of Hg increase in fish as a function of Hg increase in sediments, as well as, the distinct mercury concentration in fish from aquatic systems close one each other indicates that multiple factors influence in MeHg levels in fish.

Because mercury is a global contaminant and can cause severe adverse effects on humans, its control was proposed by the Minamata Convention, which is a binding commitment adhered by more than a hundred of countries, including Brazil. The main idea is to control anthropogenic sources which Artisanal and Small Scale Gold Mining (ASGM) has been singled out as responsible for about 40% of the anthropogenic mercury emitted to the atmosphere annually. Article 7 and Annex C to the Minamata Convention deal specifically with ASGM.

ASGM in Brazil occurred mainly in the Brazilian Amazon, which is located in the northern region of the country. Brazilian Amazon covers more than 5 million km2; it is the largest rainforest in the world and presents great biodiversity still little known.

From 2015 to 2018 we worked with ASGM, in two projects: the first was a prospective study for certified gold production and the second one was an inventory of mercury emissions for the environment by ASGM. By using Hg metallurgical balance in ASGM processes in about 30 sites located in Brazilian Amazon. Results showed that Hg emissions increase as illegality grows. At the moment, we are following the struggle for demarcation of indigenous lands and the complaints of the presence of more than 20,000 illegal gold miners in the Yanomami territory, in Roraima. There is also a lot of pressure for the legalization of mining, including ASGM in indigenous lands. All of this is running parallel to high unemployment rate in the country. Then, the studies of environmental mercury contamination and risks to human health in Amazon are inside this dynamic context.

Acknowledgments: The author thanks Lillian M. Domingos, Jessica Z. Ramos, Márcia Sá Ribeiro and José Rodrigues for all the assistance.

# STUDENT PRESENTER ABSTRACTS

# Quantitative Microbial Risk Assessment (QMRA) for swimming and fishing activities in Las Cañas beach, Uruguay

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The aim of this study was to estimate the risk of group A Rotavirus (RVA) and human astrovirus (HAstV) infections for bathers and fishers at Las Cañas beach, Uruguay.

During one year, samples (10 L of surface water) were collected monthly at Las Cañas beach, Uruguay: one site used for swimming (n = 12) and the other one used for fishing (n= 12) activities. For dose d, the following expressions were considered: d = C x 1/R x Infection Rate x V for swimming activities[1] and the expression d = C x 1/R x Infection Rate x QHM, were used for fishing activities[2].The dose response models used were β Poisson and 1F1 hypergeometric for RVA and HAstV, respectively[2].The probabilities of infection were calculated using a kernel density estimate to fitting the data.

The probability of RVA infection for fishers presented a distribution between 0 and 65%. The probability of infection for swimmers (under 18 years old) was between 0 and 50%, while for those over 18 the probability of infection was among 0 and 38%. For HAstV the probability of infection for fishing activities was distributed between 0% and 45%. The probability of infection for swimmers (under 18 year olds) was between 0 and 38%, while for those over 18 the probability of infection was between 0 and 18%.

This work highlights the differences in the health impact for RVA and HAstV infections according to the age of the people involved in swimming activities and suggest that fishers are at higher risk of infection for both viruses.

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# Nutrient Pollution Impacts of Tourism in Cenotes from the Northern Yucatan Peninsula

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Yucatán Peninsula sinkholes (cenotes) are affected by nutrient pollution (N & P) from sewage, runoff, related to the growth of local and tourist populations[1]. Cenotes are also part of the regional underlying freshwater aquifer and a vital component of water resources and economy of the peninsula[2]. Nutrient pollution can lower dissolved oxygen concentration, cause eutrophication, and impact the health and economy of the communities[2]. To examine the role of tourism, in this study we compared pre-pandemic findings to 2021 in different cenotes.

Methods used were designed to investigate how cenotes respond to nutrient input and depth profiles of nitrate, nitrite, ammonium, phosphate. Our study focused on three cenotes: Tourist, local, and no tourism. These cenotes were compared with values from pre and post COVID-19. We compared their chemical and physical parameters (pH, total dissolved solids, oxidation-reduction potential, temperature, dissolved oxygen, and major anion/cation concentrations). In this way, we built a thermodynamic model that defines if nutrient input is pushing the chemical system out of equilibrium concerning N & P.

Results in the study shows that nitrate concentrations are generally higher in 2019. Cenote NAK is in risk of higher eutrophication (see figure 1). Eh-pH values indicate fewer oxidizing environments than predicted, contradict measured concentration of N species. Input of wastewater or runoff may come from vegetated areas or untreated sewage around the cenotes. Nitrogen speciation result of microbial activity or reaction kinetics.

Conclusions, this work demonstrates how tourism, in conjunction with improper wastewater treatment, can lead to nutrient pollution in the Yucatan Peninsula. We identified the different cenote characteristics from 2018-2021 that helped us determine when nutrient input is polluting the cenotes. Understanding the equilibrium values of nutrient pollution concentration in cenotes can help detect potential sources of contamination, which could help local authorities and tourists in pollution risk control.

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# Particle deposition estimates in the lung by inhalation after iron mine tailings dam failure using Multiple-Path Particle Dosimetry Model

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Field work and literature data show that the tailings disposed on the soil by the failure of Dam I, by VALE SA, in Brumadinho, are rich iniron, silica, aluminum and manganese. They also contain fine particles (from 10 to 100 μm), ultrafine particles (from 10 to 1 μm) and colloidal particles (less than 1 μm). Particle inhalation and their consequent deposition in the airways are important risk parameters for human health. This work presents the conceptual model of human environmental exposure to iron ore mining tailings after dam failure and the preliminary results estimating particle deposition in the lung by inhalation exposure using Multiple-Path Particle Dosimetry Model (MPPD). Besides the particle density, particle concentration and size are important factors for their differential deposition in the human respiratory system.

The preliminary results showed that 10μm particles are deposited almost exclusively on lung heads (upper respiratory tract). On the other hand, in regards to 2.5 μm particles, for those the density effects were evaluated, data showed an increase in total deposition and changes in tissue distribution. Therefore, a higher percentage of particles is deposited on lung heads in detriment to lung deposition. This information may be important when it comes to the chronic environmental human exposure to fine particulates of iron tailings after a dam collapse scenario. Additionally, it is essential to assess the morphology of such particles as well as the solubility of the chemicals present in those particles to better evaluate the human health risks.

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# Source Apportionment of Lead in Children's Blood Living in a Metallurgical Site, Using Lead Isotopic Ratio Analysis

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The exposure of lead (Pb) is considered a major public health problem worldwide especially for young children, because its nervous system is still in development and their body may absorb up to 50% of what they ingest or inhale. Adverse effects have been documented even at blood lead level (bll) of < 5 µg/dL, denoting a great impact of a decelerating relationship on lead-associated intelligence quotient (IQ) deficits[1]. In Mexico, the history of contamination by Pb is unique, the artisanal production and use of glazed ceramics, the use of unregulated Pb- containing paints and the exploitation of large mineral reserves since the 16th century, constitute common sources of this element throughout the country. Such is the case of Cedral in North-Central Mexico, where silver-lead ores from a nearby mining district were processed by amalgamation since 1773, generating tailings with high concentrations of mercury and lead which were deposited in unsecured areas in and around the town. Furthermore, as in other rural communities of Mexico, the use of glazed ceramics to consume or store food is frequent. The aim of this work was to trace the origin of Pb pollution and identify the principal source(s) of environmental and human Pb contamination in Cedral S.L.P., using lead isotopic ratios (LIRs) in blood samples of children, food items and environmental samples.
182 blood samples were obtained from children between 3 and 8 years old; environmental samples were collected from the possible sources of Pb: tailings, surface soil, soil profiles of the urban area and house interior and exterior dusts in selected sites. Food items and glazed ceramics for local sale were also collected. LIRs and PbT were measured by inductively coupled plasma quadrupole mass spectrometry (ICP-QMS).
The geometric mean of children´s bll was 3.79 ± 4.75 µg/dL and more than 37% of blood samples are above the reference[2] value of 5 µg/dL. Concentrations of courtyard soil and house dusts showed a range from 4.0 to 3552 mg/kg, while tailings reached PbT values up to 6000 mg/kg. Most of the food items tested are within the 0.1 mg/kg limit of PbT established by FDA. The glazed ceramic utensils released more than 500 mg/L of PbT during the leachate tests. The LIRs of the soil and dust samples point to the tailing heaps as the main pollution source in the Cedral urban area, reaching floors, courtyards, windows, and house interior surfaces, induce ingestion and/or inhalation of polluting particles by children, being more affected those who live near tailings dams. LIRs of other sources show some influence over a portion of the sampled population; this may be attributed to the use of glazed ceramics and the consumption of the sampled food items, mainly chili containing candies, consumed on a regular basis.
The PbT found in environmental samples highlights the contribution of the environmental liabilities, which in turn, is reflected in bll; however, the use of LIRs as a tool to evaluate sources and routes of Pb transport, allowed us to determine that there are secondary Pb sources that contribute to the bll of children in Cedral.

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# Association between Environmental Pollution by $PM_{2.5}$ Exposure and Childhood Overweight/Obesity in Children from 6 to 59 months in Lima and Callao, Peru

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There is evidence that $PM_{2.5}$ can behave as an obesogenic agent increasing physiological and behavioral markers to develop overweight and obesity [1,2]. Moreover, Lima is one of the most polluted cities in South America [3].

Database of $PM_{2.5}$ modeling in Lima and Callao and number of overweight and obesity cases (O/O) were used. This research is a time-series study in which it has been calculated a mobile media for a 6-month exposure window (Lag0-6m). Negative Binomial regression to assess the association between O/O cases and $PM_{2.5}$ of the diagnosis day and for a Lag0-6m were performed.

The probability of developing O/O in children aged 6 to 59 months increases with the duration of the $PM_{2.5}$ exposure and is higher as quartiles of exposure increase. Furthermore, it was observed that the exposure is associated with an acceleration of the "Adiposity Rebound" when we evaluated by age in children who are exposed to concentrations above the limits established by World Health Organization (WHO) and Ministry of Environment (MINAM), the effect that promotes the development of overweight and obesity earlier.

In conclusion, there is an association between $PM_{2.5}$ exposure and O/O in children aged 6 to 59 months in Lima and Callao. Prolonged exposure to $PM_{2.5}$ above WHO and MINAM limits is associated with an acceleration of "Adiposity rebound".

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# Assessment of the effluent of Pedro Vicente Maldonado canton main drinking water treatment plant along with water quality index and health risk assessment

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The quality of drinking water is so important for public health that its assurance is part of 6th sustainable development goal "Clean Water and Sanitation"[1]. Not only the amount of available water for human consumption is a significant factor, but also the water quality must be considered. Therefore, drinking water treatment plants seek to supply suitable water for human consumption. This study evaluates the effluent water quality of a treatment plant in Ecuador, according to water quality index and health risk assessment.

The quality of the influent and effluent water of the treatment plant was monitored monthly from January 2017 to December 2019. Physicochemical parameters evaluated were temperature, pH, turbidity, color, total suspended solids, conductivity, free chlorine, nitrates, nitrites, ammonia nitrogen, sulfates, fluorides, manganese, and iron. Regarding the microbiological parameters, fecal coliforms and total coliforms were selected. The water quality index (WQI) was computed based on World Health Organization (WHO) water quality standards[2]. To evaluate the impacts on human health, health risk assessment for non-cancerogenic elements (nitrates, fluorides, manganese, and iron), including hazard index (HI), were used. Statistical analysis was performed using the IBM-SPSS Statistics software.

The results revealed that the physical properties and chemical ionic concentrations in almost all of the collected influent water samples are below standard maximum permissible limits. However, it was observed that the 100% of influent water samples exceeded the WHO standards, thus the water quality was assigned directly to class V (water not suitable for drinking). The physicochemical and microbiological concentrations in effluent water samples were within the permissible limits. WQI results showed that the status of water quality in effluent water is in the excellent category. The results also showed that the HI values for all parameters considered are lower than the defined threshold.

In this study, the water quality of Pedro Vicente Maldonado canton, Ecuador, was evaluated through the physiochemical and microbiological analysis of water parameters, compared with the drinking water standards of WHO, and using water quality index method. Moreover, the non-carcinogenic health risks associated with the use of this resource were assessed. The obtained results revealed that the physicochemical concentrations in influent and effluent waters are below the maximum permissible limits of WHO. However, the influent water quality is deteriorated due to the presence of high levels of bacterial pathogens. WQI results showed that the effluent water quality is in the excellent water quality class. The HI results showed that the non-carcinogenic substances studied had a low risk for both adults and children.

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# Geoenvironmental Risk Study Due To The Arsenic Presence In The Main Aquifers Of The Southwest Of Uruguay And Its Possible Impact On Human Health From A Geomedical Approach

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Geogenic arsenic levels in groundwater intended to be supplied for the population is a matter of very recent concern in Uruguay given the international scientific evidence of adverse effects such as cancer, caused by higher levels of Arsenic (As) in water than those recommended by the WHO (<10 $\mu gL^{-1}$).

The general research goal of this study is to find relationships between the spatial distribution of arsenic levels in groundwater with the reports of cancer incidence associated with this element, through GIS tools and statistical tools, as well as to evaluate the current situation about the available drinking water and cancer data quality in the country. We selected a study area based on the geochemical and epidemiological available data collected from the official water supplier OSE, the rural housing program MEVIR, and the Cancer Registry CHLC, with a total of 209 wells studied. After data processing and cleaning phases, we made subsequent analyses using GIS tools, preparing heat maps, and statistical tools to evaluate possible correlations between the arsenic levels and the cancer incidence. Many variables were considered such as cancer types associated with Arsenic and other quality water parameters besides Arsenic (pH, Fe, F, $NO^3$-N, nitrates, sulfates, TDS, salinity, conductivity, total alkalinity). Arsenic's maximum level reporter was 110 $\mu gL^{-1}$.

Using this Medical Geology approach, we are able to show that it is possible to overlap geochemical data with epidemiological data when they are well georeferenced, providing a scientific basis for estimating health risks.

However, based on the currently recorded data, and in addition to the cancer´s multiple causes, the relationships found between arsenic and cancer in Uruguay have not been statistically significant in contrast to various cases reported worldwide. It is, therefore, necessary to continue researching on this topic and harmonizing cancer registries with more environmental information.

# Human Health Risk Assessment by exposure to arsenic through groundwater in a rural area of Uruguay

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Introductory paragraph: Groundwater quality has been the focus of Medical Geology multidisciplinary research studies in Uruguay, being Arsenic (As) one of its main concerns for health impacts in regions where As levels are higher than WHO recommendations (<10 µg/L)[1]. These geogenic As levels of in different aquifers of Uruguay, have been reported only since 2006 up to now. In Uruguay, safe drinking water is supplied to 94% of the population by the state company[2]. However, some rural areas have no access to this "official" water supply and people drink water from their own wells, that cannot be properly controlled, with the potential serious health risk to that consuming population.

The aim of this work is to investigate the association between arsenic exposure via drinking water from those wells and adverse health effects by a multidisciplinary approach of Medical Geology in a rural population located in San Pedro, Colonia department.

Methods: The study was performed in San Pedro where we studied 39 private wells with a range of As (2,3-39,7) ug/L. Health risk was estimated using WHO assessment tools with exposure frequency and exposure duration to these wells´ water. The As levels in water were used to calculate the As average daily dose (ADD)[3]. The risk was represented by the hazard quotient (HQ) and the cancer risk (CR). HQ was estimated for dermatological manifestations, using As toxicity reference dose of 0.0003 mg/kg/day3. Health risk situation was assumed when HQ levels were >1. Cancer risk (CR) was calculated using the cancer slope factor of 1.5 mg/kg/day−13. Values between $10^{-4}$ y $10^{-6}$ are considered safe[3].

Results: 87% of the wells had a HQ greater than 1 if the water is consumed by the residents daily for 70 years. The CR was higher than $10^{-4}$ if 15 years of residence was assumed, so 94 % of the wells are no safe and the population had an increased cancer risk.

Conclusions: These results showed that more studies linking groundwater As levels and rural population consumption, should be carried out to address risk assessment and health management including biomonitoring of arsenic in urine of exposed population that is the next step of this research study.

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# Has COVID 19 impacted the groundwater of public supply by psychopharmaceuticals? A bibliographic review in the period 2020/2021.

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Abstract

Drinking water has a strong influence on public health. Improvements in its quality, assessments and mitigation actions to exposures to avoid related diseases are permanently necessary. The presence of environmental pollutants, especially psychopharmaceuticals, in underground water sources that supply part of urban populations, the highest percentage of users currently in the world (55%)[(1),] will limit the use of this strategic resource. The Covid- 19 pandemic confined populations and forced people into social isolation. Facts that have proven these asymmetries is the increase in psychiatric drug sales.

In Brazil, according to the Federal Council of Pharmacy, from January to July 2020 there was an increase (14% to 17%) in sales of antidepressants and mood stabilizers, used in cases of affective disorders, such as depression, dysthymia (depressive neurosis ) and bipolar affective disorder. In the case of anticonvulsants, which act against epilepsy, the increase was almost 13%([2-3]).

The presence of psychotropic drugs, even in low concentrations (nanogram/liter and microgram/liter) in groundwater becomes complex for understanding and tracking. After therapeutic prescriptions and administrations, these substances are not fully metabolized by the body, and their metabolites or conjugates may go to ETES – Effluent Treatment Stations that do not remove these substances. The objective of the article is to evaluate the between the increase in the consumption of psychotropic drugs and their risks to human health resulting from the ingestion of contaminated groundwater that supply public systems.

Method – Bibliographic search of articles disseminated online in the field of environmental health, using the PUbMed, Scopus, Scielo, PubChem, WHO, NCBI, ANVISA and FIOCRUZ databases.
Conclusions - The results will contribute to public health, to health surveillance bodies, especially for underground water used in public supply, to managers of water supply companies and business managers for collaborating in decision making regarding water safety supply for society.

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# Study of the effects of polluting sources in aquifers and their effects on population quality of life in Russas-CE

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Due to the seasonality of rainfall, the Brazilian semiarid experiences times of water scarcity, resulting in negative water balances and, as a result, poor access to water for human consumption[1]. Groundwater is a significant source of high-quality water in the interior of Ceará's state. Unorderly habitation, population increase, and the precariousness of sanitary sewage services, on the other hand, can degrade the quality of subsurface water sources and make their usage impractical[2]. This research was conducted in an area of the municipality of Russas with the goal of identifying potential anthropogenic sources of aquifer contamination and assessing human health concerns.

Vectorized highways, well data integration, land use and land cover from orbital satellite imagery were all incorporated in the base map. Local reconnaissance, visits to the wells, and in-situ measurement of electrical conductivity (EC) and pH were all conducted in the field.

Local reconnaissance, visits to the wells, and in-situ measurement of electrical conductivity (EC) and pH were all conducted in the field. There were eighteen functioning wells visited, eleven of which collected water from permeable aquifers for human consumption. There is at least one polluting source in each of the catchment areas surveyed, which includes agricultural operations, urban effluents, industries, and the city landfill. The pH value of the water samples from the wells was within the consumption level defined by Ordinance GM/MS Nº. 888/2021. The EC ranges from 868 to 1254 μS/cm, and the STD estimate suggests that four samples are brackish, four are salty, and ten are sweet.

The sandy texture of sedimentary aquifers encourages fluid infiltration and percolation, which can be hampered when polluting sources are present. The general public's awareness of these issues is still intermittent, which can lead to people drinking contaminated water and spreading infections.

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# Application of geochemical mapping in the Iron Quadrangle in Minas Gerais for the evaluation of contaminations and their possible effects in the health

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Natural processes and human activities are continuously modifying the chemical composition of our environment, so it is important to determine the current concentration and spatial distribution of chemical elements on the surface and understand their possible effects on environmental health. This work concerns the geochemical mapping of the Belo Horizonte, Ouro Preto and Igarapé sheets, scale 1:100,000, located in the region of the Iron Quadrangle. The objective was to determine the regional background of some elements of environmental and health relevance and to identify some points with anomalous concentrations.

A total of 731 active stream sediment samples were collected and univariate statistical treatments were performed. To access the level of contamination the quality guidelines established by NOAA, which defines TEL (value below which adverse effects on human health are rarely expected); PEL (level of probable effects) and SEL (level of severe effects), was used.

The Supergroup Rio das Velhas presents higher values for almost all the elements when compared with the UCC (Upper Continental Crust) values. As and Ni present higher averages than the PEL value, and when the Cr is analyzed, the background of this lithology is higher than the SEL- For the elements Cd, Pb, and Zn the highest background values found in the area are below the TEL values.

It is concluded that part of the results can be explained by the geogenic origin of the elements in conjunction with punctual supergene enrichment processes that may be linked to the Rio das Velhas Supergroup that generate considerable increases in elemental concentrations. However, the establishment of public policies for monitoring the health of the population is necessary, since some elements presented values above the limits of probable and severe adverse effects to human health.

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# Mercury exposure assessment in a Brazilian ASGM Community and estimated chronic Hg levels in the atmosphere

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This pilot study addressed the environmental exposure to mercury (Hg) by goldminers and their families living inside the Artisanal and Small-Scale Gold Mining (ASGM) area in Mato Grosso state, Brazil. Air Hg levels were assessed and the study also evaluated urine Hg levels and clinical signs and symptoms of mercury intoxication.

Secondary and primary ore gold are processed at mineral processing center (MPC) located at the community. Closed amalgamation process and amalgam thermal decomposition using fumehood take place, more than once a day, every day. Tailings are stored in dams for further reprocessing. The community lives close to the MPC, not far from 50m distance, in the opposite side of fumehood exit. The field work was performed in August, 2017. Eighty-six first morning urine samples were collected from men and women, goldminers or not, aged 3 to 79 years old. In addition a semi-structured questionnaire was applied for personal and occupational information including number of dental mercury amalgam and food habits. Samples were acidified and transported under refrigeration to CETEM and, after acid humid digestion, total Hg levels were analyzed by using LUMEX Atomic Absorption Spectrometry - Cold Vapor. The methodology was validated and uncertainty was established in 0.0058µg/L; acceptable results (95-112%) were obtained with certified reference materials (SRM 2670a -NIST).

Mean total Hg in urine was 18.98µg/L (range from 2 to 172.87µg/L). Such results are four times greater than the average reference concentration of mercury in urine (4 µg/L) and almost 1.8 times higher than levels observed in other Brazilian ASGM communities (Castilhos et al., 2015). No clinical signs and symptoms of mercury intoxication were detected in the studied population. In order to estimate air Hg levels from urine Hg levels, the correlation of 1:2.5 for non-symptomatic persons was used (Inorganic Mercury, WHO, 1991), resulting in 7,500 ng $m^{-3}$.

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# Analysis of the heterogeneity of the Pampeano Aquifer sediments: towards a better understanding of the behavior of arsenic and fluoride in the Pampean Plain

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Although considerable progress has been made in the study of arsenic (As) and fluoride (F) in groundwater, the number of people affected by this problem in Argentina is still high[1]. The city of Azul in the province of Buenos Aires is located in the Pampean Plain and is supplied with groundwater from the multilayer Pampeano Aquifer, whose thickness is about 100 m. The aquifer has a complex geological heterogeneity that leads to important variations in hydraulic conductivity, which in turn affects As and F behavior. It has been shown that Pampeano Aquifer has high concentrations of As and F, but distributed erratically, both laterally and in depth[2]. These chemical species originated in several sources and are mobilized and transported by various mechanisms, both physical and chemical[3]. In addition, there are local factors such as lithology, geomorphology, topography and hydraulic parameters that affect these processes.
The main objective of this study is to determine which layers of the Pampeano Aquifer contain water with low As and F concentrations and to relate them to heterogeneity in subsurface geology.
The methodology used to characterize the aquifer sediments includes analysis of drilling logs and geophysical measurements. The use of chemical and isotopic techniques is intended to help in the understanding of hydrodynamics. The use of specific software EMMA-MIX is proposed to gain insights into the degree of mixing of water due to lithological heterogeneity and groundwater pumping[4].
An hydrogeological conceptual model it is planned to be developed which allow us to establish some criteria for water quality in the city of Azul. It is expected that this model provide scientific guidelines for hydrogeological exploration with the lowest concentrations of these ions as possible. Undoubtedly, this progress will have a positive impact on the health of the population, providing them with better water quality.

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# Soil Geochemistry from Tailings Deposits in Barra Longa City, MG - BR

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The collapse of the Fundão Dam, in November 2015, operated by Samarco Mining Company, dumped an estimated volume of 3.2 million m3 of tailings in the municipality of Barra Longa/MG, more than six years after, only 157 thousand m3 were removed.1 The affected areas show contamination in the surface soils of lowlands, it is also where most of the community of urban and rural areas at the region live. This was a multidisciplinary project with the main objective of technical support to the community, by researching the geochemistry and mineralogical soil composition from tailings deposits.

To analysis the contamination, twenty-five samples of surface soils were collected in the delimited region. All samples were submitted to analytical and chemical analysis via ICP-OES, using Agilent device, model 725. For better viewing, tables and graphics were created by EXCEL 2013, and geochemical maps by ARCGIS 10.5.

The elements As, Ba, Sb, Fe and Mn exceeded the concentration limit values by CONAMA 420/09 and the American Environmental Protection Agency, presenting potential direct or indirect risks to human health, settled by a standardized exposure scenario.2 The presence of these elements, associated with fine particle fractions, can expose the community to toxicity, mainly via inhalation, ingestion and dermal contact, which can worse in the long term if adequate measures to prevent exposure routes are not taken. With the results, were held workshops and explanatory booklets presenting the risks and advices to the community.

Results points to the presence of five contaminants of interest present in tailings and soils in Barra Longa/MG, corroborating the assertion of the existence of potential risks to human health. We recommended continuous monitoring, incentive more detailed studies and discussions with the community, claiming a definition of intervention measures, as the removal of tailings from the municipality for a greater control of risks.

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# Identification of refractory nano and microparticles from catalytic converters in dust: An emerging pollutant in urban environments

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**Introduction:** A Three-Way Catalyst (TWC) is a device used to convert exhaust emissions. TWC contains a cordierite ceramic monolith and a washcoat made of a nanocrystalline mixture of $Al_2O_3$, $Ce_xZr_{1-x}O_2$ and platinoids. Despite the environmental benefits attributed to the TWC, some studies report the release of Pt, Pd, and Rh[1]. Under standard operation conditions, the other refractory compounds can be released into the environment. The objectives of this study are to characterize the crystalline structure of TWC components and to identify it in pipe exhausts and environmental dust samples.

**Methods:** We collected samples from TWCs (brand-new, moderately, and highly used), exhaust pipe, and road dust. We characterized each sample by Raman microscopy, X-Ray Diffraction (XRD), and Scanning Electron Microscopy - Energy Dispersive X-Ray Spectroscopy (SEM-EDS).

**Results and Interpretation:** We detected $Zr_{0.8}Ce_{0.2}O_2$ composite and the decrease of oxygen vacancies by Raman experiments. Also, the crystalline $Zr_{0.8}Ce_{0.2}O_2$ solution is broken and begins to separate into $ZrO_2$ and $CeO_2$ phases in the TWC. This causes the emission of $ZrO_2$, $CeO_2$, and $Zr_{0.8}Ce_{0.2}O_2$ particles smaller than 1 μm, that was found in environmental samples. **Conclusion:** The release of ultrafine crystalline particles is the most important consequence of the overuse of catalytic devices. These particles can reach the alveolar macrophages in the lungs. In this way, the emission of refractory micro to nanocrystals to the atmosphere may represent an emerging public health issue underlining the importance of implementing strict worldwide regulations on TWCs regular replacement.

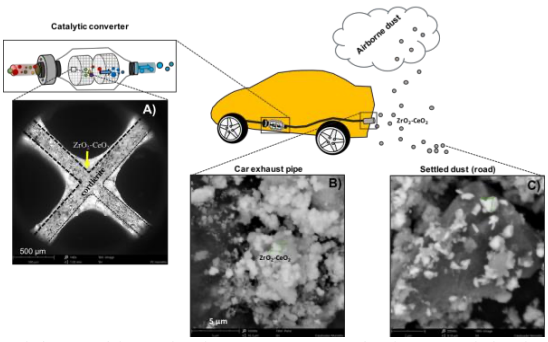


Figure 1: Schematic representation of the tracking of refractory nano and micro particles in different samples by SEM. Image obtained from Meza-Figueroa *et al.* (2021)[2].

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# Future Conferences

**2022** The International Student Conference on Medical Geology and Environmental Health: Africa Edition.
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**2023** The International Student Conference on Medical Geology and Environmental Health: Russia and the NIS

Future conferences will focus on Europe, East Asia, South Asia, North America and the Caribbean, Oceana, and Middle East