Newsletter No. 2
December 2022

GEO-NETWORK OF LATINAMERICAN-GERMAN ALUMNI (GOAL)

Este edición del boletín está dedicada a las presentaciones que se efectuaron en el evento GOAL de Alemania 2022.

CONTENT

1. Editorial Note

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Dear Goalistas,

The meeting of the alumni network GOAL (Geo-Network of Latin American-German Alumni) took place from October 10th to 15th in Greifswald and Freiberg. This network is funded by the German Academic Exchange Service as part of the "Alumni program for further training and retention of international alumni from developing countries and industrialized countries (2022-2023)". The topic of the current funding period is "Geosciences in the 21st Century: digitalization, sustainability and strategic resources". The first part of the meeting took place at the University of Greifswald. The goalistas were clearly happy about seeing each other when they met the evening before in the Geologists' Cellar of the Institute for Geography and Geology.

The piano piece "Ticotico no fuba", played by Prof. Dr. Martin Meschede, the host and GOAL coordinator, preceded his greetings. Rector Prof. Dr. Katharina Riedel opened the conference with words about the University of Greifswald. Prof. Dr. Sebastian van der Linden delivered a greeting as a representative of the institute. Latin America coordinator Reinaldo Garcia, co-organizer Prof. Dr. Jörg Matschullat and coordinator PD Dr. Christina Ifrim also warmly welcomed the 26 guests from 15 countries. The program of the first day included oral and poster presentations by all participants on their current projects with a wide range of topics. On the second day there was a workshop on remote sensing methods. It became clear that LiDAR and photogrammetry are comparatively cheap and promising methods for numerous geological questions. In the meantime, the students of the institute prepared dinner in the Geologist's Cellar.

The first conference excursion went to the Island of Rügen. The forming of the Rügen chalk and the Pleistocene overprinting by the glaciations were the topic. The glaciotectonic deformation is excellently exposed in this key region for the development of the Baltic Sea. In the Chalk Museum in Gummanz, the participants found out about the mining and use of Rügen chalk.

GEO-NETWORK OF LATINAMERICAN-GERMAN ALUMNI (GOAL)

The transfer to Freiberg also included an excursion. The Big Stone of Altentreptow is the second largest known erratic boulder in Northern Germany. The Niederfinow ship lift and the Rüdersdorf Museum Park on the outskirts of Berlin over Triassic Muschelkalk limestone were reasons for further stops. The excursion from Freiberg the next day focused on mining, resources and sustainability. The Muldenhütte and the Freiberger Mulde have changed from an area of major pollution to sustainable raw material processing and healthy nature. The number of trucks bringing car batteries for recycling and raw material recovery from all over Germany was impressive during the short stop. Other companies for the recycling of aluminum, zinc and solar systems were on the way. Even waste water from large spoil heaps no longer supplies pollutants but raw materials thanks to recovery. It became clear: raw material extraction can be operated in an environmentally friendly and sustainable manner. There are no "additional costs" for this, because the investments pay for themselves within a few years, while large-scale pollution causes higher costs by orders of magnitude. Another aspect of the excursion was the forest and paper industry in the Ore Mountains. In the region around Tharandt, the value of forests was recognized as early as the 18th century and Germany's first forestry school was founded there. The paper industry is now also working sustainably, the forests and watercourses in the Ore Mountains are now healthy ecosystems again. Certain water bodies once had pH levels around 3 or below and are now either on the right track or are already reaching healthy, normal pH levels around 6. The large Altenberg sink (“Alterberger Pinge”), which could be clearly seen from the colliery in Altenberg, was impressive. Today it is known that the deposit, which was already being exploited in the mid age until the mine collapsed, also contains Li mica, which provides Germany with a medium-term supply. Another stop in the Georgenfelder Hochmoor became a lesson in how important it is to heal even smaller ecosystems. 11 years after the deactivation of the drainage one finally sees a recovery of the ecosystem and its balancing influence on the regional climate. The climate station in Oberbärenburg not only impressed colleagues from environmental departments. The measurements there made a decisive contribution to classifying the origin of atmospheric pollution caused by industry and to minimizing this through measures. While many trees suffered from large amounts of pollutants there in the 1990s, the station now measures clean air in a forest that is once again intact. The catastrophic flood of 2002, the subsequent hydraulic engineering measures and their balancing effect on heavy rain events rounded off a very informative day at the Malter dam.

GEO-NETWORK OF LATINAMERICAN-GERMAN ALUMNI (GOAL)

The last day of the GOAL meeting started at the Helmholtz Institute for Resource Technology in Freiberg. Deputy Director Jens Gutzmer welcomed the participants and introduced them to the concept behind the Helmholtz Center. Geoscientists quickly understand the importance of circular resource management and the challenges along the way. The subsequent tour of the laboratories and halls allowed for a preview of how digital and automated raw material exploration on a small and large scale can contribute to this in many ways. A workshop on geochemical sampling planning, evaluation and international database management closed the loop from the stations seen back to the post-Ice Age isostatic movements that were treated on Rügen.

The program lived up to the title of the event "Geosciences in the 21st Century - Digitization, Sustainability and Strategic Resources" in every respect and in many different aspects. At each station, the Latin American colleagues from the respective departments immediately started technical discussions and first approaches for project ideas. Some pre-arranged appointments with other colleagues had been arranged to discuss specific project ideas. In addition, many colleagues used the stay to arrange further appointments in other German institutions around the GOAL network meeting. Unfortunately, a number of colleagues had to cancel because of the flight prices, others could not come at all. In addition to technical topics, the participants also discussed a number of interdisciplinary common challenges. The networking of German and Latin American colleagues was intensively and successfully revived with this meeting after the five-year break.

The next meeting of the goalistas is planned for March 2023. The preparations are already underway and the organizers in San José in Costa Rica have registered. There, too, will be excursions in addition to the conference, where current topics will be discussed. After the successful reunion in Greifswald and Freiberg we are looking forward to the next meeting in Costa Rica.

With our best regards,
Christina and Martin

2. Desafíos de los programas de formación doctoral en geociencias: la experiencia cubana

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Resumen:
El concepto de Industria 4.0 ha ganado espacio en la actualidad, está más desarrollado en la industria manufacturera que, en la industria extractiva. América Latina y el Caribe pueden aprovechar su capital natural y desarrollar soluciones sostenibles para desarrollarse, donde, la actividad minera puede ser un motor del desarrollo bajo estas nuevas concepciones. Cuba se propone asumir con mayor amplitud los conceptos que trae consigo la Industria 4.0. El Sistema de Gestión de Gobierno basado en Ciencia e Innovación, se propone fortalecer el papel de la ciencia y la innovación en la búsqueda de soluciones creativas a problemas del proceso de desarrollo económico y social del país, en el mismo la formación doctoral es un aspecto clave. En este trabajo se presenta una experiencia exitosa basada en la vinculación Universidad – Empresa para el logro de este importante objetivo.

Palabras clave:
Industria 4.0, Sistema de Gestión de Gobierno basado en Ciencia e Innovación, vinculación Universidad – Empresa, Formación doctoral

Summary:
The concept of Industry 4.0 has gained space today, it is more developed in the manufacturing industry than in the extractive industry. Latin America and the Caribbean can take advantage of their natural capital and develop sustainable solutions to develop, where mining activity can be an engine of development under these new concepts. Cuba intends to assume more broadly the concepts that Industry 4.0 brings with it. The Government Management System based on Science and Innovation, intends to strengthen the role of science and innovation in the search for creative solutions to problems in the country's economic and social development process, in which doctoral training is an aspect key code. This paper presents a successful experience based on the University-Enterprises relationship to achieve this important objective.

Keywords:
Industry 4.0, Government Management System based on Science and Innovation, University-Enterprises relationship, doctoral training

Introducción:
El término Industria 4.0, de origen alemán, fue acuñado por el presidente de la Academia Alemana de Ciencias e Ingeniería, Henning Kagermann, el año 2011. La misma consiste en la implementación de una red tecnológica de producción inteligente, para máquinas, dispositivos y sistemas que colaboren entre sí, permitiendo aumentar la optimización del control de los procesos y las cadenas de suministro.
El concepto de Industria 4.0 está en estos momentos más desarrollado para la industria manufacturera que, para la industria extractiva. En el caso del sector extractivo, existen, elementos diferenciadores respecto a una industria o fábrica convencional, por lo que no se pueden extrapolar de manera directa alguna de las estrategias o incluso tecnologías a los diferentes procesos que se llevan a cabo.

En las minas del futuro se utilizarán todo un conjunto de tecnologías que permitirán alcanzar los objetivos de productividad, seguridad y economía. Algunas de estas tecnologías innovadoras son: redes eléctricas inteligentes, ventilación bajo demanda, desagüe automatizado, mantenimiento predictivo, modelización integrada de información geoespacial, gestión del tráfico, etc.

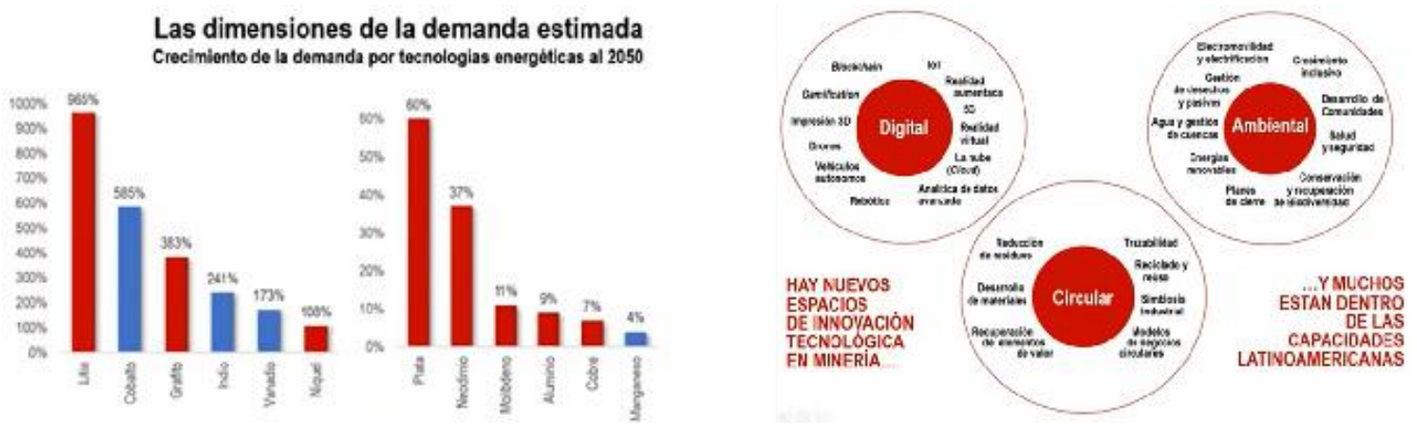

Figura 1. Espacios para la innovación tecnológica en minería y dinamización del perfil de las exportaciones basadas en georecursos Fuente: Perez, 2021

Desarrollo:

En América Latina y el Caribe muchas ideas establecidas sobre desarrollo están siendo cuestionadas en los hechos. Las circunstancias requieren un repensar informado y audaz. Hoy, América Latina y el Caribe está a tiempo de aprovechar su capital natural y desarrollar soluciones sostenibles para mitigar y adaptarse al cambio climático y acelerara el desarrollo. Si las condiciones institucionales y las prácticas corporativas son adecuadas, la actividad minera puede ser un motor de desarrollo de productos y servicios de altísimo valor agregado y complejidad.

Adoptando la automatización, la robótica y la digitalización, la minería puede impulsar la transición hacia la electromovilidad, la economía circular, y un mayor desarrollo de energías renovables.

Si bien Cuba tiene mucho camino por andar todavía en pos del desarrollo industrial que necesita, y asumir con mayor amplitud los conceptos que trae consigo esta llamada cuarta revolución industrial, sus instituciones no están de brazos cruzados.

La cuarta revolución industrial no solo tributa a la industria, tributa a toda la sociedad y estas tecnologías, de manera general, van tributando a ese desarrollo de la economía que necesitamos.

El tema no solo puede verse como una necesidad del país, sino que es, además, una oportunidad de aprovechar el capital humano que poseemos, para solucionar problemas y retos que tenemos hacia adentro e incrementar la independencia y la soberanía tecnológica, a partir de creaciones propias y exportaciones.

Las exigencias de la actual dinámica demográfica, que ha llevado a que cada vez haya menos población económicamente activa para sostener más población económicamente no activa, lo cual demanda de procesos más productivos y eficientes, y una vía para lograrlo es a través de la Industria 4.0.

El Sistema de Gestión de Gobierno basado en Ciencia e Innovación (SGGCI) es un sistema de trabajo gubernamental que persigue fortalecer el papel de la ciencia y la innovación en la búsqueda de soluciones creativas a problemas que surgen en el proceso de desarrollo económico y social del país, tanto en la producción de bienes y servicios, como en los ámbitos de la administración pública, las actividades de CTI, la educación, la cultura, u otros.

Las funciones del SGGCI son fundamentalmente dos. Lo primero son sus bases conceptuales y en segundo lugar los componentes que lo integran y las principales acciones asociadas a los mismos.

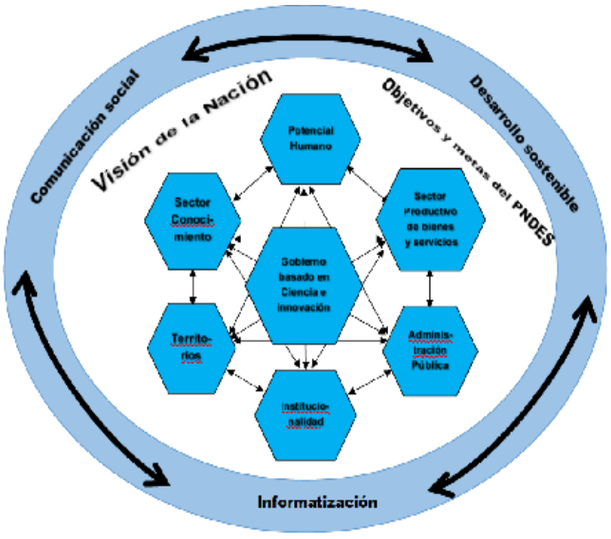

Figura 2. Representación gráfica del sistema de gestión de Gobierno basado en ciencia e innovación (SGGCI) Fuente: Díaz-Canel 2021.

La formación doctoral en cualquier país es un proceso selectivo, riguroso, extenso y complejo. En Cuba este proceso consta de multiples pasos (incluye la formalidades de planillas y registros), entre ejercicios académicos, publicaciones, participación en eventos, mínimos y documentos, de los cuales algunos pasos como las sesiones científicas y socialización del tema ante la comunidad científica en empresas, Institutos de Investigación y Universidades deben ser repetitivos hasta lograr el pase a la predefensa, que solo se otorga en sesión científica en la Universidad.

Este proyecto: VOLUNTAD REAL DE INTEGRACIÓN UNIVERSIDAD-EMPRESA Y POTENCIALIDADES PARA LA FORMACIÓN DOCTORAL EN EL MINEM, surgió por iniciativa de la Dirección General de Minería del MINEM

Demostrar que para incrementar la formación doctoral en el MINEM es necesario realizar cambios de pensamiento y actuar, entre los directivos de las OSDE, empresas y sus investigadores así como en los profesores, directivos e integrantes de los consejos científicos de las universidades.

Conclusiones:

El proceso de formación doctoral es un proceso largo complejo que en ocasiones demora años y solo es posible reducir si existe una voluntad real de las Universidades, los OACE y sus empresas.

En lo que respecta a la Universidad de Moa, se ha logrado inscribir a seis doctorandos del sistema MINEM en tres meses.

Con este proyecto se demuestra que sin perder rigor ni calidad, es posible lograr una real integración Universidad-Empresa, con mayor efectividad en el proceso de formación doctoral.

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3. Applications of drill-core hyperspectral data at mineral deposit scale

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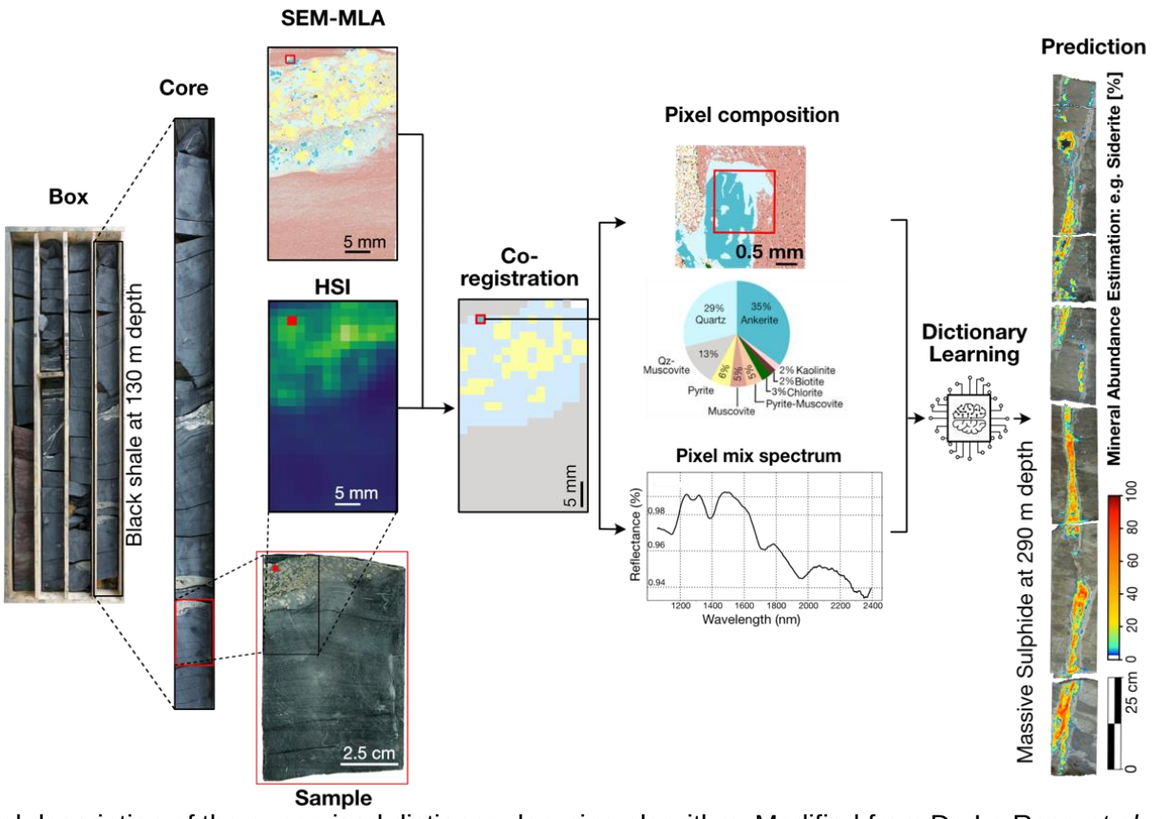
Abstract
Hyperspectral drill-core scanning can complement traditional logging techniques by providing continuous, high-resolution mineralogical data over the length of entire boreholes in a fast, reproducible, non-destructive, and cost-effective way. However, when applied for an entire deposit, the results are big datasets that are challenging to interpret, validate and incorporate into the traditional workflows. In this contribution we showcase a procedure to increase the value of hyperspectral imaging to an exploration campaign by incorporating the following: An automated pre-processing. A supervised classification of hyperspectral data for quantitative mineral abundance predictions along boreholes, using quantitative mineralogical data as training input and dictionary learning, an efficient machine learning technique. A transformation of mineral abundance predictions into multi-scale and geologically meaningful lithological domains via a segmentation algorithm based on a continuous wavelet transform and subsequent classification. The classified domains are sensible from a geological point of view and spatially coherent across the boreholes in cross-sections. This method is fast, is appropriate for multivariate geological data along boreholes, and provides a choice of scales for hierarchical geological domains along boreholes with mineralogical composition characteristics that can be modeled in 3D.

Introduction
Hyperspectral sensors cover a wide spectral range from visible and near-infrared (VNIR) to short and long wave infrared (SWIR and LWIR). The spectral features in this range will help to characterize a large number of mineral phases and complement the traditional core logging techniques. The hyperspectral core scanning provides mineralogical information in a millimetre scale for the entire borehole, which fills the gap between the microscopic scale of some of the laboratory analytical methods or the sparse chemical assays and the meter scale from the lithological descriptions. However, applying this technique to the core samples of an entire ore deposit results in big datasets. Therefore, there is the need of a workflow to build a 3D geological model conditioned by the data applying suitable data reduction methods and appropriate interpolation techniques. The application of these methods in the geological remote sensing community is growing. Nonetheless, there is no clear implementation of these techniques for the analysis of drill-core Hyperspectral (HS) data at deposit scale. In this contribution, we showcase the increase value of HS imaging to an exploration campaign by incorporating unsupervised ML techniques in the sampling selection strategy and supervised ML technique for mineral abundances prediction using as training data high-resolution mineralogical analysis.



Graphical description of the supervised dictionary learning algorithm. Modified from De La Rosa *et al*., 2021

Results and conclusions

The results are condensed in the mineral abundance prediction along the boreholes where significant variations in composition and mineral abundance estimations are observed. We demonstrated that machine learning can be used to automatically process large amounts of hyperspectral data from drill-cores, making exploration campaigns more efficient (De La Rosa *et al.,* 2022). This approach based on machine learning adds value to the drill-core data, allowing for a better understanding of the geological setting of mineral deposits and providing valuable insights for future exploration targeting. The resulting domains along boreholes are described by their mineralogical composition which produces geologically meaningful domains that can be modeled in 3D.

Acknowledgements

This study has been done within the framework of project NEXT (New Exploration Technologies, project webpage: http://www.new-exploration.tech). This project has received funding from the Euro- pean Union's Horizon 2020 research and innovation programme under Grant Agreement No. 776804 – H2020–SC5–2017.

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4. Contaminant-rich geothermal fluids as hazardous materials

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Summary
Geothermal Arsenic – A global problem
Arsenic-rich geothermal fluids are hazardous materials of global impact. They can be released naturally or through human activities. In this research a systematic global assessment of geothermal arsenic (As) in fluids of the six principal types of geothermal reservoirs and their environmental impact was performed based on research of the geochemical characteristics and geotectonic setting of the formation of natural geothermal reservoirs worldwide.

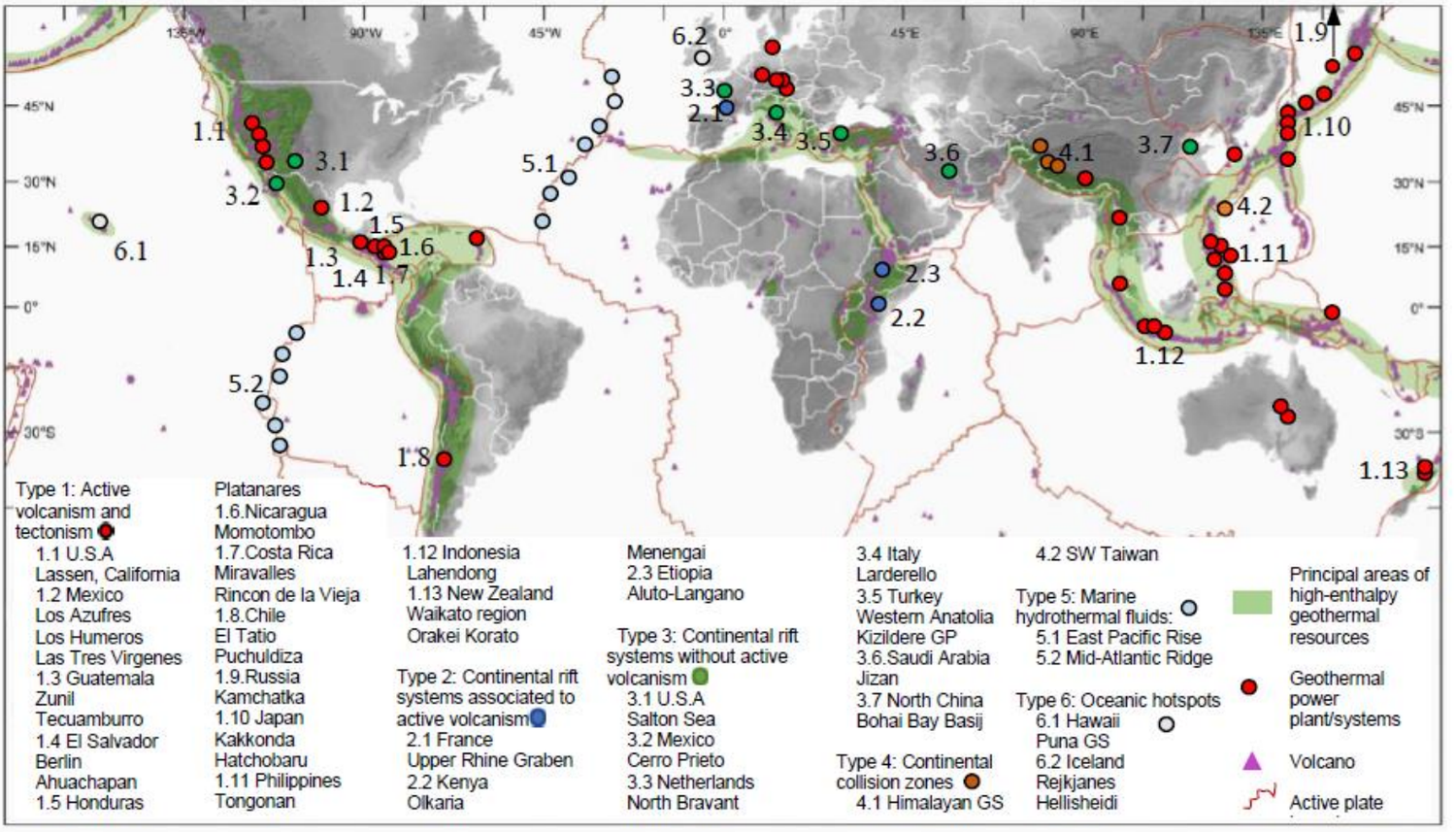
Type 1 (geothermal systems associated to active volcanism and tectonism). Most of the geothermal sites (66 sites, As: >73.6 – 0.01 mg/L, Temp: 98.0–31.7 °C, pH: 8.3–1.4) belong to this geothermal reservoir type. Highest As concentrations (e.g., 73.6 mg/L in Los Humeros, Mexico; 47.5 mg/L in the Tatio, Chile) are generally found in these geothermal reservoirs. Type 2 (geothermal systems of the continental rift system associated with active
volcanism) which is like Type 1 related to active volcanism, but rifts as the active plate boundary. This type contains 31 sites (As: 8.5–0.0001 mg/L, Temp: >85.6–22.2 °C, pH: 10.9-5.2).
Type 3 (geothermal systems associated with continental rifts without active volcanism. This type of geothermal reservoirs corresponds to this of type 2, but they are lacking active volcanism. This type contains 25 sites (As: 11.0–0.02 mg/L, Temp: 76.0–13.5 °C, pH: 8.3–6.6) and the typical reservoir rocks are plutonic intrusions (granite) and volcano-sedimentary rocks.

Type 4 (geothermal systems associated to collision zones and non-volcanic fields). This type contains 24 sites (As: 4.6–0.004 mg/L, Temp: 87.1–15.9 °C, pH: 8.9–3.0) and the reservoir rocks include plutonic to metamorphic rocks.

Type 5 (hydrothermal systems in shallow and deep marine environments). This type of high temperature geothermal systems is distributed near coastlines or along the spreading zones between tectonic plates, where active tectonism and volcanism play an important role.

Type 6 (geothermal systems associated to continental and oceanic hot spots). This type of geothermal reservoir contains 15 sites (As: 9.5 – 0.02 mg/L, Temp: 85.6 – 66.6 °C, pH: 8.3 – 4.1). They are typical of volcanic to sedimentary environments, where active volcanism and tectonism play an important role.

This will improve the sustainability of geothermal energy use which is an excellent renewable environmental friendly energy resource for electric power production and direct heat use. Arsenic in geothermal fluids (up to several tens of mg/L) originates especially in deep seated (several kilometers) reservoirs. Proper management of geothermal fluids during exploration, exploitation, use and disposal of resulting waste products are crucial. However, more research about As speciation and volatile As is necessary to fulfil this aim. Therefore As (and its principal species) needs to be included as parameter for standard analysis and monitoring program in any project using geothermal fluids in order to define appropriate mitigation and prevention actions.



Global distribution of geothermal power plants and geothermal systems (with available As data) located in six different types of geological and tectonic settings. The location of the geothermal sites was taken from the Current List of Geothermal Power Pants (GEO, 2020).The colors of the circles represent the different reservoir types. The global elevation map (PIA3388) is courtesy of NASA/JPL-Caltech. http://photojournal.jpl.nasa.gov.
GEO, 2020. Current list of Geothermal Power Plants. Retrieved from http://globalenergyobservatory.org/list.php?db=PowerPlants&type=Geothermal..

Conclusions

Geothermal arsenic is a global problem. There are a number of pathways how geothermal fluids with variable As content exceeding the WHO guideline limit (0.010 mg/L) for drinking water can impact close earth surface environment.. These pathways can be purely natural (e.g., geothermal fluids rising up from the deep geothermal reservoir along of faults) or they can be technically enhanced by human activity (e.g., extensive pumping of groundwater which can increase the inflow of geothermal fluids. Understanding geothermal reservoir formation on basis to their geochemical characteristics and geotectonic settings is an innovative way to improve exploration techniques and protect natural resources..Most of the geothermal systems belong to Type 1, which is associated to active volcanism and tectonism. Arsenic concentrations in this type of geothermal system vary between 0.05 to 73.0 mg/L and the higher concentrations of As are found in NaCl waters. Most of the bigger geothermal power plants such as Los Azufres (México), Momotombo (Nicaragua), Miravalles (Costa Rica), Kakkonda (Japan), Tongonan (Philippines), Wairakei (New Zealand) are located on this type of geothermal system.

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5. Pollution of the aquifer by industrial activities of university campus UANL

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Resumen:
El campo de pozos Monterrey está ubicado en el acuífero urbano del Área Metropolitana de Monterrey (México), y ha sido objeto a aumentar considerablemente el estrés hídrico. Esta área está en constante crecimiento, tanto en términos de infraestructura como de población (Figura 1).

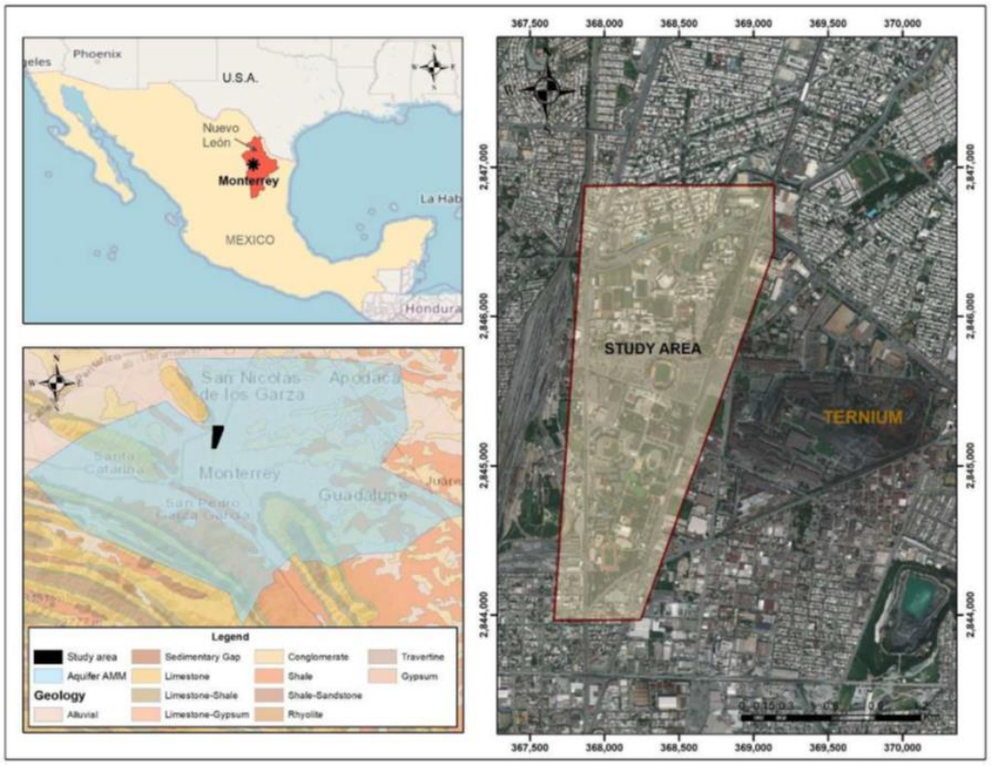

Figura 1: Localización del área de estudio y acuífero urbano de Monterrey

El objetivo general del presente estudio es evaluar y validar la vulnerabilidad del acuífero a la contaminación mediante la aplicación de métodos DRASTIC y GIS, y análisis hidrogeoquímicos. Para ello, se realizaron cuatro campañas de medición de profundidad de aguas subterráneas y tres muestreos de agua durante los años 2018 y 2019, cuando existían condiciones de sequía.
Los resultados hidrogeológicos muestran que el agua subterránea fluye principalmente en dirección suroeste a noreste. Con respecto a los hallazgos hidrogeoquímicos, se determinó el tipo de agua por iones de Ca^{2+}, Na^{+}, Mg^{2+}, Cl^{-}, que pueden ser alterados por las concentraciones de SO_4^{2-}. El mapa de la vulnerabilidad con el método DRASTIC, indica que las áreas más vulnerables fueron contaminadas por influencias antropogénicas, donde SO_4^{2-}, Cl^{-}, Fe, Al y partículas coliformes estaban presentes (Figura 2).

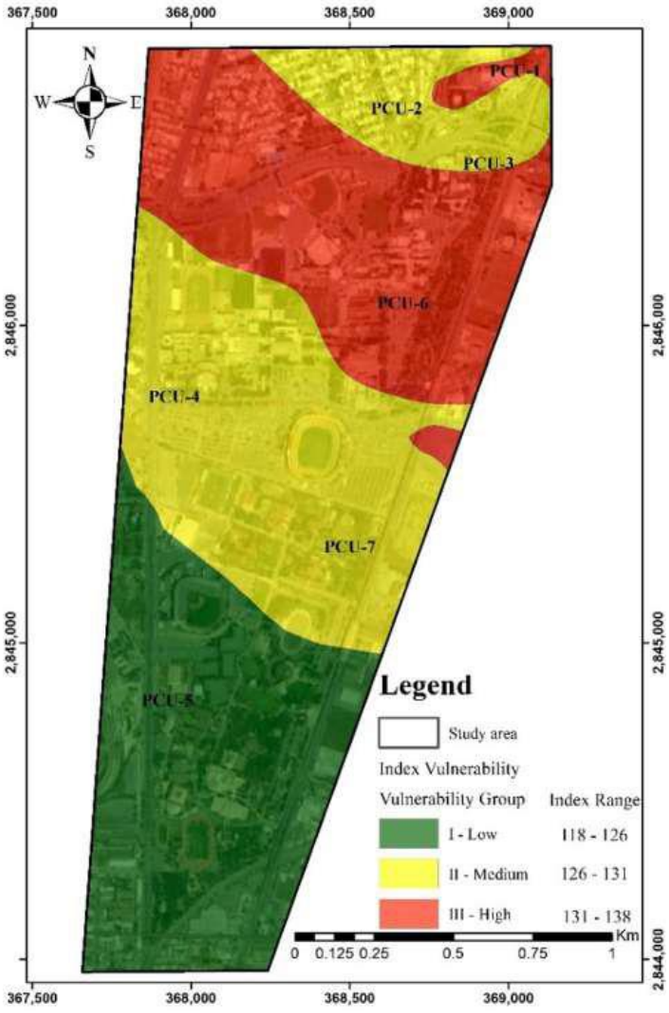

Figura 2: Mapa de índices de vulnerabilidad del área de estudio

En general, los niveles de agua subterránea no cambiaron significativamente, y varió de 498 a 520 msnm. En el agua subterránea se encontró que esta fluye de suroeste a noreste. Los cambios hidrodinámicos más significativos ocurridos en los años 2016 y 2017, fueron cuando el flujo del agua subterránea cambió debido principalmente a la sobreexplotación de la misma. Es importante mencionar que el agua subterránea se mantiene estable, a pesar de la extracción de agua de los pozos para satisfacer diversas necesidades. Las concentraciones de metales de Fe, Al y coliformes indican que el agua subterránea puede estar contaminada por fugas en el sistema de alcantarillado y la infiltración de esas aguas pluviales. Los metales pesados y las concentraciones que se identificaron pueden deberse a actividades realizadas por la empresa siderúrgica ubicada muy cerca de la zona de estudio. Las mayores concentraciones de estos indicadores fueron principalmente en la zona de alta vulnerabilidad, que puede explicarse por fugas del sistema de alcantarillado.

Además de lo anterior, es necesario tomar las medidas necesarias para las gestiones ante las autoridades y las empresas correspondientes para tener acceso a los diferentes pozos y así poder hacer un inventario de los pozos que actualmente se encuentran en funcionamiento, qué junto con las fuentes potenciales de contaminación, pueden ser consideradas en una red de monitoreo de la calidad del agua.

De la misma forma, como mencionan otros estudios, utilizar los mapas de vulnerabilidad para implementar y priorizar políticas sobre protección de acuíferos y gestión de recursos hídricos, puede ser una herramienta muy útil.

6. Evidencia preliminar del paleoambiente registrado en rocas del límite Cretácico Superior en Guayaquil Ecuador

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Resumen:
En este trabajo se presentaran resultados preliminares de un estudio que se está realizando en rocas asignadas a formaciones geológicas del Cretácico Superior. Estas rocas afloran en diversos lugares del bloque geotectónico denominado “Bloque Piñón”, las muestras para los resultados de este trabajo son de la ciudad de Guayaquil, específicamente de los Cerros Lomas de Urdesa, Santa Ana y Del Carmen. Los óxidos son procesados en Excel-SEDMIN, de allí se reconoció que los minerales. Cuarzo+calcita+clorita+sericita están en casi un porcentaje superior a Albita+hematita+rutilo+apatito en el otro porcentaje. Esto, junto con la petrografía, permitió reconocer que los sedimentos que conformaron estás rocas procedían de dos ambientes. La correlación de los diagramas de REE a condrita fueron usados para definir que todas las rocas corresponden a una sola unidad geológica. Los diagramas de procedencia geotectónica permite definir que los sedimentos son ceniza y piroclastos de arco volcánico y de aportes sedimentarios en un ambiente marino, esto último por la presencia de glauconita y depositados en zona somera profunda (batial) esto por el carbonato de calcio.

Palabras claves:
Axiolithic textures, cerium, volcanoclastic, marine platform, devitrified glass.

Introducción:
En la región costera del Ecuador se han efectuado trabajos geológicos que aportan de forma representativa y significativa a la geología de la costa ecuatoriana, la costa es una región con bajo relieve ubicada al Oeste de la Cordillera Occidental. La mayoría de los terrenos superficiales de la costa consiste de suelos volcánicos y aluviales cuaternarios. La Formación Cayo es un grupo potente de rocas de origen volcanoclásticos, es una de las formaciones más representativas de las costas ecuatorianas perteneciente al cretácico superior, en el Bloque Piñón (Figura 1a) compuesta por algunas rocas como las pizarras arcillosas y areniscas conglomeráticas de color pardo a negro, las brechas predominan en la base de la secuencia. El presente estudio plantea realizar análisis petrográficos y químicos de los afloramientos ubicados en la Av. Las aguas, Bosque Protector Palo Santo y Club de Leones (Figura 1b), donde afloran la Formación Cayo, que mediante esta exploración nos permitirá identificar textura, composición, forma, y tiene como base contribuir con información para los diferentes trabajos geológicos científicos posteriores de interés social o económicos (Altafulla, 2020; Basurto, 2020; Benítez, 1995)

Procesos genéticos a partir de la textura y fábrica

Los procesos que suceden para la formación de rocas volcanoclasticas son registrados en la microtexturas de las rocas, así como la fabrica de los granulos. se reconoce que abundan cristales de plagioclasa (Pl) tipo maclas polisinteticas y feldespatos alcaninos como la sanidida así como también piroxenos correpondientes a cristales de augita (Au) con zonaciones concentrias y con maclas La matriz que sostiene los cristales es de vidrio vitrificado (Vv) y vidrio desvitrificado (Vd; indica altas temperaturas) y corresponde a una fábrica de armazón de granos, es decir granos sostenidos en una matriz y entre ellos (Escobar, 2019; Espinoza, 2014).

Tierras raras (REE)

Se reconoce que los estratos corresponderían a un solo paquete formacional, como es a la Unidad Cayo. En los estratos de avenida la aguas hay estratos que se diferencian uno con más alteración de plagioclasas (Eu negativo), se puede decir que estos estratos son emitidos de una misma fuente con un corto tiempo geológico de diferencia, y que uno de ellos estuvo en contacto con fluidos que aceleraron la alteración de las plagioclasas. Los estratos de las otras zonas de estudio son similares al estrato de Av. Las Aguas (Figura 2).

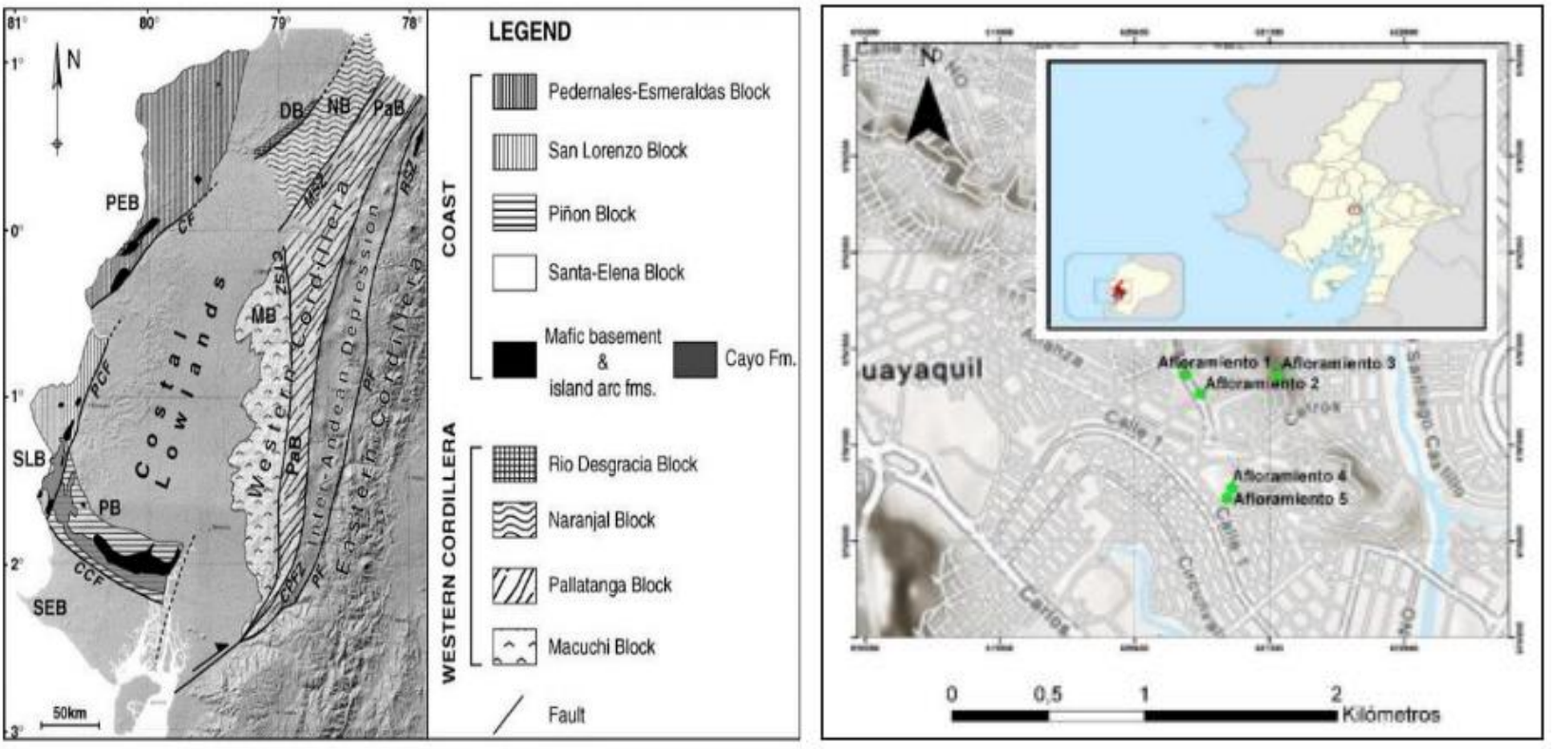

Figura 1. Mapa de ubicación del área de estudio. a) Bloque geotectónicos del antearco del Ecuador, la zona de estudio está ubicada en el Bloque Piñon (PB). b) afloramiento 1 y 2 corresponde a Av. Las Aguas, afloramiento 2 a Bosque Palo Santo, afloramiento 4 y 5 a Club de Leones.

Resultados

Debido a la presencia de minerales productos de alteración como la sericita y clorita (indican temperaturas de 300°- 400°C), cuyo mineral original habrían sido la albita (plagioclasas) y la augita (piroxenos), respectivamente; se reconoce que los sedimentos provienen de erupciones volcánicas. El ambiente es netamente marino, debido a la presencia de glauconita. • Las texturas de vidrios desvitrificados corresponden a magmas que se enfrían a altas temperaturas (700° C), esto habría sucedió por la breve y cercana deposición de la pluma de nube de ceniza en el agua de mar, la evidencia es las texturas axiolíticas del vidrio desvitrificado y vitrificado (Figura 2).

Los carbonatos presentes corresponderían que la deposición fue en la plataforma marina que se juntan con los volcanosedimentos de la erupción. El cuarzo, se encuentran de dos tipos monocristalino y polocristalino. El primero es muy escaso y de pequeños tamaños, el segundo es abundante y nos permite reconocer la temperatura que sería de 150°Celcius, que es el mínimo para que este mineral se funda. Las correlaciones de REE permite decir que los afloramientos son asignables a la Formación Cayo, únicamente y corresponden a la continuidad de estratos de Cerro del Carmen, Santa Ana, Cerro Bellavista, Cerros las Cabras (Duran) y Villas del Rey (Daule) (Ibarra, 2021).

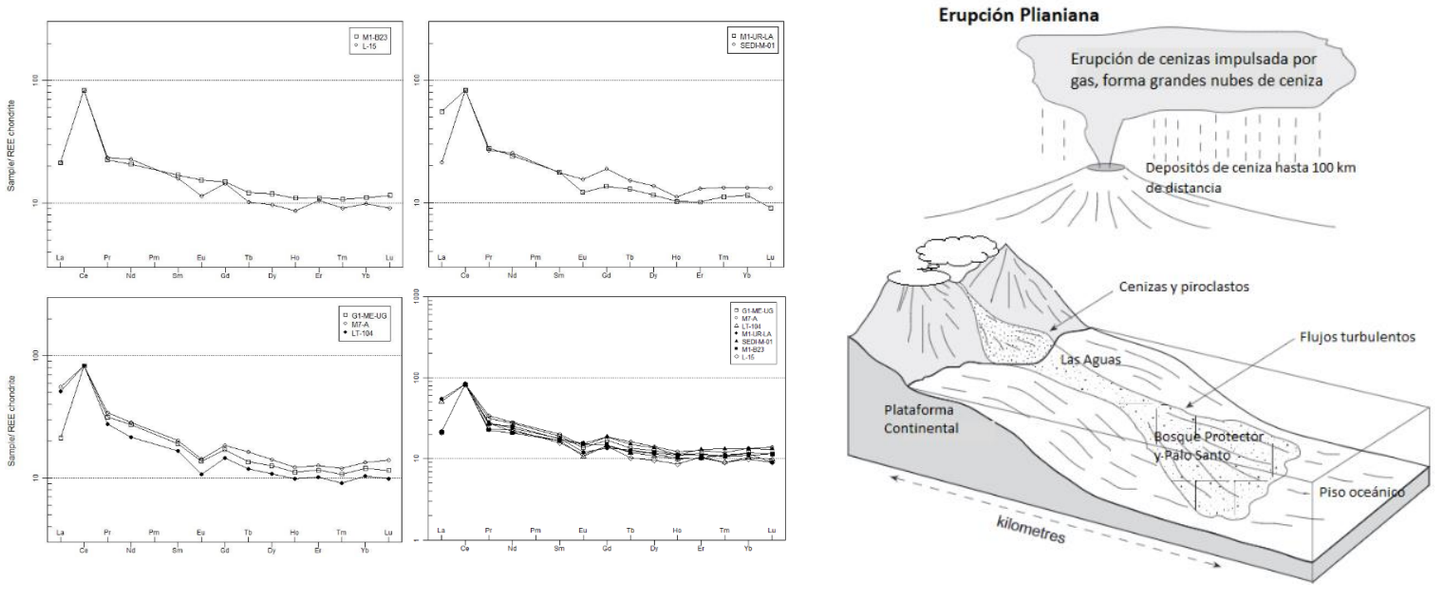

Figura 2. Diagrama Spider-plot REE chondrite (Anders and Grevesse, 1989), presentes en las muestras del área de estudio. a) Av. Las Aguas, b) El Bosque, Palo Santo, c) Club Los Leones y d) Todas juntas.

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7. Variabilidad espacial del suelo y la topografía, y su relación con el crecimiento de las especies cebo, almendro y guapinol, en Sarapiquí y Upala, Costa Rica

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Resumen:
Se analizó la relación de la variabilidad espacial del suelo y la topografía, con el crecimiento de las especies forestales nativas Vochysia guatemalensis (cebo), Hymenaea courbaril L. (guapinol) y Dipteryx panamensis (almendro), como indicador de la aptitud natural de los sitios, en tres plantaciones mixtas forestales (fincas) en Costa Rica. Para esto, se realizó una revisión bibliográfica para caracterizar el contexto social y biofísico de las áreas de estudio, posteriormente se determinaron los puntos de muestreo en cada una de las fincas, en donde se realizaron micro-calicatas y se tomaron muestras para posteriormente analizar las propiedades físicas del suelo. Una vez con esto se realizó un análisis estadístico para encontrar las relaciones más significativas entre las variables estudiadas para las tres especies en las tres fincas.

Palabras clave:
Estudio forestal, plantaciones mixtas forestales, suelos tropicales

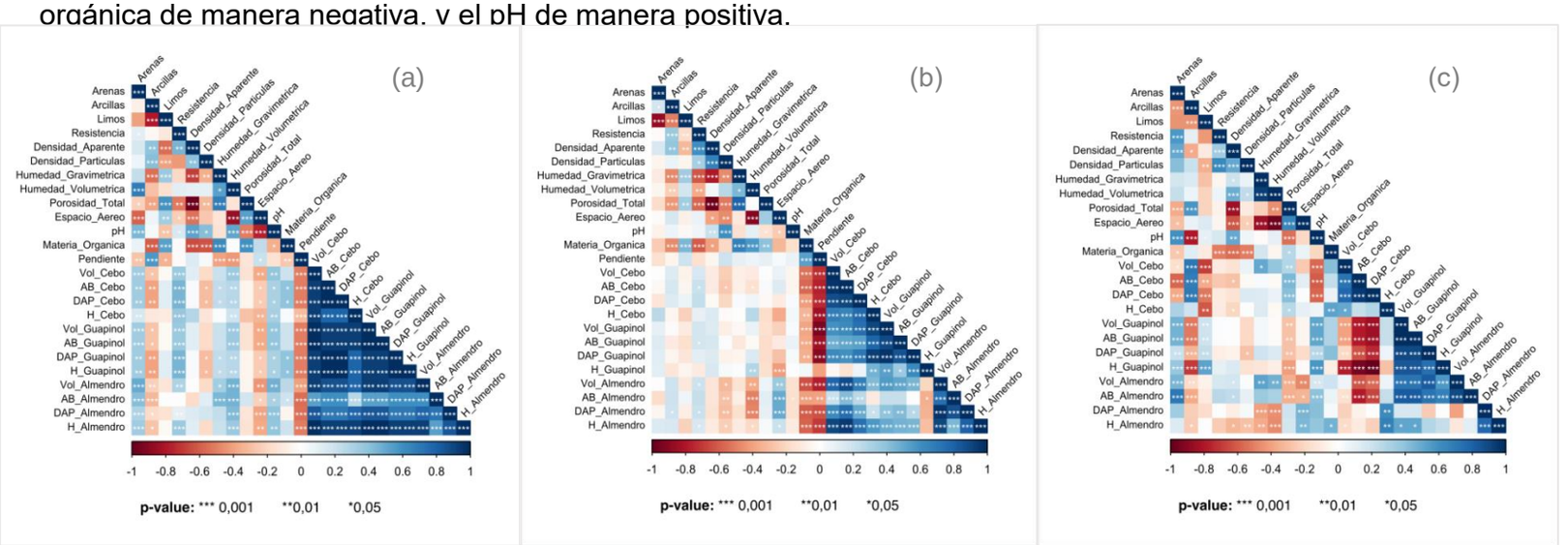
Introducción:
Las plantaciones mixtas forestales, entendidas como siembras forestales de diferentes especies con características funcionales y ecológicas distintas y en este caso, con especies nativas, se pueden analizar desde la perspectiva de gestión sostenible de recursos forestales y además como una estrategia de manejo de recursos naturales (Montagnini, 2005). La posibilidad de estudiar la variabilidad espacial del crecimiento de tres especies nativas en tres sitios diferentes de la Zona Norte de Costa RIca permite apreciar la influencia de las variables biogeofísicas en el desarrollo de las especies. Conocer este tipo de relaciones sirve como referencia para la toma de decisiones en cuanto a la selección de sitios apropiados para plantaciones.

El objetivo principal es analizar y explicar la relación de la variabilidad espacial representada por variables biogeofísicas (variables climáticas, topográficas y edáficas) con el crecimiento de las especies nativas Vochysia guatemalensis (cebo), Hymenaea courbaril L. (guapinol) y Dipteryx panamensis (almendro), como indicador de la aptitud natural de los sitios, en las fincas Las Delicias (Upala), San Ramón I y El Peje II (Sarapiquí).

Objetivos:
- Caracterizar las variables biogeofísicas y su espacialidad en las áreas de estudio.
- Identificar los requerimientos, distribución y estructura de las formaciones forestales incluidas en la investigación.
- Analizar la relación entre el crecimiento de las especies y las variables biogeofísicas por medio de un análisis estadístico.

Resultados y conclusiones:

Se encontró que la especie Vochysia guatemalensis tiene la mayor capacidad adaptativa a gran variedad de ambientas y suelos, seguida por la especie Hymenaea courbaril. Mientras que la especie Dipteryx panamensis presenta requerimientos más específicos que pueden llegar a ser limitantes. Por otra parte, la finca Las Delicias, es la que brinda mejores condiciones para las tres especies, particularmente para Dypterix panamensis y Hymeanaea courbaril. Las fincas El Peje II y San Ramón I presentan altas pendientes, a diferencia de la finca Las Delicias, este factor se reconoce como limitante para las especies Vochysia guatemalensis y Hymenaea courbaril. Además, en términos generales, las variables que se correlacionan con mayor fuerza y significancia con las características dasométricas de las tres especies de árboles son la pendiente y el porcentaje de materia orgánica de manera negativa, y el pH de manera positiva.



Coeficiente de correlación y nivel de significancia (p-value) para las variables de las fincas: (a) El Peje II, (b) San Ramón I y (c) Las Delicias. Tomado de Araya-Castro (2021).

Como principales criterios a considerar para el establecimiento de futuras plantaciones mixtas forestales de cebo, almendro y guapinol se deben considerar, sitios con pendiente de moderada a plana, suelos con pH de ácido a neutro, suelos con bajo contenido materia orgánica, y con un alto contenido de arenas en horizontes superficiales. Se debe considerar enfocarse principalmente en los requerimientos del almendro y el guapinol ya que estas dos se reconocen como las especies con más factores limitantes.

Por otra parte, Las plantaciones mixtas forestales se reconocen como un aporte significativo en términos de conectividad de paisaje, en restauración de ambientes degradados y adaptación al cambio climático, es por esto que se recomienda profundizar en sus aportes más específicos en estas temáticas, así como también en los aportes en términos de biodiversidad. Esto tomando en cuenta el impacto que se puede generar por estas plantaciones entendiendo todo su proceso con el fin de aprovechamiento de madera.

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8. Aportes de las geociencias en resolver problemas puestos en evidencia en la pandemia

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La pandemia del COVID19 puso en evidencia y exacerbó a nivel mundial especialmente en el Perú y otros países latinoamericanos, debilidades estructurales en salud, educación y condiciones de vida de la población mayoritaria. Por otro lado la corrupción marcó el retraso de solución a esta crisis sanitaria. Aquellos países con desarrollo de institucionalidad y manejo económico sostenible pudieron enfrentar con mayor eficacia a la pandemia.

Las recomendaciones básicas de lavado constante de manos, uso de mascarillas y distancia social resultaron poco consistentes en países con distribución tan desigual en recursos como el agua potable, seguridad alimentaria, salubridad, precariedad laboral generalizada, elevada desnutrición infantil, etc. Algunos países como Brasil y EEUU (periodo Trump) gestionaron la pandemia en forma política, sin basarse en la ciencia y evidencia, lo que incrementó innecesariamente la cantidad de muertes. El rápido desarrollo de vacunas y su aplicación significó un "parteaguas" para el control relativo de la pandemia.

Se considera que son tres aspectos básicos en los que las geociencias aportan en la resolución de estos problemas:

1) Aplicación de sistemas de información geográfica para la representación de datos sanitarios y el uso de metodologías de diseño de muestreos representativos que permitan adecuadas tomas de decisiones. Se obtienen mapas como en la figura 1 en la que se muestran los avances anuales de deforestación en el Perú (GEOBOSQUES, Minam.Gob.pe, 2022), lo que permitiría caracterizar áreas de deforestación definiendo sus posibles causas.

2) Desarrollo de estudios colaborativos entre científicos multidisciplinarios (geoquímica, ciencias agrícolas, ciencias ambientales, hidrología, antropología, etc.) sobre recursos hídricos y suelos en los que las geociencias tiene rica experiencia en técnicas de diseño de muestreo, aspectos analíticos e interpretación de datos.

3) Desarrollo conjunto de proyectos interdisciplinarios para la detección de metales pesados en productos agrícolas como el cacao (ver figura 2), la palta (aguacate) y sus posibles fuentes, técnicas de remediación y mejora de suelos.

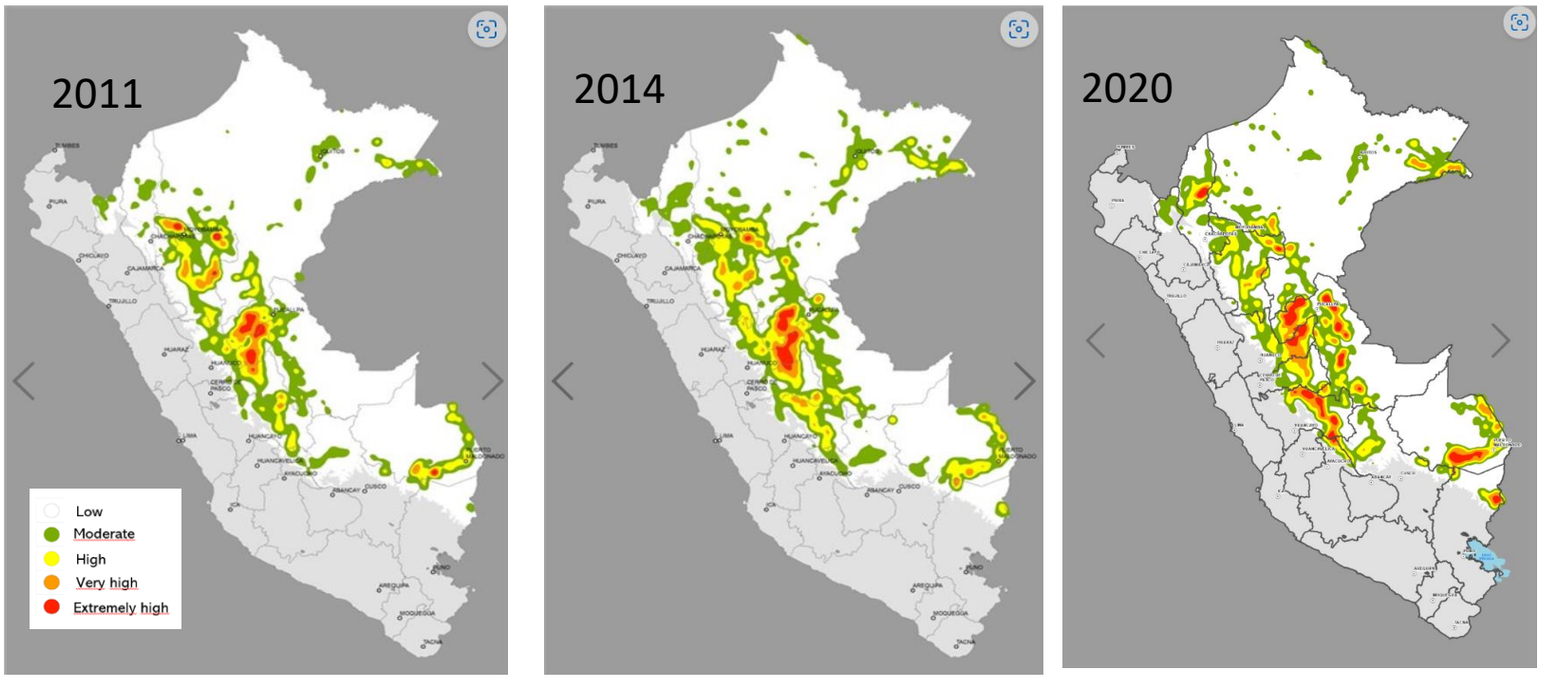

Figura 1: Mapas mostrando el avance de la deforestación en Amazonía peruana. Fuente: GEOBOSQUES-Minam.gob.pe

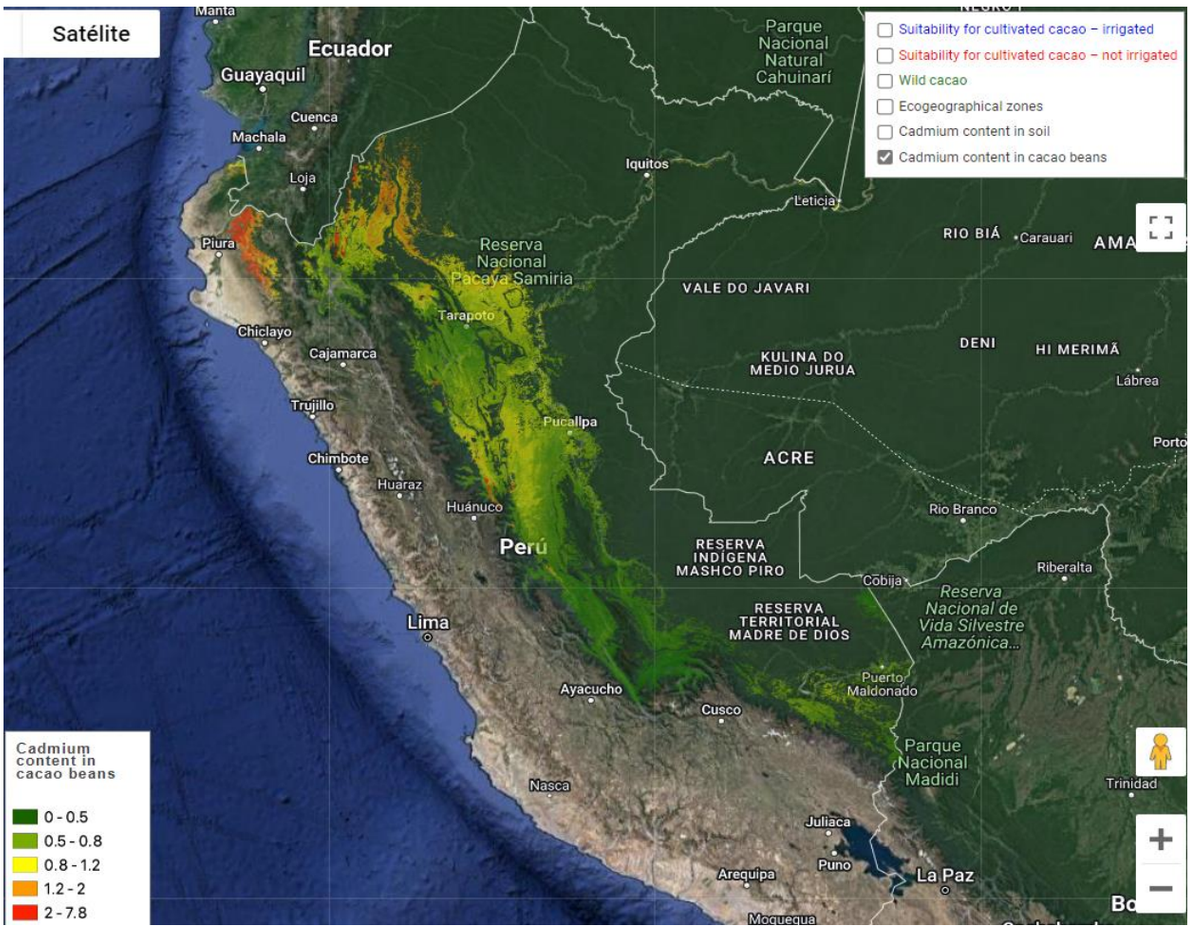

Figura 2: Cadmio en las pepas de cacao, Mapa elaborado por investigadores del INIA – CGIAR –Perú en base a 18,000 datos en campos de cultivo de cacao. Tomado de Cacaodiversity.org – CGIAR

9. Use of digital and georeferenced method in environmental impact mapping and projection. Example from marginal lagoons and veredas of the upper to middle São Francisco River Basin

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Introduction:
From the beginning of the 20th century took place an intense use of the natural resources of the São Francisco River Basin, like electricity production, fish creating, agriculture and heavy industry. The population multiplied in some years. All these economic important activities caused an immense and increasing impact on the river system.
Sediments deposited in equilibrium with watershed in marginal lagoons are good indicators of the natural and anthropogenic induced changes in a river system. The annual floods after rain periods inundate these lagoons and deposit an overall marker of the contamination situation of the intermediate period.

Location:
The study area is located in the surroundings of Pirapora city in the upper to middle course of São Francisco River, in the Northern part of Minas Gerais State (Figure 1).
Two of these marginal lagoons were selected for this study (Figure 1a).

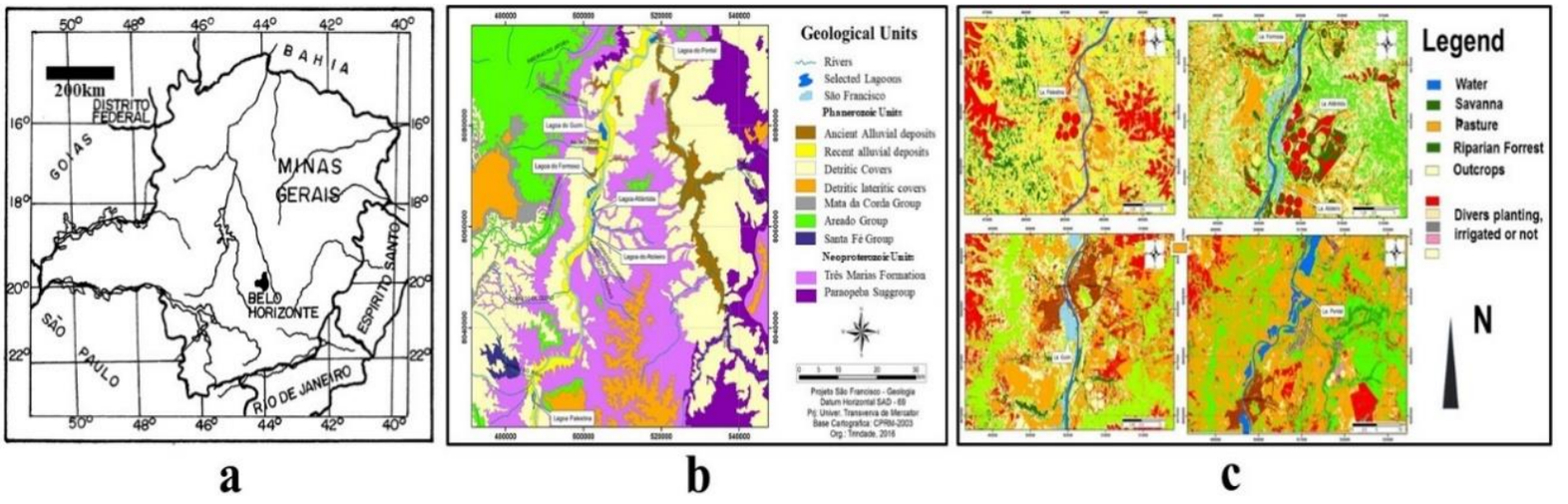

Figure 1: Location (a), geology situation (b) and land use (c) of the investigated marginal lagoons in the São Francisco River Basin, Minas Gerais, Brazil.

The study area is totally inserted in the Neoproterozoic Sanfranciscana basin, formed by Três Marias Formation of the Bambuí Group and covered by Mesozoic and Cenozoic sediments (Figure 1b). In the river plain mainly occur at the borders dystrophic alicos soils, in the form of alicic or fluvic neosoils, poorly developed eutrophic, and not discriminated planosols.
Semi deciduous seasonal- or permanent forests, savannas, pioneer formations, sometimes substitutes by anthropogenic forests and the agricultural systems can be observed.
Based on the Köppen classification, the climate is of Aw- type, tropical rainy, hot, humid with dry winter and rainy summer with an average temperature always higher than 18ºC.
The natural landscape has been greatly modified by the replacement of native vegetation, and the installation of industry in urban centers (Figure 1c).

Material and methods:
For the exact location and seasonal observations of the selected lagoons were used the principally information of satellites like CEBERS, Landsat 7/9 or SeNtinel. The lagoons were observed during wet and dry periods to obtain the maximum and minimum extensions of the water level and de duration of inundation. The data were treated with ENV, SNAP desktop, Q-Gis 324.3, Quantikov.
GPR profiles permit the observation of the sediment column in the lagoons, obtain their extension, some of their internal structures and the evolution in space over the lagoon extension. The investigation was done, using equipment Mala/Ramac with antennas of 100 MHz and the following parameters: common offset, horizontal steps: 0,1m; stacks: 8; time window: 400ns. All profiles were obtained perpendicular to the lagoon direction. The GPR profiles were processed using the program Gradix (DOS version), and the sections were plotted on EPS extension.
Samples were collected in boreholes along profiles oriented by GPR results, using a percussion-coring rig, which allowed the extraction of testimony with a good preservation of the sedimentary layers. The material was sealed in plastic bags and transported in coolers under low temperature conditions and the samples were stored at 40C until analyzed. The samples were dried at 120oC, sieved and the particle size fraction <0.164µm used for chemical analyses.
Analytical investigation of the selected elements (Cr; Ni; Cu; Zn; Cd; Pb; Co and As) were done by using FRX, ICP-OES. The fine sediment (<0.063 mm) was subjected to acid digestion in microwave MARS-CEM in accordance to the method SW-846-3051 – US EPA. About 0.50 g of fine fraction of the sediment was digested with 10 ml of concentrated nitric acid (HNO3) for 10 minutes (ramp time) and temperature stabilization at 180 ° C and pressure (350 psi) for 4 '30 "(hold time). Samples were then filtered in cellulose filter (0.45 µm) and analyzed by ICP-OES.

Results:
- All lagoons differ in sediment depth, related to location, water influx by flood periods and its morphological situation. The investigation reveals a chaotic change between deposition and erosion, caused flood events and contributions from torrential surface water transport, and after the construction of the Três Marias power plant, the granulometric distribution seems to be more homogeneous and of finer, denser material.
- The assessment of minerals and the grain size distribution in the sediment profiles indicate variations in river transport energy (sand, gravel - silt and clay), base rock erosion (Bambui Group; granitic-gneissic basement), and also intensity of agricultural activities and water level changes;
- The principal elements distribution is very similar and reflects the mineralogical composition. The presence of Fe_2O_3 indicates the oxidant environment of the transport system. The high TiO_2 tenor is related to the gneissic-granitic basement rich in rutile, anatase, titanite and titanomagnetite.
- The trace element distribution decreases with profile depth (deposition time). Zn show a correlation with the fine fraction and an increase with industrial activity and probably also with the intensification of foresting in the basin and the use of fungicides (e.g.: heavy elements) and the growth of the urban region along the margins.

Conclusions:

- The use of satellite sensor information permits the location of the lagoons and their inundation events, in time, greatness and duration for best sampling.
- The use of geophysical methods provides initial information about the sediment distribution, structuration and extension and permit to define the best places for core drilling.
- The application of x-ray diffraction, x-ray Fluorescence, ICP-OES together with grain size determination has proved to be a fast and effective technique in physical and chemical sediment characterization.
- Dating of the profiles permit the time allocation of sediment parameters to the environmental evolution and contamination events.

- The methodology, described and executed in the research seems to be a powerful tool for environmental activities to evaluating the environmental situation in a river basin by quantifying contaminants and correlating them to their respective sources.

Agreements: We thank DAAD, FAPEMIG and CAPES for financial and UFMG, UNIMONTES and industry and local farmers for logistic support.

10. The Retiro Baixo Lake at the Paraopeba River-MG. Environmental situation three years after the Brumadinho dam disaster

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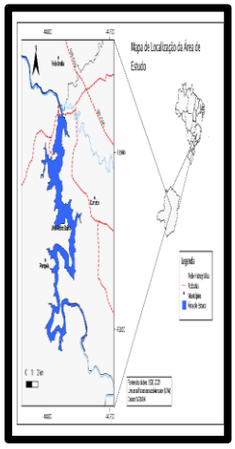
Introduction:

The human occupation of the San Francisco basin resulted in an increase of negative impacts. From the beginning of the 20th century, the intense use of natural resources of the São Francisco River, such as iron and gold mining, electricity production, fish farming, agriculture and heavy industry led to those negative impacts. The population multiplied in a relatively short time. All these major economic activities caused a massive negative impact in the river system. The natural and anthropogenic induced changes in the system are reflected in the bottom sediments.

In 2019, a rupture of the tailing dam at the Feijão Creek near Brumadinho-MG, a tributary of the Paraopeba River occurred. It was a major environmental disaster, which led to the direct death of approximately 295 persons and dumped large amounts of iron ore tailings in the Paraopeba River. Located 383 km from the site on the Paraopeba River, the Retiro Baixo Lake was temporarily shut down to prevent a possible flow of these sediments into the São Francisco River. This research aims at investigating, quantifying, and evaluating the concentration of chemical elements, and physical-chemical parameters of the water and sediments three years later.

Location and Results:

Water and sediment parameters and chemical data before, during and after the disaster. The mud avalanche coursed a movement of older river sediments and consequently an increase of their compounds. Only Fe, Al and Mn were significantly higher by direct influx. Data from CPRM (Brazil Geological Service), UFRJ (Federal University Rio de Janeiro) and own observations.



Lake water

	Mg	Al	Ca	K	Na	Cr	Fe	Co	Cu	Cd	Ti	Mn	Ni	Zn	Ba	Pb
2022	1.740	0.008	3.085	nd	nd	<0.013	0.003	<0.003	0.002	<0.001	<0.004	<0.005	<0.006	<0.001	<0.002	<0.002
2019	1.749	0.102	5.997	2.15	7.28	<DL	0.120	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.016	<0.002
1991	nd	1.540	nd	1.40	7.60	<0.013	<DL	<0.003	<0.002	<DL	<DL	<DL	<DL	0.040	<DL	<DL

	T°C	pH	ORP (mV)	EC (µS/cm)	TDS (ppt)	Sal (PSU)	DO (ppm)
2022	27.1	7.7	130.4	200	0.01	0.010	1.36
2019	27.9	nd	130.4	192	nd	0.093	7.50
1991	26,5	5.5	nd	nd	nd	nd	nd

Lake sediment

	Mg	Al	Ca	Fe	K	Na	Cr	Co	Cu	Hg	Cd	Ti	Mn	Ni	Zn	Ba	Pb
2022	0.01	0.528	0.019	0.52	nd	nd	0.76	0.58	10.12	nd	21.02	37.2	3.084	7.06	1.51	31.6	15.89
2019	0.03	0.515	0.03	1.74	0.05	0.005	30.5	6.85	7.3	0.02	0.03	900	459	3.35	23.5	31.5	8.7
1991	0.05	1.300	0.04	3.11	0.08	0.005	84.0	8.80	124.0	0.03	1.41	400	351	12.60	127.0	51.0	90.0

Map of the Paraopeba River Subbasin, indicating the investigated lake and the disaster location.

Water: 1. The chemical composition of water samples is very similar to pre-event values. 2. The large amount of "aguapé" (Eichhornia crassipes) indicates the presence of organic materials like phosphates, nitrates, detergents, phenols, heavy metals, etc. dangerously leading to eutrophication. 3. The concentration of the selected elements and physical-chemical parameters "in situ" are nearly all within current legislation.

Sediments: 1. The mineral composition of the sediment samples is compatible with the geological units crossed by the river and its tributaries. 2. The main elements, specifically Fe and Mn are high due to the oxidized environment in the lake and the mineral transported from the Fe-quarries located upstream in the basin. 3. Al and Si are compatible with the main composition of the rocks of the Bambuí Group and units of the iron quadrangle. 4. The selected trace elements indicate a contribution by industrial and mining activities, and contributions from agriculture and forestry.

Conclusion:
1. Considering the investigation results at the Bom Retiro Lake, in the Paraopeba River Basin, the conclusion is that the event shows no more influence over the water composition in the current situation. The pollution is like that before the dam breaking and it may be caused by the anthropogenic activities upstream. After an initial increase of metals, turbidity and pH influenced by the mechanical disturbance of older river sediments and an increase of Fe and Mn from the slum, the conditions returned to the pre-event levels.
2. The concentration and physical-chemical parameters are within the permitted range.
3. The sediments still show high Fe, Mn and Al and trace element concentrations which may be related to the release of material from quarries and mining places.
From the study of samples taken from the bottom, it is not possible to determine the exact sources and the time it happened. For a more accurate evaluation it is necessary to obtain core samples and execute segmental analyses with profile dating.

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11. Self-Supervised Learning for seismic image segmentation from few-labeled samples

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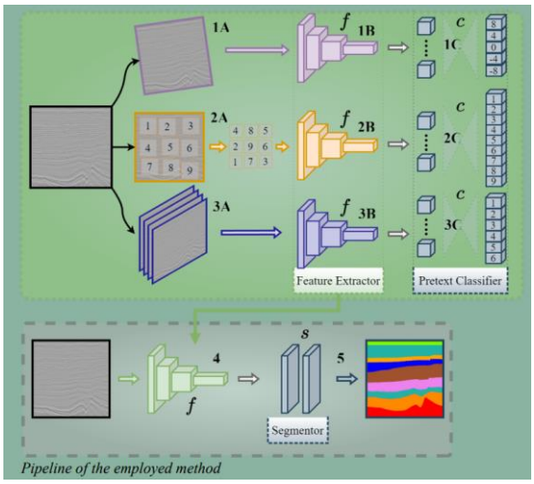
Abstract:
Current deep learning methods for interpreting seismic images require large amounts of labeled data, and due to strategic and economic interests, these data are not plenty available. In this scenario, seismic interpretation can benefit from self-supervised learning (SSL) by relying on prior training without manually annotated labels within the target data domain and subsequent fine-tuning with few shots. To demonstrate the potential of such an approach, we conducted experiments with three classic context-based pretext tasks: rotation, jigsaw, and frame order prediction. Our results for 1, 5, 10, and 20 shots showed significant improvement for mean Intersectionover-Union (mIoU) measurements for semantic segmentation in most scenarios, outperforming the baseline method in 38% in the one-shot scenario for the F3 Netherlands Dataset and 16.4% in the New Zealand Parihaka dataset, and this gap grows even higher after performing ensemble modeling. These experiments suggest that applying SSL methods can also bring great benefits in seismic interpretation when few labeled data are available.

Key words:
Convolutional neural network (CNN), seismic image, self-supervised learning (SSL), semantic segmentation.

Introduction:
The identification of different stratigraphic facies allows the distinction between distinct geological groups, essential to the comprehension of basins tectonics, hydrocarbon migration, and imprisonment. The tridimensional acquisition of seismic data results in vast amounts of data, making the manual interpretation of the seismic sections or volumes slow and biased. Semantic segmentation has an important role in image understanding and has a plethora of applications in traditional visual recognition tasks. As manual labeling for segmentation is a slow, expensive, and biased process, self-supervised learning (SSL) methods are proposed as an alternative for representation learning.

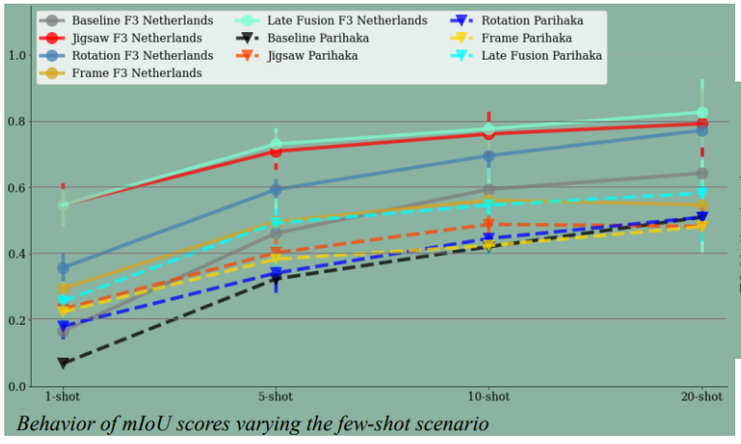
Objectives
Design and evaluate pretext tasks for seismic images based on classical image processing techniques and pre-train models within the same data domain as the final task.
Fine-tune pre-trained models to segment lithostratigraphic facies.
Perform ensemble techniques to enhance segmentation predictions

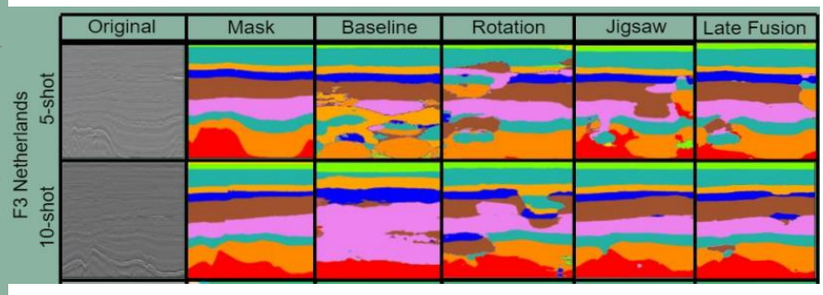
Proposed Approach and Experiments



1) Training the network to predict the rotation performed in the input image:
(1A) we rotated the image at a modest angle;
(1B) passed it into the convolutional network alongside its rotation label;
(1C) a fully connected classifier head tries to predict which of the applied rotation in the original image.
2) The second is a jigsaw puzzle:
(2A) we crop the original image into nine tiles and permute them;
(2B) these crops are used as input to the convolutional backbone;
(2C) then fed to a fully connected classifier that tries to retrieve the original position of each given tile.
3) The third is the frame order prediction: first, provide six key positions;
(3A) randomly picks a set of the crossline sections;
(3B) passes them through the convolutional backbone;
(3C) provides the latent space as input to a classifier that predicts the key that is closer to each section.
(4) Leverages the extracted features from f in the fine-tuning stage
(5) Replace the pretext classifier c with a randomly initialized segmentor s. The key idea of the self-supervised learning pretext task consists of pretraining the backbone f on the same data domain of the final task.

Results





Conclusions and Future Works

Considering the characteristics of seismic images, we applied three classical SSL techniques, rotation prediction, jigsaw puzzling, and frame order prediction, to enhance the semantic segmentation of lithostratigraphic facies on two open seismic datasets. The obtained mIoU scores are significantly better than random initialization, reinforcing that pretrained models can be an alternative when not many labels are available. Our results suggest that the usage of adequate self-supervised pretext tasks can benefit the final model in a few-shot scenario, and that employing ensemble methods can provide more robustness for seismic segmentation. To the best of our knowledge, this is the first work on fusing SSL methods to enhance segmentation performances on seismic images. Furthermore, we intend to investigate the use of state-of-the-art contrastive learning techniques as an alternative to manually factored pretexts, as well as methods for measuring and reducing uncertainty.

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12. The Social License to Operate – a way to link sustainable development and the extraction of non-renewable resources?

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The idea of sustainable development emerged in the 1980s as a political concept to express that the development path of the industrialized countries is no more sustainable regarding the limited resources of the earth. Sustainable development advocates a development path that simultaneously combines economic, social and ecological aspects in such a way that current development does not impair the development opportunities of future generations. Since its first public mention in the Brundtland Report (Brundtland 1987), sustainable development has become the dominant development policy discourse at the international level.
The mining sector has also not been able to ignore this new discourse. Since the 1990s, there have been a number of initiatives trying to convince companies to adopt to the new development thinking (Nouri Qarahasanlou et al. 2022; Malan 2021; Moran et al 2014).

The concept of the Social License to Operate (SLO) can be counted among these efforts. Its origins go back to a presentation of Jim Cooney, himself an employee of Placer Dome, at a World Bank workshop on the future of the mining industry. Cooney identified two major challenges. First, companies must meet the growing regulatory demands of national governments, and second, they must be able to build and maintain a lasting and positive relationship with the communities in which they conduct their operations (Heffron et al. 2021).

While SLO could still be seen as an idea "invented by business for business" in the early 2000s, from the 2010s onwards the loss of industry's interpretative authority over the concept became increasingly clear. There were a shift from an industrial-controlled approach to manage risk to an instrument for communities to contest weak regulatory regimes and environmentally damaging resource extraction projects (Brueckner and Eabrasu 2018; Mather and Fanning 2019).

This shift reflects a fundamental problem of SLO. There is no generally valid definition of SLO; it is an open concept whose semantic formulation follows the interests of the stakeholders. There are problems of demarcation from other concepts such as corporate social responsibility (CSR), social impact assessment or stakeholder engagement. The general consensus is limited to the fact that it is about a relationship between companies and communities, and that SLO should serve the social acceptance of mining activities (Parsons et al. 2014)

This minimal consensus opens up possibilities for conflict regarding the content of the SLO, and its legal nature, function, stakeholders and objectives.

In the following, two aspects will be addressed: the possibilities for its legal fixation and the normative character of the SLO.

To be effective, SLOs must be given an adequate legal form. They must be binding, and companies must be held accountable if they fail to fulfil their commitments. This legal form must be independent of other legal obligations derived from mining and environmental legislation. (Heffron et al. 2021)

Possible forms are community development agreements (CDAs), or memoranda of understanding (MOUs) between local governments and mining companies. CDAs can be bilateral (investor, community) or trilateral (investor, community, state). Particular attention must be paid to implementation, management and the legal nature of the contract.

With an MOU a mining operation will be subject to local regulations through contractual mechanism even if the local government do not have jurisdiction to legislate. In most cases a MOU leads to an improvement of the community's trust of the local government.

A challenge for the preparation of CDAs is the long-lasting lifespan of mining projects. Over time, unpredictable events may occur, and community desires, values and priorities may change. It is also difficult to adequately take into account the wishes of future generations in an agreement. As a way to address these issues, a monitoring programme to ensure ongoing engagement with the local community and stakeholders is recommended. In addition, the validity of CDAs should be limited in time. In the binding renegotiations, changed wishes and priorities can then be taken into account.

Like all designs for social development, a SLO needs a normative grounding that clearly defines which development goals are to be implemented and which social groups will be affected how and by what. Ideally, these visions of the future already exist before a discussion on SLO. This makes it easier to assess the impact of a mining project in terms of its compatibility with local or regional development projects. Public welfare is thus constituted as a normative basis to which SLOs must conform, by this way subjecting a SLO to the same normative basis as the political licence and the actuarial licence.

The definition of a normative basis resolves the functional orientation of an SLO, but does not prevent conflicts in its concrete formulation, because public welfare is not a fixed principle, but the result of political conflicts that are power-based.

Some of these conflicts will be described below.

Any development design must define its spatial, social and temporal reference. In other words, specify where, what and how is to be changed. In the case of a SLO, this demarcation is by no means trivial. Many conflicts have their origin in the fact that there is no consensus on which stakeholders and thus which interests and demands can legitimately participate in the elaboration of a SLO. To what extent is it legitimate and necessary to include the interests of actors outside the region in which the extraction project is anchored?

SLO is often interpreted as an instrument to strengthen the interests of the stakeholders of a mining project. Its importance is particularly emphasised for regions where corrupt state elites or a non-functioning legal system cannot or will not impose effective regulation on the often multinationally operating companies. However, this line of argument overestimates the function and effectiveness of a SLO. Political and legal structures that are unable or unwilling to enforce effective regulation of mining companies offer little possibility of being called upon to make an impartial decision in the event of a conflict between the groups involved in a SLO. One way to overcome this obstacle would be to have internationally binding negotiated norms and rules on SLOs and to create global organisations that can act as arbitrators in case of conflict.

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13. Transición energética: Producción de h2 en Paraguay bajo criterios de sostenibilidad Ambiental

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Abstract
Research conducted in Paraguay on the potential for the production of green hydrogen, its use as an energy vector in an important segment such as transportation and the feasibility of exporting it, has led to the understanding that its inclusion would contribute to the sustainable development of the energy sector, while contributing to the process of decarbonization and climate change mitigation, in line with the Sustainable Development Goals. The availability of water, about 63 m³/inhabitant /year, is an advantage to the surplus of electricity from renewable sources (100%). The combination of these qualities and the potential for electricity generation from solar and photovoltaic energy makes the country very attractive for H2 production.
The text tries to show the availability of water and energy resources for the production of green hydrogen under sustainability criteria for its use and commercialization at national and international level.

Key words: Energy transition, Green Hydrogen Potential, Environmental Sustainability, Decarbonization

Introducción
La inclusión del hidrógeno verde como vector energético en Paraguay representa un avance importante del desarrollo sostenible del sector debido a que colabora en el proceso de descarbonización y mitigacion al cambio climático en consonancia con los compromisos asumido por el país en el acuerdo de Paris.
La disponibilidad de agua en el territorio es abundante y, actualmente la disponibilidad es de cerca de 63 m³/hab/año. Adicional a esta riqueza hídrica, el Paraguay cuenta con excedentes de energía eléctrica, todos ellos de fuentes renovables (100 %). La combinación de estas cualidades y el potencial para la generación de energía eléctrica a partir de energía solar y fotovoltaica hace del país muy atractivo para la producción de H2.
El uso a nivel nacional del Hidrogeno verde producido bajo criterio de sostenibilidad ambiental, permitirá además de fortalecer la soberanía energética, reducir el consumo de combustibles fósiles a nivel local y, convertir al Paraguay en un país exportador en el contexto muy actual de la transición energética a nivel global. La localización de Paraguay en el contexto geográfico, en el centro de Sudamérica, permite mirar al país como un potencial para un HUB logístico en la región y de fuente de energía removable.

Potencial de hidrógeno del Paraguay
El Paraguay tiene un potencial importante para la producción de hidrogeno verde aprecios competitivos de alrededor de 2,2 Usd/Kg H2 obtenido vía electrolisis del agua utilizando la electricidad de los grandes excedentes en territorios competitivos y con precios competitivos.
El país esta en condiciones de desarrollar emprendimientos para la producción de hidrogeno electrolítico sin comprometer el balance de energía eléctrica. Esta oportunidad contribuirá a asegurar la economía energética nacional e iniciar la descarbonización del sector transporte y de esa manera permitir la transición energética en la movilidad terrestre marítima y aérea. La disponibilidad de electricidad en territorio fuera del punto de carga (entre las 9 p.m – 5 a.m) puede ser almacenada en celdas a combustible, lo cual contribuiría en los servicios auxiliares en los sistemas eléctricos.

El mercado de hidrogeno en Paraguay apunta a las industrias que utilizan el H2 como materia para la elaboración de urea fertilizante y el metanol (Galeano 2013). En la Tabla 1 Mercado de Hidrogeno en el Paraguay en el periodo 2005-2011 se aprecia los movimientos de derivados del hidrogeno en el Paraguay.

Mercado de Hidrogeno en el Paraguay en el periodo 2005-2011 (Ton/Año).
Fuente: Modificado de Mercado de Hidrogeno en Paraguay

Año	Amoniaco	Metanol	H_2O_2	Hidrogeno	Urea	HNO_3
2005	31,41	68,50	42,34	0,510	438,94	8,16
2006	42,18	150,02	42,40	1,049	641,01	8,73
2007	45,00	200,22	47,57	0,000	977,04	8,49
2008	37,24	186,75	41,75	0,179	933,77	10,02
2009	**46,42**	**414,36**	**50,80**	**0,141**	**1054,53**	**13,40**
2010	**64,42**	**315,66**	**78,09**	**0,196**	**1233,59**	**11,30**
2011	**79,77**	**123,53**	**57,80**	**0,636**	**1679,73**	**20,03**

Actualmente las industrias cuyas demandas de altas temperaturas son los destinos más importantes de las leñas. Prospectiva energética del Paraguay (Itaipu Binacional, Fundación Parque Tecnológicos Itaipu y Fundación Bariloche 2015). Según (IEH 2019) en las industrias de altas temperaturas el hidrogeno tiene utilidad, de manera que su utilización de reforzaría el manejo sostenible de los bosques en Paraguay.

La matriz energética esta dada por una alta participación de derivados del petróleo (41%) en el consumo fluvial energético por lo que la inserción del hidrogeno verde en la matriz energética nacional, tendría un alto impacto (positivo) en el sector de transporte. Se prevé la reducción en un 20% el consumo de combustibles derivados del petróleo para el 2030, escenario que se lograría con el hidrogeno como vector energético a través de una producción cercana a los 90 mil toneladas de H2 para el año señalado. La reducción de emisiones bajo estas condiciones esta de aproximadamente 1,3 millones de toneladas de CO2 provenientes del sector transporte principalmente.

Conclusiones

- La manera más asequible de producir hidrogeno verde en Paraguay es atraves del método de electrolisis aprovechando la abundancia de agua y de energías renovables que cuenta el país.
- Las condiciones hidro – energéticas presentes en el Paraguay lo sitúa como uno de los países con mayor potencial de producción y utilización de hidrogeno verde en la región.
- La inserción del hidrogeno como vector energético para el sector transporte posibilitaría la reducción de la importación de derivados de combustibles fósiles y la reducción de emisiones de CO2 en el contexto de la transición energética.
- El país por su condición agrícola es un gran consumidor de fertilizantes lo cual significa que con una combinación de Hidrogeno y Nitrógeno para producir urea sería capaz de abastecer el mercado local y exportar a los países vecinos.

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14. UAV hyperspectral and magnetic surveys for mineral exploration

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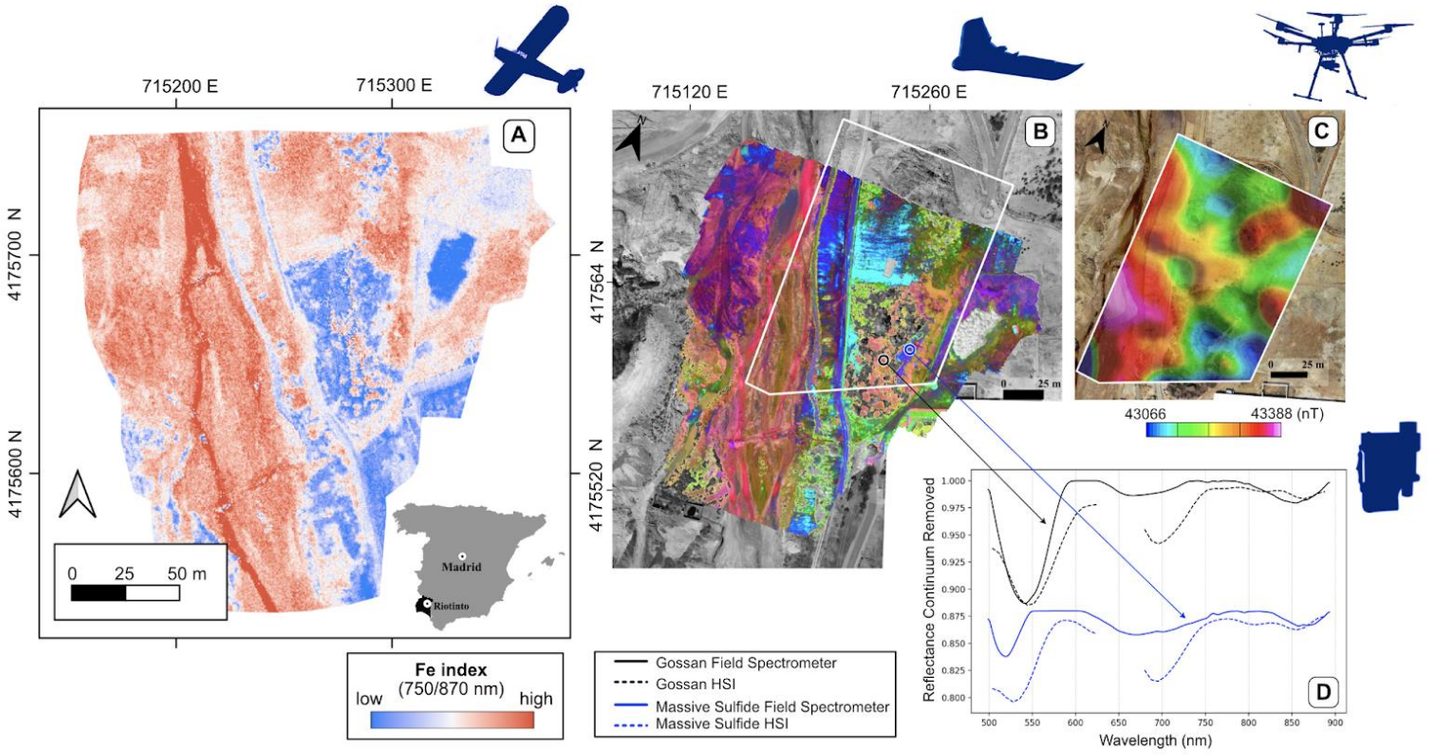
Abstract:
Geophysical methods for mineral exploration require cost- and time-effective procedures to acquire high-resolution data to supplement field mapping. We propose the combination of hyperspectral data and aeromagnetic surveys from uncrewed aerial vehicles (UAV) to provide a rapid and cost-effective technology improving the detection of shallow targets and delineating mineral structures in potentially hazardous conditions where traditional techniques cannot be safely operated. We present a case study using two commercially available UAVs by means of structure-from-motion (SfM) photogrammetry, Visible-near infrared (VNIR) hyperspectral imaging (HSI) and aeromagnetic techniques. We attempt to demonstrate that the spectral information from the UAV HSI can be used to distinguish mineralogical associations while UAV magnetic data can delineate structural features of interest and provide additional information of the subsurface. To test the potential of our approach we selected as study site one of the EU Horizon 2020 INFACT project (Innovative, Non-invasive and Fully Acceptable Exploration Technologies) reference sites, that offers active mining conditions in Riotinto, Spain. Based on the results, the hyperspectral data allowed to discriminate among similar materials of iron-bearing facies due to the characteristic spectra in the VNIR spectral range. While the UAV magnetic survey showed east- west lateral variations associated with NW-SE faults systems.

Key words:
Uncrewed aerial vehicles, hyperspectral data, magnetic surveys, fluxgate magnetometers, airborne surveying.

Data acquisition and processing:
The presented site is situated in Nerva, Spain, adjacent to the famous Riotinto deposit within the Spanish Iberian Pyrite Belt (IPB) widely recognized for containing the largest volcanogenic massive sulphide deposits on Earth. Our research area contains a gossanous ridge with cross-cutting NW-SE trending strike-slip faults. For a high resolution photogrammetric model we mounted a Canon PowerShot S110 RGB camera on a fixed-wing platform eBee SenseFly. We conducted a UAV hyperspectral survey using the Senop Rikola Hyperspectral imager on a DJI M600Pro multi-copter. The Rikola is a hyperspectral snapshot-camera with a spectral resolution up to 50 bands within the spectral range of 504 to 900 nm (VNIR). We placed four PVC panels with known spectra in the scene to make the conversion to reflectance. Field validation spectra is acquired in-situ using a portable spectro-radiometer Spectral Evolution PSR-3500, from 350 to 2500 nm, Furthermore, airborne hyperspectral data was acquired using the Specim Asia Fenix sensor with 450 bands in the spectral range from 400 to 2500 nm (Fig. A).

To process the UAV hyperspectral dataset we geometrically rectified the data using an automated keypoint detection and matching workflow (Jakob et al., 2017). For a high-resolution 2D orthophoto the VNIR mosaic is masked using a Normalized Difference Vegetation Index. Subsequently, a Principal Component Analysis (PCA) is applied to evaluate the variance of the data and to obtain an initial estimation of the mineralogical differentiation. Fig. B shows the PCA containing 96% of the spectral variance. The band ratio (511.9 / 751.9 nm) highlights subtle spectral characteristics differentiating between gossan, massive sulfides, altered shales, and the water of the Rio Tinto river. For validation we used the airborne survey (Fig. A) and the in situ measurements from the portable spectro-radiometer (Fig. D).



Figures A, B, C and D. Hyperspectral and magnetic data from Nerva, Spain. (A) Band ratio of 750/870 nm from airborne data (2020), a proxy for iron (hydr-)oxides, shows high values in the Rio Tinto river bed and on the eastern side of a gossaneous ridge. (B) Vegetation-masked color composite of the first 3 principal components from UAV-borne hyperspectral data (2019) superimposed on the photogrammetry model with the location of two spectral validation points (D) Comparison of the image (dotted line) and field (continuous line) spectra. Gossan and chalcopyrite were identified and compared against the USGS spectral library. (C) Total magnetic field map.

To compute a total magnetic intensity (TMI) map of the area a UAV aeromagnetic survey is conducted using a Sensys MagDrone R3 magnetometer mounted on the multi-copter DJI Matrice 600. The survey was flown perpendicular to the strike of the regional geology at a constant speed of 5 m/s, a nominal height of 25 m and a line-spacing of 12 m. A base station was set up to account for temporal variations and a calibration figure was performed to address manoeuvring errors. Successive magnetic compensations are aplied and a TMI map (Fig. C) is generated using a minimum curvature gridding algorithm to interpret structural features in the area.

Conclusions:

As illustrated, UAV hyperspectral surveys represent an important source of geological information for mineral exploration with many advantages over traditional methods. HSI allows discriminating similar materials of iron-bearing facies due to the characteristic spectral shapes in the VNIR spectral range. We tested the potential of UAVs equipped with lightweight magnetometers to operate closer to the ground and to improve the identification of magnetic sources with a high-frequency content. UAV magnetic surveys provide high-resolution constraints about the distribution of magnetic materials at the surface and below.

References:

Jakob, S., Zimmermann, R. and Gloaguen, R. (2017). The need for accurate geometric and radiometric corrections of drone-borne hyperspectral data for mineral exploration: MEPHySTo – a toolbox for pre-processing drone-borne hyperspectral data. Remote Sensing, 9(1): article 88, 1-17. DOI: https://doi.org/ 10.3390/rs9010088.

15. Book Review: A Climber's Guide to El Potrero Chico, edited by Frank Madden, 2022, hardcover with color illustrations, 400 pp. ISBN-13: 979-8-218-02431-4.

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Researcher and Extension Specialist in Science, Monterrey, Nuevo León, México.
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This well-structured text about thirty-nine climbing crags was regarded so highly by the climber community since the first edition (2017) that it needed further updated reprints. The genesis of this new book required far more than the ideas of the authors alone. The original impetus was the invitation to [re]organize the guide and add descriptions about the nature of mountains in the climbing zones. The broad public interest in Earth and understanding the formation of mountains were reasons to collaborate in this new release (i.e., Garlick, 2009).

As a consequence of the updating of the previous edition, the chapters are now five; each is divided into numerous individual routes nicely explained. The contents are in layouts that make searching for information more intuitive and properly acknowledge other climbers' contributions. The fact that many of the illustrations are in color greatly enhances the usefulness of the guidebook compared to its digital version. For complete up to date information, go to the following website and download the app:
https://rakkup.com/guidebooks/el-potrero-chico-rock-climbing/

Praise for the third edition that is greatly updated. The book has no equal and is easily the best guide of its type on climbing localities referring to El Potrero Garcia, La Popa, and closed-down quarries, not only in El Potrero Chico (EPC). Besides the friendly indications about the enigmatic sierras de San Miguel and del Fraile, the author suggests the visitor some amenities and local places to sort daily basic human needs making their stay comfortable.

A chapter in *Geology and Rock Climbing* is new. The book is of extreme value to anyone climbing or exploring the rock formations in northeastern Mexico, north to the curvature of Sierra Madre Oriental near Monterrey City (Figure 1). The Sierra del Fraile and Sierra de San Miguel in Nuevo León are natural protected areas by the State. This site holds significance for understanding and reaching the enigmatic geometries on the landscape. Its natural geological heritage receives attention from local and foreign communities. As a result of academic and recreational expeditions, field interpretations of the mountains and basins in northeastern Mexico beginning in the final years of the Twentieth Century have contributed the El Potrero Chico to emerge as a world-class locality for geologists and rock climbers.

Latitude (Y) 25.935233° ” North ; Longitude (X) -100.478589° ” West

The mountains in EPC correlate to the deformation of the Cretaceous-Paleogene Mexican fold and thrust belt. The mountain formation resulted from the shortening of strata on a salt substrate, with a contrasting geologic history of salt diapirism with salt-detached fold and thrust tectonics (Lawton et al., 2021).

There are numerous high-quality printed topo maps, geologic sections, time scales, and charts for the most prominent features of the rocky landscape (Figure 2). These infographics are worth a thousand words describing geologic processes to the reader. The regional and local examples of rocks forming the climbing crags in EPC make this book even more valuable to outdoor enthusiasts; however, its target audience is variable and extensive. This information is also oriented to stimulate the awareness of visitors to protect the natural heritage and take caution of the geologic hazards in the surroundings.

This chapter alone proves the book is easily worth it to mountaineers. No serious geologist or climber who wants to integrate their roles can fail to have this copy on his\her bookshelf. The book is very tastefully done, printed in a format for a practical purpose; it has durable pages, typed with large font size for easy reading and carrying it on the backpack.

The rising worldwide awareness for exploring or climbing fold and thrust belts ensures that this region in EPC will continue to be important in studying geology and mastering ascents in mountaineering.

Acknowledgments

The reviewer is most grateful to Frank Madden for his confidence and support through the Geology and Rock Climbing project.

Figures

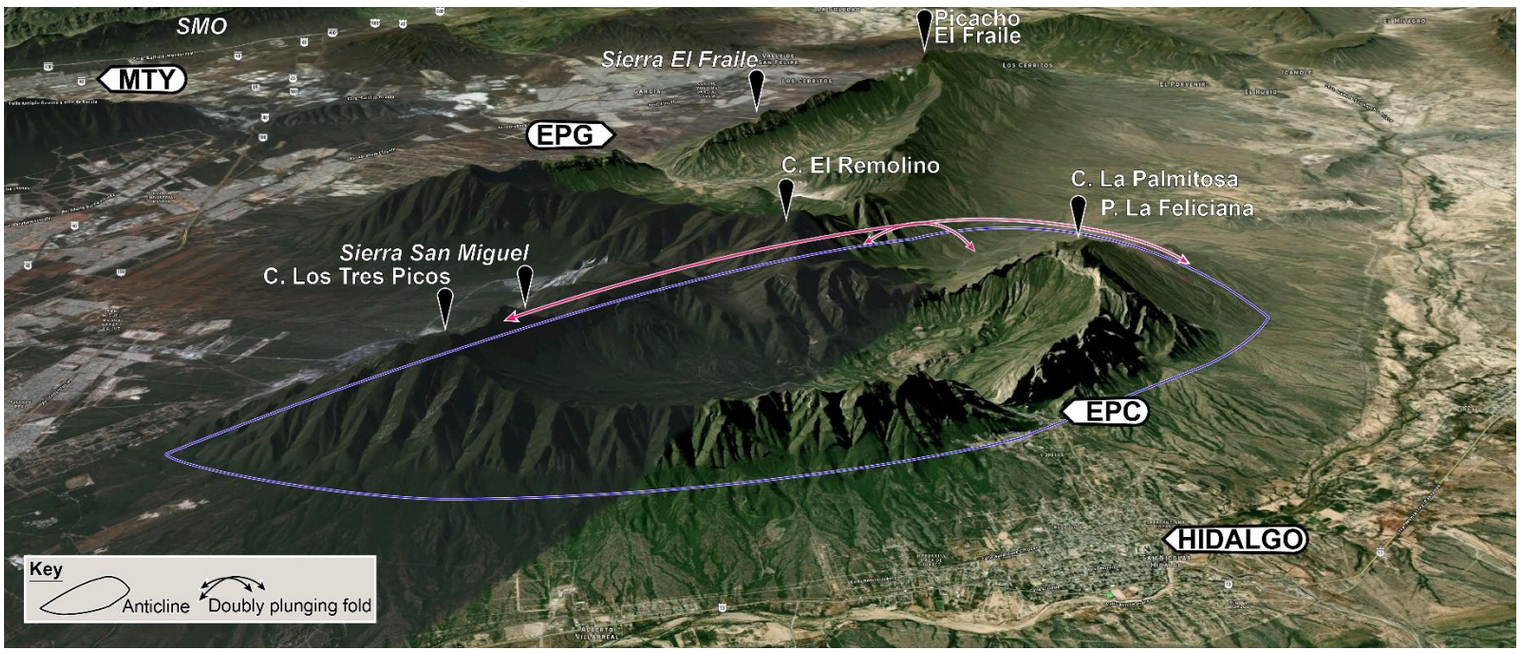

Figure 1. Aerial perspective for Hidalgo, Nuevo Leon, north of Monterrey (MTY) and Sierra Madre Oriental (SMO). Tags indicate names for pertinent elevations in the Sierra de San Miguel and Sierra del Fraile with their potreros, El Potrero Chico (EPC) and El Potrero Garcia (EPG), respectively. Pen lines indicate anticline extents and doubly plunging fold structure. C- cerro, P- pico, A- arroyo. Apple Maps is used for reference and tags are retrieved from Instituto Nacional de Estadística, Geografía e Informática (INEGI).

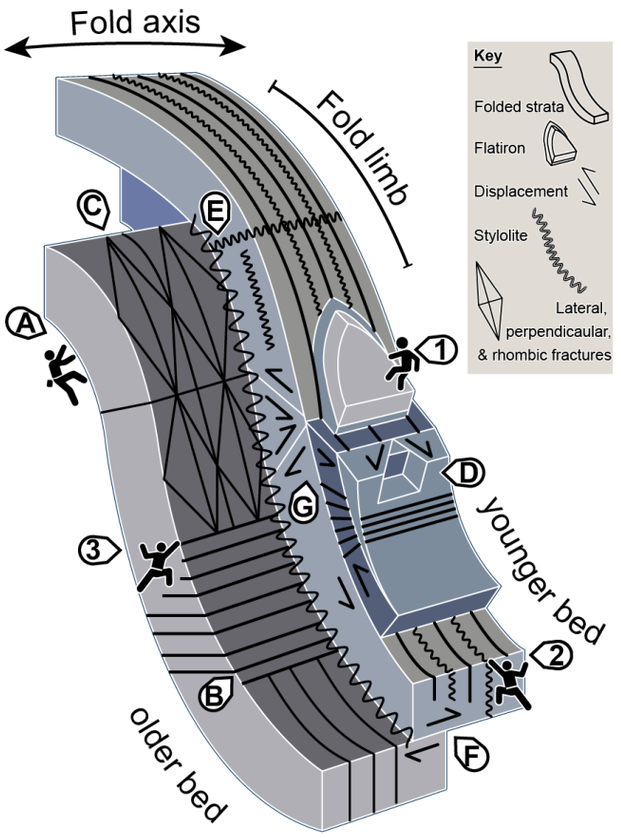

Figure 2. Infographic for basic faces of the rock to climb and structural features in a fold: 1- Bedding plane or over flatirons' surface; 2- Lateral to bedding plane; 3- Perpendicular to the bedding plane. Some structural features of the fold structure: A- Overhanging wall bedding plane (opposite to climbing face 1); B- Lateral fractures and foliation; C- Oblique fractures and joints perpendicular to fold axis; D- Wedges and plane failure from fractures, joints, and faults with slickensides; E- Bedding and Tectonic stylolites or dihedrals; F- Lateral displacements; G- Thrusting displacements. Younger bedding planes over older strata illustrate superposition. Interpretation modified from Chavez et al., 2004.

About the Author

Frank M. started climbing in 2010 when he stumbled across some climbers who introduced him to rock climbing. Based in the Red River Gorge, since August 2014, he started the project of a pocket guide for Potrero Chico and its surroundings. He is an active community member, demonstrating recursive support for nature, maintaining the crags, and documenting the development of climbing routes in each new edition of the guidebook. He is committed to the life of natural surroundings and outdoor sports.

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16. GOAL's new members

Bruno Monteiro

I graduated in Geology from the Federal University of Minas Gerais (UFMG) in 2019, always with great interest in computer science, data science, and machine learning. Now, as a master's student in computer science (UFMG) I've been researching methods for the automatic interpretation of seismic data using deep learning and self-supervised learning techniques. Meanwhile, I've been working in consulting and formation in data science for mining companies in Brazil. Recently I've been employed by the UFMG as a Research Geologist as a part of the team for the Research and Development with PETROBRAS in the project GODeep (Geoscience Oriented Deep Learning).

Ana María Araya Castro

I graduated in Geography from the University of Costa Rica I did my final graduation project on forestry soils, studying the relationship between tree growth on mixed forest plantations and the physical properties of soil. Part of my research process was along the German company BaumInvest, and thanks to this, I did a research internship in Freiburg, Germany. I did this internship at the BaumInvest headquarters and the Albert-Ludwig-Universität of Freiburg. During the last few years, I have worked as a consultant for cooperation agencies and Costa Rican public institutions on climate change, energy modeling, and geospatial technologies. I am currently working as a lecturer at the School of Geography of the University of Costa Rica.

Carolina Consuegra

I am a civil engineer graduated from Universidad del Norte (Barranquilla, Colombia) in 2016. I finished my master in Applied Physics with an emphasis in Oceanographic physics in 2019. Since then, my passion for estuaries started. I studied the Magdalena River estuary (Barranquilla, Colombia) during my master and now during my PhD, which I started in 2019, I study the Weser estuary (Bremerhaven, Germany). In both estuaries, I worked as a research assistant, collecting, processing and analyzing data i.e., currents, density, salinity, temperature, turbidity, and bathymetry. My focus is hydrodynamics and sediment transport in estuaries, based on measured data. I have also participated in projects related to coastal erosion in Urabá, Colombia.

Juan Felipe Bustos Moreno

I am a Colombian Geoscientist and PhD candidate at Lehigh University (Bethlehem, USA). I am supervised by Dr. Gray Bebout as member of his research group focused on metamorphic geochemistry and volatiles cycling in subduction zones. I received an undergraduate degree in Geosciences from the Universidad de los Andes (Bogotá, Colombia) in 2017 and continued my graduate studies at the TU Bergakademie Freiberg (Freiberg, Germany) from which I received a master's degree in Environmental Geosciences in 2020. My master's thesis under the supervision of Dr. Jörg Matschullat aimed to constrain the nitrogen concentration of the upper continental crust by analyzing a variety of rock-forming minerals. This work set the path for starting my PhD at Lehigh working with Dr. Bebout. Since then, I have served as a TA for the Earth and Environmental Science department and as a Research Assistant at Lehigh. My research interests are the fate and behavior of carbon and nitrogen during subduction zone processes such as prograde metamorphism, devolatilization, decarbonation reactions, carbonate dissolution, fluid-rock interactions, partial melting amongst others. For my research I combine fieldwork and laboratory work for stable isotopes and geochemical analyses as well as petrographic descriptions and geochemical modelling.

17. International Scientific Events

Geociencias en el Siglo XXI: digitalización, sustentabilidad y recursos estratégicos, Marzo 15-22, 2023, Costa Rica.

XXI Ingua Congress in Paleoseimology and Neotectonics, July 14-20, 2023, Sapiensa University of Rome, Italy: More information: https://inquaroma2023.org/

GOAL Homepage: *https://geonetwork-goal.org*

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