SSAGI

XII South American Symposium on Isotope Geology

3-6 July 2022, Santiago de Chile, Chile

ssagi.science

Abstracts book

Compiled and edited by Calderón, M., Deckart, K., Muñoz, M., Martínez P.

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Background Information and Welcome to SSAGI 2022

The aim of the South American Symposium on Isotope Geology, SSAGI, is to provide a fertile environment for the discussion of methods and applications of stable and radioactive isotopes in Earth Sciences, and their development in South America. It encourages scientific interaction in this field at both national and international levels.

The first SSAGI was held at Campos de Jordão, Brazil, in June 1997, organized by geoscientists of the Institute of Geosciences of the University of Sao Paulo. Over time this international conference has been held every two years and celebrated in various cities around South America and Mexico: XII SSAGI continues from XI SSAGI held in 2018 in Cochabamba, Bolivia. This will be the second time that Chile has hosted the symposium: III SSAGI was held in Pucón in October 2001, organized by the Servicio Nacional de Geología y Minera, SERNAGEOMIN, with participation of geoscientists from the University of Chile.

The Organizing Committee thanks online and remote participants for their contributions to this Scientific Event.

Francisco Munizaga Villavicencio (1945-2020)

Key to the development of geochronology in Chile (by Dr. Francisco Hervé)

Prof. Francisco Munizaga Villavicencio graduated as a Geologist at the Geology Department of the University of Chile, where he worked for more than 50 years since 1970. He was the main promoter of geochronology in Chile.

Among his most outstanding actions is the co-leadership of the IGCP 120 Magmatic Evolution of the Andes Project, together with Professors Umberto Cordani and Enrique Linares for more than a decade, which incorporated geologists from all South American countries and disseminated the benefits of using isotopic geochronology in determining the age of magmatism and tectonics. This international contact allowed him to influence the creation and modernization of the K-Ar laboratory at SERNAGEOMIN, and to create a scientific collaboration network in South America. Later, he expanded his network of collaborators in both Americas and thus gained access to the most modern methodologies, extending their application to mineral deposits. The geochronological community in South America will always remember him as a simple person, eager for scientific knowledge, endowed with a great humanity that allowed him to add the human dimension to scientific collaboration. The SSAGI, of which he was a recurrent participant, is closely related to his interests and ideals.

See also:

Hervé, F., Tassinari, C., Cordani, U., Stipp Basei, M., Zentilli, M. 2022. Francisco Munizaga Villavicencio (1945-2020): the developer of geochronology and isotope geology in Chile. Andean Geology 49(2): 307-309.

http://www.andeangeology.cl/index.php/revista1/article/view/3481

IN MEMORIAM

Dr. Márcio Martins Pimentel (1959-2018)

Leader in South American Isotope Geology and geochronology (by Dr. Umberto G. Cordani)

Dr. Márcio Martins Pimentel obtained his Geology graduation (1982) and his Master's degree (1985) at the University of Brasilia (UNB). At the University of Oxford, he concluded his Doctorate in 1991. He was professor at the Institute of Geosciences of the UNB between 1989 and 2009 and full professor at the Institute of Geosciences of the Federal University of Rio Grande do Sul (FURGS) at Porto Alegre, between 2009 and 2013. Then Márcio returned to UNB, where was full professor until the time of his premature death.

Márcio Pimentel became known internationally for his geochronological research and achieved great prominence in the areas of regional geology and geotectonics. Between 1995 and 1997 he founded the Laboratory of Geochronology at the Institute of Geosciences of the UNB, of which he was the head until 2009. In addition, between 2011 and 2013, he coordinated the Laboratory of Isotopic Geology (LGI) at the FURGS.

Throughout his career, he published about 200 articles in specialized journals and received several awards and achievements. Among other prizes, he received, in 1992, the Silver Hammer award from the Brazilian Geological Society (SBG). In 2000 he received three honors. The José Bonifácio gold medal from the SBG, the International Geological Prize L. A. Spendiarov of the Russian Academy of Sciences and was elected as a member of the Brazilian National Order of Scientific Merit.

Those of us who were fortunate to have been associated with him will remember Márcio with affection and deep respect. Admired in the university community, it is a pity that he left us so young, when he still had so much to contribute. He has been and will be greatly missed.

See also:

Hauser, N., Fuck, R.A., Sial, A.N., Ramos, V.A., Reimold, W.U., 2022. A tribute to Márcio M. Pimentel - A leader in South American Geology and Isotope Geology. Journal of South American Earth Sciences 115: 103726.

https://www.sciencedirect.com/science/rticle/pii/S0895981122000177

ABOUT CHILE

Chile is located along the western side of the Andes for over 4000 km and is known worldwide for its highly active volcanism and seismicity related to the subduction of the Nazca and Antarctic oceanic plates beneath South America. Old continental basement rocks of the Chilean Andes were formed during the growth of the southwestern margin of Gondwana and are constituted by accreted Paleozoic terranes and associated accretionary complexes developed along ancient subduction zones. Due to the successive accretion events, the subduction-related Paleozoic plutonic belts were added gradually towards the west. Mesozoic and Cenozoic development is characterized by almost continuous subduction activity with early development of marginal basins and successive magmatic arcs migrating eastwards, accompanied by several orogenic events and development of copper-rich ore deposits distributed along crustal-scale fault zones. The Chilean Andes comprise more than 80 Pleistocene and Holocene volcanoes with historical activity, which have been key natural laboratories for the study of volcanism, magma genesis and crust-mantle interactions in subduction settings. The geomorphology and landscape evolution have been influenced by latitudinal differences of tectonic plate kinematics and climate variabilities. Neogene landscapes are preserved in the hyper arid mountain ranges of northern Chile, Quaternary uplifted marine terraces along the coastline are characteristic and glacial geomorphology dominates in southernmost latitudes.

Lonquimay Volcano

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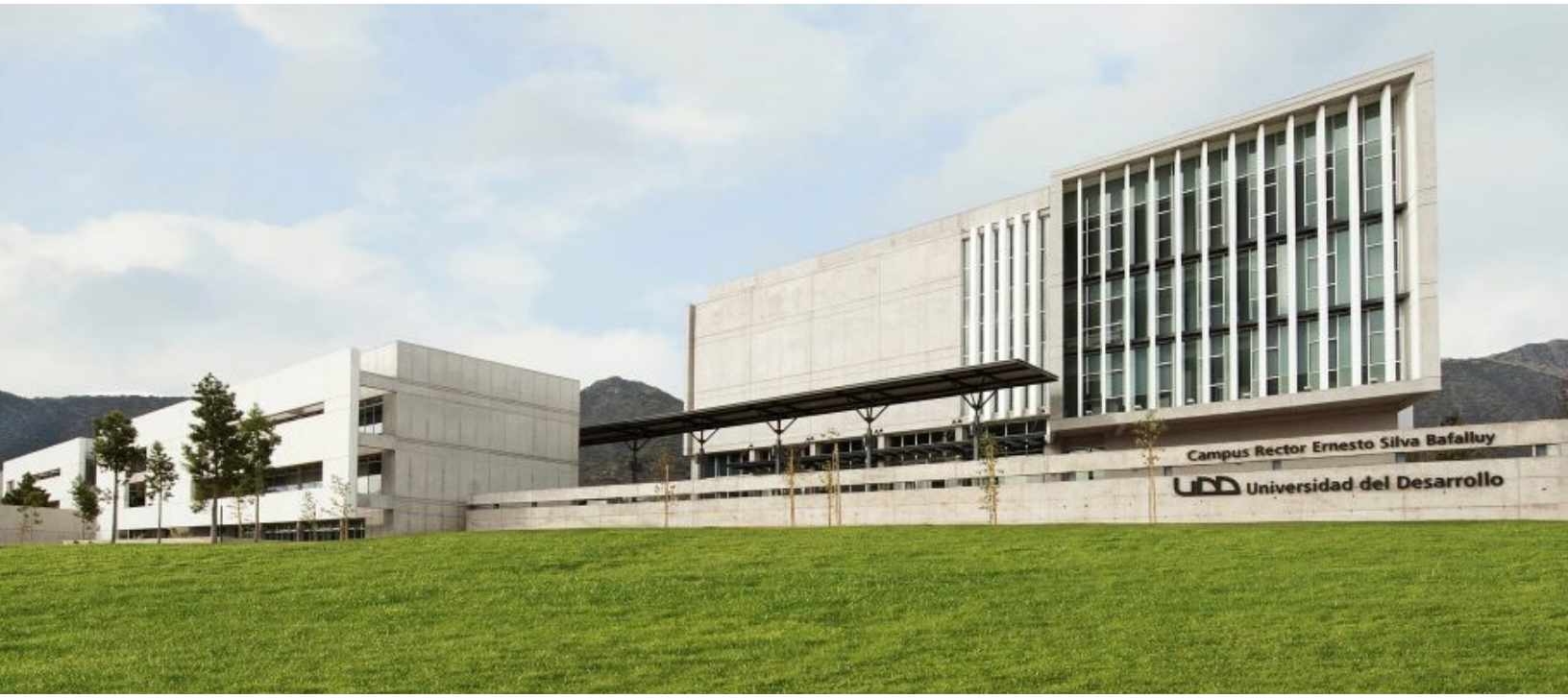

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The Organizing Committee gratefully acknowledges the support of our Sponsors.

Plenary Lectures

New tools in crime solving and prevention: the use of stable isotopes in Forensic Sciences

Joao Carlos Ambrosio[1]

(1) Academia Brasileira de Ciência Forenses, Brazil

The main focus of this lecture is to discuss new applications of stable isotopes in solving and preventing crimes. During the presentation, we will first discuss the theory behind stable isotopes. The presentation will then focus on the role stable isotopes are playing in determining drug origin as well as the origin of wood, gold, and oil. Finally, it will discuss the use of stable isotopes in Humanitarian Forensics, specifically in trying to identify Unindentified Human Remains.

Modern Microbial Carbonates and Possible Correlations with Pre-Salt Microbialites of Santos Basin

Anelize Bahniuk[1], L. Cury[1]

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Modern carbonate environments, where microbialites are forming under comparable geomorphological, biological, climatic, volcanic and tectonics characteristics as those during the formation of the Aptian Pre-Salt microbialites on the Brazilian continental shelf, are possible analogues to improve our understanding of the physical-chemical processes involved the formation of ancient microbial carbonate deposits. Nevertheless, it is difficult to study a single modern example, which fulfils all the criteria required to define a realistic evolutionary model for the Aptian equivalent. Thus, we have selected for our evaluation several modern locations containing microbialites, which form under variable environmental conditions, e.g., the Pantanal, Central Brazil, Patagonia, Chile, and Puna, Argentina. These environments present vastly different conditions, which can furnish important insights, and taken together provide fundamental information to decipher relationships between the inorganic and organic processes involved in carbonate reservoir formation. In the Pantanal region, thousands of lakes are found distributed throughout one of the largest fan river systems. Microbial activity in many of these water bodies mediates the production of carbonates associated with authigenic clay mineral precipitation, e.g., smectite. In Chile's Patagonia Torres Del Paine region, the Sarmiento and Amarga lakes are located in an area of glacial regression, which represents an environment with recent microbialite formation in a cold and arid climate. Additionally, in this cold, arid region, Lake Pali Aike, situated in the crater of a dormant volcano, is potentially an interesting case study. Finally, in the Puna region, northwest Argentina, between the provinces of Salta and Catamarca, the lakes are situated in *salares* located on the altiplano at altitudes of ~5000 m and are often surrounded by volcanic structures. Each of these three different regions is characterized by extreme environmental conditions, such as a desert climate with high temperatures during the day and very low temperatures at night, strong winds and high incidence of solar radiation. The primary goal of integrating studies of these three distinctly diverse environments located in varying geological settings is to develop an actualistic facies model representing the ancient conditions of the various Pre-Salt lacustrine depositional environments, ranging from deep subaqueous, intermediate subaqueous, shallow subaqueous and subaerial systems.

A new view of the solar system from recent sample return missions

Trevor Ireland[1]

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Exploration of our solar system has reached an exciting point with detailed photographic and other sensor information available for all planets, the dwarf planets Ceres and Pluto, as well as a variety of planetesimals and smaller objects. The solar system does appear structured, with the terrestrial planets composed of rock and metal, lying inside the giant planets richer in gas (H, He), and ice. But, looking is one thing, getting samples back to Earth for detailed analysis is another.

Meteorites provide our main inventory of solar system materials, and these appear to be delivered from the Near-Earth asteroids. Asteroids can be characterised according to infrared (IR) spectra, where reflectance and absorption are the main defining features. The most common type of asteroid is the C-types, which have a low reflectivity and flat IR spectrum. The closest

analog to C-type material in the meteorite inventory is the group of carbonaceous chondrites (CC). However, this type of meteorite is quite uncommon comprising less than 5% of meteorite falls. The second most common asteroid type is the S type, which has higher reflectivity and absorption bands related to ferromagnesian silicate minerals. These minerals are common in chondrites, where chondrules are predominantly composed of olivine and pyroxene, and in particular in Ordinary Chondrites (OC).

Three missions have visited asteroids and two of these missions have safely returned to Earth with samples. The JAXA Hayabusa (1) mission visited the S-type asteroid Itokawa in 2005 and returned to Earth in 2010. While only a small amount of material was returned, detailed examination of the particles revealed they were a close match to the LL chondrite class of meteorites. The Hayabusa 2 mission arrived at the C-type asteroid Ryugu in 2018 and returned to Earth in 2020. That sample is indeed a carbonaceous chondrite, but again we have a surprise, it is a rare type - a CI chondrite.

The matching of C and S-type asteroids to known meteorite classes allows a better interpretation of the material in the asteroid belt. The main asteroid belt is structured with the Ordinary Chondrites featuring in the inner regions, whereas Carbonaceous Chondrites are more common in the outer regions. Ordinary and Carbonaceous chondrites appear to be distinct in their chemistry and isotopic compositions, for example in terms of oxygen and chromium isotopes. These attributes have been used to suggest that carbonaceous chondrites might have initially formed outside Jupiter's orbit, thereby separating CC and OC source regions, but that large planet migration pushed the CC back inside Jupiter's orbit. Nevertheless, there are issues with this interpretation because CC can contain a large proportion of refractory inclusions, objects that appear to have formed close to the Sun.

The radial distributions of asteroid materials appear to relate to a temperature gradient in the early solar system. Gravitational collapse of the solar system leads to a rise in temperature, but not nearly enough to explain melting of refractory mineral assemblages in their current parent body positions. This either suggests transport of materials back through the disk, or that additional heating is provided by other mechanisms. One possibility is that outflows related to solar jets ejected material back out from the inner solar system. An additional corollary to the nature of jets is that magnetic fields caused protons to be accelerated causing frictional heating, and in regions that are close to the places where we currently find the meteorite sources. As such, the inner solar system appears to be a refractory remnant of the solar nebula whereas the outer solar system is closer to the original nebula composition. There are a number of chemical predictions that could allow better constraints, if only we could get samples back from the outer solar system.

Financing: TRI acknowledges support from the Australian Research Council (DP210101798) for analysis of Ryugu samples.

Applications of copper isotope geochemistry for mineral exploration

Ryan Mathur[1]

(1) Juniata College, USA

Copper isotope values in ores, weathered rocks, soils, surface water and groundwater have been used in mineral exploration. In this presentation, a current review of the mechanisms of copper isotope fractionation applied to fingerprint and/or vector to buried mineralization will be presented. Several case studies on the applications of copper isotope fractionation in groundwater from the Pebble Deposit in Alaska, Mount Isa inlier in Australia, and brines from several different Chilean basins will be discussed. Finally, new data from porphyry copper deposits show copper isotope spatial patterns in sulfides and iron oxides in leach caps that can be used to vector to mineralization.

Tracking critical element enrichment in the Earth's surface using stable isotopes and cosmogenic radionuclides

Martin Reich[1,2]

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(2) Andean Geothermal Center of Excellence (CEGA), FCFM, Universidad de Chile, Santiago

Critical or strategic elements are essential for low-carbon economic growth and the clean energy transition. Demand for critical elements is on the rise because they are crucial for current and emerging energy technologies—electric vehicles, wind turbines, photovoltaic cells, and batteries—which are key for lowering carbon emissions and mitigating anthropogenic climate change.

Within this context, supergene metal deposits are economically interesting because of their accessibility for extraction, increased grades, and their importance as targets for the exploration and exploitation of critical elements such as Cu, I, Ni, Co, Cr and rare earth elements (REE), among many others. Supergene metal deposits form when recurrent chemical weathering promotes the dissolution, remobilization, and reprecipitation of key elements at or near the Earth's surface, creating a chemically stratified profile, which in many cases defines the economic viability of a mining project (1).

Supergene metal deposits host a comprehensive record of climate-driven geochemical reactions that may span the entire Cenozoic. Products of these reactions can be dated by a variety of radiogenic isotopic methods (e.g., $^{40}Ar/^{39}Ar$, (U-Th)/He, U-series disequilibrium). The frequency of mineral precipitation, determined by dating a representative number of samples of a particular mineral collected from distinct parts of the supergene ore body, reflects times in the geological past when weathering conditions were conducive to water-rock interaction, and potentially, economic metal enrichment (2). Stable isotopes and cosmogenic radionuclides, on the other hand, allow tracking fluid sources and unravel geochemical processes that occur during weathering, including oxidation of primary minerals, downward or lateral migration of metal-rich fluids, and the precipitation of secondary or supergene minerals at or near the Earth's surface.

In this talk, I will present several examples in the Chilean Andes where the application of isotope geochemistry to supergene systems has provided new insights about critical element enrichment. I will focus on the supergene evolution of copper and nitrate deposits in the Atacama Desert of northern Chile, the world's leading Cu, Li and I producing province (3). I will provide an overview of isotopic data on supergene deposits including different systems such as ^{36}Cl, ^{129}I, $\delta^{18}O$, $\delta^{15}N$, $\delta^{37}Cl$, $\delta^{65}Cu$ and $\delta^{53/52}Cr$. These data, when coupled with geochemical proxies for aridity (e.g., mass-independent fractionation of oxygen, $\Delta^{17}O$), permit identifying weathering-prone periods conducive to supergene ore genesis that were triggered by changes in climate and tectonics (3). I will show that the formation of world-class supergene deposits represents an unusual convergence of common physical-chemical processes with an ideal geologic, tectonic, hydrologic, and climatic setting that is specific to Atacama (4).

(1) Reich, M. and Vasconcelos, P. (2015). Elements 11, 305-310.
(2) Vasconcelos, P. et al. (2015). Elements 11, 317-322.
(3) Reich, M. and Bao, H. (2018). Elements 14, 251-256.
(4) Perez-Fodich, A. et al. (2014). Geology. 42, 1-4.

Frontiers of carbonate clumped isotope geochemistry, within an inclusive science framework

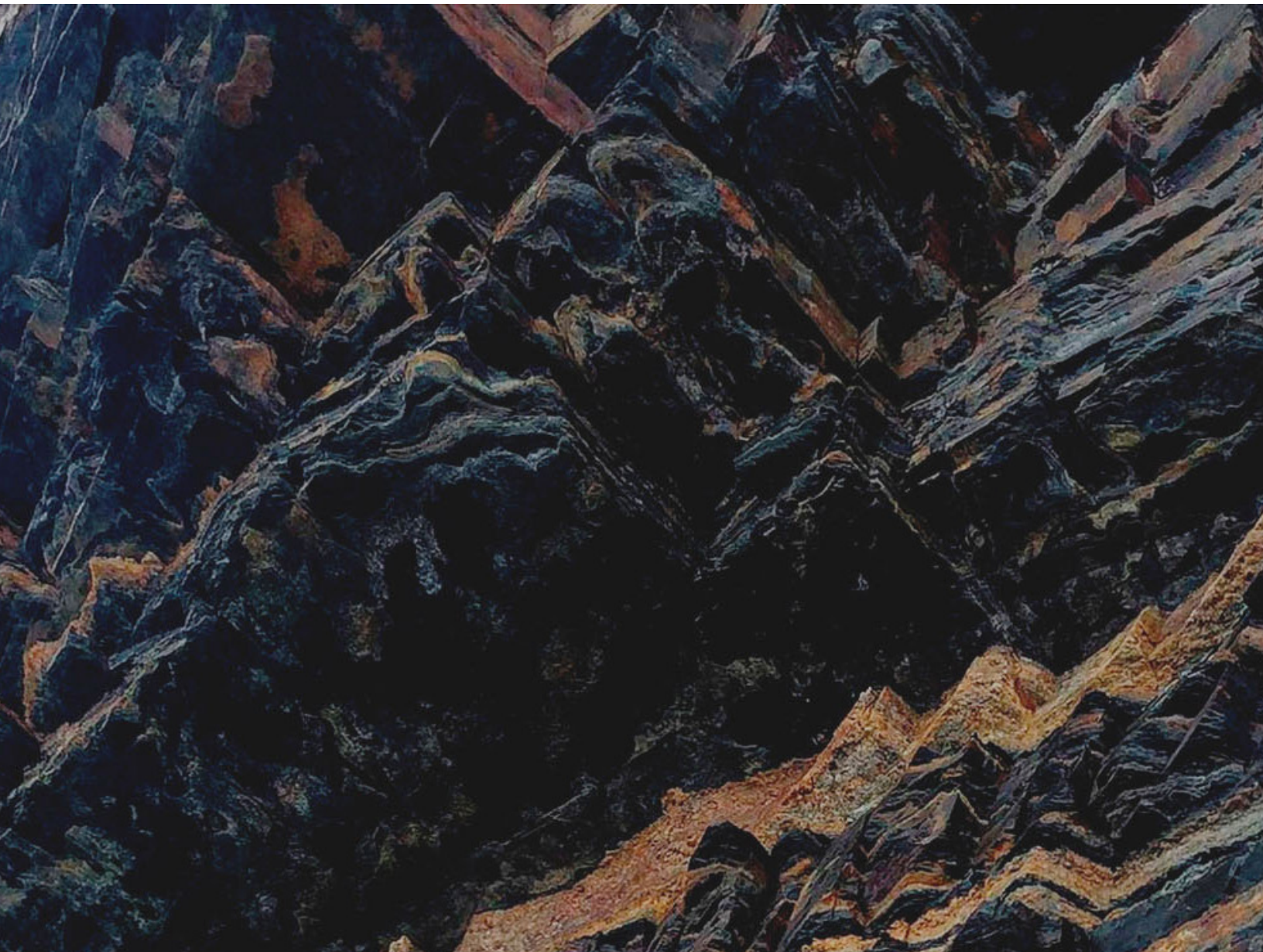
Aradhna Tripati[1]

(1) University of California, Los Angeles, Earth, Planetary, and Space Sciences, 595 Charles Young Drive East, Los Angeles, United States

The emergence of new isotopic tools enables us to address fundamental questions about Earth's evolution. A promising tool for the study of past conditions is the carbonate clumped isotope thermometer. In principle, this technique can provide a thermodynamically-based estimate of carbonate mineral formation temperature and a relatively assumption-free calculation of the oxygen isotopic composition of seawater. Over the past fifteen years, I have worked to probe equilibrium and kinetic isotope effects and to develop its usability for paleotemperature reconstructions. These efforts include studying the systematics of carbonate clumped isotopes in foraminifera and coccoliths and other geological archives including coral, mollusks, and lacustrine carbonates. I also have worked on experimental and theoretical studies to advance our understanding of fractionations in dissolved inorganic carbon species, amorphous carbonates, and carbonate minerals. Another frontier I have explored relates to dual carbonate clumped isotope fractionations. In this talk, I will summarize work we have done to improve analytical capabilities, determine equilibrium and kinetic isotope effects, advance Bayesian tools, and highlight several applications to reconstruct past temperatures. Our work is being done in fields that have extremely low levels of diversity, with negative impacts on culture, the health of the discipline for people in it, and scientific innovation, and I will describe our work to address this issue.

Financing: This work has been supported by DOE, NSF, and the Heising-Simons Foundation.

ORAL PRESENTATIONS



Rhyacian-Orosirian tectonic history of the Juiz de Fora Complex: Evidence for an Archean crustal reservoir within an island-arc system

Rasec Almeida[1], Vitalino Elizeu[1], Henrique Bruno[1], Samuel Moreira Bersan[1], Lucas Eduardo de Abreu Barbosa Araujo[1], Ivo Dussin[1], Claudio de Morisson Valeriano[1], Carla Neto[1], Monica Heilbron[1]

(1) Universidade do Estado do Rio de Janeiro, Faculdade de Geologia, Rua São Francisco Xavier 524, Maracanã, Rio de Janeiro, Brazil

The southern São Francisco Paleocontinent (SFP) comprises Archean nuclei and Paleoproterozoic complexes encompassing magmatic arcs juxtaposed during a Rhyacian to Orosirian orogenic event. The Juiz de Fora Complex (JFC) represents an imbricated thrust system that comprises orthogranulites with a wide compositional range formed in an intra-oceanic setting during the Siderian to the Orosirian and later accreted to the southeastern margin of the SFP. Here we report new petrological, geochemical, whole-rock Nd and Sr data, as well as zircon U-Pb ages from felsic and mafic orthogranulites from the JFC. The new data is combined with a regional compilation that enables an evaluation of the interaction between magmatism and orogenetic episodes in the context of the consolidation of São Francisco Paleocontinent during the Rhyacian-Orosirian. Pre collisional Island Arc tholeiites (IAT), Tonalites-Trondhjemites-Granodiorites (TTGs) and sanukitoid magmatism occurred from 2200 Ma to 2085 Ma. This was followed by post-collisional magmatism, which is represented by hybrid granitoids coeval with the emplacement of E-MORB basic rocks. Crustal signatures for the Rhyacian to Orosirian evolution are highlighted by the dominance of negative $\varepsilon Nd_{(t)}$ associated with Meso- to Neoarchean Nd T_{DM} model ages as well as inherited zircon grains from the hybrid granitoids. The JFC is extensively highlighted in the literature as a primitive intra-oceanic arc, but here we propose the reworking or recycling of ancient crustal segments within the mature arc stage of the JFC, suggesting a Mesoarchean crustal source involved in the JFC evolution.

Financing: Rio de Janeiro State University and the Faculty of Geology (FGEL).

Hydrogeochemical processes controlling the solute geochemistry in the Salar de Atacama: New insights from Li, B, and Sr isotopes

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(5) Rutgers University, Department of Earth and Planetary Sciences, Piscataway NJ, USA

The Salar de Atacama in northern Chile corresponds to a world-class reservoir of lithium, even compared to other closed basins in the lithium triangle (NE Chile, NW Argentina, and SW Bolivia). The occurrence of extremely elevated Li concentration is restricted to brine deposits contained within the halite nucleus, this extraordinary enrichment is still controversial and different hypotheses have been proposed over the years, including, geothermal waters associated with active volcanism, leaching of soluble salts from volcanic rocks, and leaching of lithium-rich clays. These processes are characteristic of the whole Andean region and do not specifically explain the extreme local Li enrichment in the Salar de Atacama. Therefore, even though the Salar de Atacama has been extensively studied, most of the studies have been focused on the southern and southeastern portions, where the highest Li concentrations have been reported. However, to fully understand the dynamics of a salar basin system, it is relevant to focus on the water recharge at the marginal and detrital dominated area of the salt flat. This study explores the hydrogeochemical processes controlling the water composition and solute distribution of the Salar de Atacama. We used a combination of isotopic methods, including $\delta^{7}Li$, $\delta^{11}B$, and $^{87}Sr/^{86}Sr$ ratios, with their chemical composition of a set of water samples from salt lakes, geothermal manifestations, groundwaters, and surficial diluted waters (rivers and streams with low salinity). Our data confirm that weathering of the ignimbrites constitutes one of the most important processes in relation to solute origin in the region, where deep water-rock interactions would operate at high temperature, enhancing the leaching of Li and other solutes. Based on $\delta^{7}Li$ and $\delta^{11}B$ we suggest additional hydrogeochemical processes occur which can reproduce the modern water geochemistry. We discard that mixing between high temperature geothermal waters and waters from other reservoirs is a predominant process controlling the solute concentration, suggesting that a different process is preferential. We determine that groundwater flow entering the Salar de Atacama has undergone pre-enrichment processes associated with salt inputs in the Western Cordillera. The high salinity of these waters is probably related to previous evaporation, brine leakage, and to a lesser extent associated with evaporite dissolution. Our results provide a step forward toward a comprehensive understanding of the processes that govern brine formation and lithium enrichment in a hyperarid environment, contributing to a sustainable exploration and exploitation of lithium in these environments.

Financing: ANID-FONDECYT grant 11160325Millennium Nucleus for Metal Tracing Along Subduction (NC130065).

Paleosalinity estimate and paleoenvironmental constraints on Miocene shallow-marine incursions in Amazonia using isotopic proxies ($\delta^{13}C$, $\delta^{18}O$ and $^{87}Sr/^{86}Sr$) in fossils

André Mateus Valentim Alvim[1], Roberto Ventura Santos[1], Martin Roddaz[2], Maria Inês Feijó Ramos[4], Pierre-Olivier Antoine[3], Demerval Aparecido do Carmo[1], Ana Paula Linhares[4], Francisco Ricardo Negri[5]

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(4) Museu Paraense Emílio Goeldi, Coordenação de Ciências da Terra e Ecologia, Av. Presidente Tancredo Neves 1901, 66077-830, Belém, Brazil
(5) Universidade Federal do Acre (Campus Floresta), Centro Multidisciplinar, Laboratório de Paleontologia, Estrada do Canela Fina, Km 12, 69980-000, Cruzeiro do Sul, Brazil

The paleoenvironment of the Western Amazonia (Amazonia biome area from Colombia until Bolivia) during Miocene times was comprised of an extensive network of lakes, swamps, and rivers called Megawetland Pebas System (PMWS). Besides its continental essence, several studies have reported Miocene shallow-marine incursions in Western Amazonia during the vengeance of this system, mainly based on paleontological, sedimentological, and isotopic evidence. In this study, we present $\delta^{13}C$, $\delta^{18}O$, and $^{87}Sr/^{86}Sr$ isotopic data of macrofossils (pacu and ray teeth, crab claws and oysters), and microfossils (ostracods and foraminifera) from reported Early to Early Late Miocene shallow-marine deposits of Western Amazonia (Peru and Brazil) in order to evaluate environmental conditions and estimate water salinity during these incursions. We also analyzed Early Miocene fossils of shallow-marine deposits from Pirabas Formation (Pará State, Brazil) and present-day organisms from distinct environments (beach, sea, riverine, and estuary) as comparison bias for Western Amazonia fossils data analysis. Sample preparation and methodology used for macrofossils and microfossils analysis were distinct. Macrofossils were partially crushed with a pestle and mortar and separated into two aliquots for each sample. An aliquot was analyzed in a Finnegan GasBench II accoupled to a Delta V Plus IRMS for stable isotopes, while the other one was sent to chemical separation (through ion exchange columns) and then, analyzed in a Triton Plus TIMS for strontium isotopes. On the other hand, whole specimens of microfossils were analyzed in a Kiel IV Carbonate Device accoupled to a MAT Finnegan 253 IRMS for stable isotopes. The liquid residue obtained after the reaction of the analyzed microfossils with HPO_3 (a necessary stage for stable isotope analysis) was sent to chemical separation and analyzed in Triton Plus TIMS for strontium isotopes. As result, carbon and oxygen isotopic compositions indicate that Western Amazonia fossils display an isotopic signature similar to the present-day continental environments, while Pirabas Formation fossils display carbon and oxygen isotopic compositions comparable to those from seawater environments. We further used the $^{87}Sr/^{86}Sr$ isotopic compositions of the fossils to estimate paleosalinity conditions. Early Miocene water bodies of the Pirabas Formation (Marajó Basin) seem to vary from mesohaline to marine conditions. In contrast, Early Miocene Western Amazonian water bodies of the PMWS were characterized by freshwater conditions. Nonetheless, $^{87}Sr/^{86}Sr$ data from Middle and Early Late Miocene Peruvian fossils suggests that oligohaline conditions seem to be predominant in this area of the PMWS. Paleosalinity estimates of the Brazilian part of the PMWS at this same geologic time are less constrained and might indicate a salinity range between freshwater or oligohaline conditions. In summary, our isotopic data suggest that part of the Pebas MegaWetland System was occasionally submitted to oligohaline conditions during Middle and Early Late Miocene shallow-marine incursions.

Financing: CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior) COFECUB (Comité Français D'evaluation de la Coopération Universitaire et Scientifique avec le Brésil).

Late Pleistocene hydroclimate reconstructions of 11 pluvial lakes in Western North America

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The Last Glacial Maximum (LGM, ~20,000 years ago) was an interval where cooler temperatures and wetter conditions prevailed due to reductions in greenhouse gas concentrations and the presence of large ice sheets in North America. These cool and wet conditions allowed for the existence of hundreds of pluvial lakes in Western North America. However, the hydrologic mechanisms that supported the existence and extent of lakes over time has been the subject of debate. Thus, in this study, we explore hydrological changes that occurred from the LGM through the deglaciation and into the present by synthesizing data from several collaborative studies. We examine results for 11 closed-basin lakes that encompass a wide range of modern and past climates in Western North America (24-42°N,100-120°W). First, we utilize radiocarbon and uranium-series dating on shoreline carbonates constrain lake hydrographs, allowing for comparison of lake level fluctuations through both time and space. Second, we apply carbonate clumped isotope thermometry to shoreline carbonates and estimate past lake surface water temperatures and lake water $\delta^{18}O$. We use the values derived from clumped isotope analysis in concert with a hydrologic isotopic mass balance model that accounts for basin hypsometry to constrain past annual precipitation and evaporation rates at each site. We apply quantitative estimates of hydroclimate to test hypotheses on the evolution of moisture sources, moisture transport, and the magnitude of precipitation changes. Lastly, we quantitatively assess performance of a transient climate model (TraCE-21ka) throughout our entire time interval and paleoclimate model intercomparison project simulations (PMIP) by comparing our clumped isotope derived estimates of precipitation and temperature to model output.

Financing: NSF and Heising-Simons Foundation.

U-Pb geochronology and Sr-Nd isotopes of magmatic rocks from the north portion of the Neuquén pre-cordillera: times and sources of magmatism

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In the Cordillera del Viento, Argentina, plutonic rocks related with three main periods of magmatism in the Permian, Jurassic, and Cretaceous, are exposed. To characterize the Cretaceous magmatism in terms of ages and geochemistry and to evaluate the timing of flare-ups for the Andean Arc, some Cretaceous tonalites and their host rocks were analyzed by U-Pb geochronological analysis on zircon, geochemistry, and with Sr-Nd isotopes.

The Huingancó Granite has a shoshonitic signature. This intrusion represents the oldest magmatism in the region, with a Permian age. Sr-Nd isotopic analyses obtained on these gave values of $^{87}Sr/^{86}Sr$ of 0.72470 and 0.71700 and ε_{Nd} of -2.18 and -4.59. The latter corresponds to a Mesoproterozoic T_{DM} of 1.07 and 1.23 Ga, respectively. The Jurassic Host Rock body around the Cretaceous intrusions is a low peraluminous granite of high-K calc-alkaline composition, with a crystallization age of 184 ± 3 Ma.

The Varvarco Tonalite is composed of metaluminous tonalites with medium-K calc-alkaline signature; it is intruded by dioritic and granitic dikes. The Butalon Tonalite is metaluminous to peraluminous and has a low to medium-K calc-alkaline signature. U-Pb data on zircon (by LA-ICP-MS) indicate that the Varvarco and Butalon tonalites crystalized at 67 ± 1 Ma, and a dioritic dike crystallized at 65 ± 1 Ma. The $^{87}Sr/^{86}Sr$ values for the Varvarco and Butalon tonalites are 0.70460 and 0.70728; these rocks have ε_{Nd} values of -0.78 and +0.53 and Neoproterozoic T_{DM} ages of 0.76 and 0.75 Ga. The dioritic dike has a low $^{87}Sr/^{86}Sr$ value of 0.70460 and strongly positive ε_{Nd} of +10.77.

The Varvarco and Butalon tonalites of the Cordillera del Viento represent the main Cretaceous magmatism with an important mantle component. In contrast, the Jurassic Host Rocks granites and the Huingancó Granite have a strong crustal signature. The Sr-Nd isotopic data indicate that the parental magmas for the Varvarco and Butalon tonalites probably assimilated part of the Jurassic and Permian crust that is represented in the area by the Jurassic Host Rocks Granites and the Huingancó Granite.

For the Andean Arc, specifically the western Peninsular Ranges Batholith (wPRB), the Peruvian Coastal Batholith (PCB), and the Chilean Coastal Batholith (CCB), (1) defined a flare-up between 90 and 110 Ma. This flare-up episode is not identified at the Cordillera del Viento. Instead, the Varvarco and Butalón tonalites show peak magmatism between 65 and 70 Ma that could be correlated with the youngest age populations identified for the PCB and CCB. The rocks of the CCB show less variation in Sr-Nd isotopes and an enhanced mantle character, whereas the PCB rocks have lower $^{143}Nd/^{144}Nd$ ratios and more radiogenic $^{87}Sr/^{86}Sr(t)$ ratios. Could the Varvarco and Butalon tonalites represent a lull stage in comparison with the flare-up magmatism from the wPRB, PCB and CCB? And why is this extended flare-up phase between 90 and 110 Ma not identified in the study area? Geochemical data, U-Pb and Hf on zircon, and Sr-Nd analysis for the Naunauco (Naunauco Group and Cayanta Andesite) and Ñorquinco-Villa Pehuenia (Paso de Icalma Granodiorite and Moquehue Granite) areas in the southern Neuquén Province are being obtained to further elucidate the sources and timing of magmatism linked with the evolution of the Andean Arc. Some of these additional data will be discussed at the conference.

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Financing: This study was financed in part for CNPq fellowships (grants 309878/2019-5), PICT 2019-01809 and Coordenação de Aperfeiçoamento de Pessoal de Nivel Superior – Brasil (CAPES) – Finance Code 001.

Insights of cadmium isotopes for deciphering zero-valent iron nanoparticles remediation processes in contaminated soil

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Zero valent iron nanoparticles (nZVI) attract high interest given their effectiveness for soil remediation by reducing metals mobility due to high surface area and reactivity. Especially, promising results were obtained when applying nZVI for immobilizing Cd through its sorption with the newly-formed Fe oxide particles. However, the interactions between nZVI and Cd in the soil-plant system remain unknown, thus in this work we propose the analysis of Cd isotopic composition for understanding soil remediation process using nZVI and *Agrostis capillaris*, an autochthonous plant growing in the surroundings of the polluted site.

In this sense, untreated and nZVI-treated soils were used for preparing pot experiments, with and without *Agrostis capillaris*, in order to measure the effects of nZVI, plants and both simultaneously, on Cd isotopic composition. At the end of the experiment (45 days), plants (roots and aerial parts) and pore water samples were collected, and soils were also removed from the pots. Cadmium concentration was determined for plants, soil, and soil solution. Then, Cd isotope ratios were measured using a thermal ionization mass spectrometer (Triton, Thermo Fisher) based on the double spike method.

Initial soil analysis revealed that the concentration of Cd in the polluted soil ranged from 23-28 mg/kg, and the $\delta^{114/110}$Cd values ranged from -0.13‰ to -0.07‰. These values were also observed for all soils from the pots at the end of the experiment.

Concerning Cd availability, Cd concentration was monitored in soil solution revealing differences between soil treatments. The untreated soil without plants showed a Cd concentration in pore water of 145 µg/L, and this concentration was decreased to 33 µg/L after the application of nZVI. The growth of plants on the pots slightly decreased Cd concentration in the untreated soil (119 µg/L), although no significant differences were found in the nZVI-treated soil with plants (32 µg/L). Respecting isotopic composition, a heavy Cd isotopes enrichment was detected in pore water ($\delta^{114/110}$Cd values ranged from 0.17‰ to 0.22‰) from untreated soils, with and without plants. Furthermore, the heavy Cd enrichment in pore water was severely increased when applying nZVI to the soil without plants ($\delta^{114/110}$Cd ranged from 0.48‰ to 0.62‰). However, when plants have grown on the nZVI-treated soil, the Cd isotopes enrichment detected in pore water seems similar to the one shown in the untreated soils ($\delta^{114/110}$Cd values ranged from 0.15‰ to 0.20‰).

Plant analysis revealed that Cd concentration in the aerial part decreased after the nZVI application, from 22 mg/kg to 9 mg/kg, and respecting the isotopic composition, $\delta^{114/110}$Cd values ranged from 0.03‰ to 0.16‰ for the untreated soil and from 0.19‰ to 0.33‰ for the nZVI-treated soil.

The results suggest that the application of nZVI preferentially immobilized the light Cd isotopes pool presented in pore water and plants prefer extracting the same pool of Cd isotopes. Therefore, when applying nZVI to the soil, a decrease in Cd concentration in plants was detected. The Cd isotopic composition of plants and pore water from nZVI-treated soil revealed similar values, thus plants were up taking the available Cd from solution which was not immobilized by nZVI.

In conclusion, our results suggest that soil amendments, such as nZVI, are selective for immobilizing preferentially one pool of Cd isotopes (in our case, light Cd isotopes for nZVI), thus the analysis of Cd isotope composition is revealed as a useful technique for understanding soil remediation and selecting the most appropriate soil amendment.

Financing: Czech Science Foundation (22-36079S).European Union-NextGenerationEU, Ministerio de Universidades, and Plan de Recuperación, Transformación y Resiliencia (MU-21-UP2021-030 32892642).

Isotopic and geochemical tools to monitoring ecosystem services provided by native forest: the case study of the Nonguén National Park in the coastal area of south-central Chile.

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The Chilean population is highly vulnerable to the current climate crisis and to one of its most significant phenomenon at the local scale: the decade-long drought that affects the south-central territory, especially the coastal lands. Alongside the decline in total water precipitations and surficial temperature increase that results in lesser water reserves, the country's economic and political model of development is a key factor that combine with the physical variables to exacerbate the negative impact of climate change on human infrastructure and habitat. In the coastal area of south-central Chile, more than six decades of government-subsidized replacement of native forests by fast-growth exotic plantations (*Pinus radiata* and *Eucalyptus globulus/nitens)* has likely triggered, or at least increased, extensive soil degradation and affectations of main watersheds. This extensive replacement has seemly decreased water provision and increased nutrient and sediment loss to streamflow over the years. Recent studies in this area have pointed out to the higher efficiency of native forest in moisture retention and water provision compared to exotic plantations (1).

The tools used to quantitatively assess the ecosystem services provided by native forest are mostly direct measurements of daily streamflow, runoff, atmospheric and water pressure and wells. We tested the use of geochemical proxies as additional tools for monitoring the efficiency of the ecosystem services of water provision and water quality. The case study is the "Nonguén National Park", a 3000-ha relict patch of the sclerophyllous forests of central Chile located in the metropolitan area of Concepción surrounded by exotic plantations and agricultural lands, that feeds the Nonguén river, an important supplier of drinking water to ~100,000 inhabitants. We measured $\delta^{18}O$, δD, nitrates/nitriles, phosphates and pH-Ec in 27 locations of tributaries and nested points of the main river at the beginning of summer, autumn, winter and spring seasons. To characterize the watershed, it was further divided in three smaller catchments: the southern catchment (SC) with only native forest (but connected to agricultural lands), the eastern catchment (EC) with both native forest and exotic plantations and the northern catchment (NC), which is also the downstream flow area, with only exotic plantations.

Our results show that during the autumn and winter seasons there is a slight difference between surficial water coming from SC and EC-NC, with the former exhibiting the largest deviation from the Local Meteoric Water Line (LMWL), suggesting higher retention rates and larger contribution from groundwater. Nutrients on the other hand, are slightly more diluted in the samples of the SC and EC, recording a significant increase downstream, where exotic plantations and urban activities dominate. Samples taken during the spring and summer seasons (the driest period of the year) further record this difference, with lager isotopic deviation from the LMWL in waters sourced in the native forest area (SC), compared to those where exotic plantations are present. Within the SC a very significant decrease in nutrients is observed from the upper part of the catchment to the output area, bordering to the NC, suggesting that the less degraded soil in the native forest area acts as a more efficient system of ion exchange, helping to retain nutrients from waters.

We propose that these cost-effective geochemical tools may be part of a more diverse toolbox of chemical proxies that would help to monitoring the ecosystem services provided by areas with native forest dominance as well as in future implementation of nature-based solutions for water provision and quality.

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Financing: Center for Climate and Resilience Research (1511009)Departamento Ciencias de la Tierra, Universidad de Concepción.

Post-collisional oceanward displacement of the magmatic arc in the Fuegian Andes revealed by Cenozoic plutonic rocks at Seno Año Nuevo

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The main orogenic event in the Fuegian Andes is related to the closure of the Rocas Verdes Basin in mid-Cretaceous times (1). This major tectonic event involved the southward tectonic underthrusting of oceanic-type back-arc lithosphere culminating with the collision of the island arc against the South America continent (2). This orogenic event resulted in the high-pressure and Barrovian-type metamorphism of the seafloor remnants and continental basement rocks, which are exposed at Cordillera Darwin (ca. 54º40'S; (3),(4)). During exhumation of the metamorphic rocks, they were intruded by several Upper Cretaceous granitoids linked to the northward dipping and flat subduction of the proto-Pacific oceanic lithosphere (cf. 5). In this work, geochemical and geochronological data of plutonic rocks cropping out at Seno Año Nuevo (ca. 55º30'S) are presented. It is confirmed through U-Pb SHRIMP zircon dating that Paleocene and Eocene plutons intruded the ophiolitic remnants of the Rocas Verdes Basin and older plutonic complexes located to the south of the suture zone. Ophiolitic rocks show low-grade metamorphic mineral assemblages and a local thermal aureole with decussate biotite, epidote, and Ca-plagioclase in the contact with the Paleocene plutons. The southward migration of arc magmatism can be related to the reconfiguration of tectonic plates that probably involved the break-off of the ancient slab, trench retreat and establishment of a steep subduction system. A comprehensive geochronological and isotopic study of plutonic rocks from the Fuegian Batholith will be necessary to test this and/or other hypotheses.

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Financing: This contribution was funded by Fondecyt grants 1161818 and 1211906.

Geological nature of the pre-Andean basement and its relationship with the spatial distribution of accreted terranes along the Andean margin (13°-43°S)

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The crustal basement along the active western margin of South America is composed by different terranes, which together show a complex evolutionary history during the Paleozoic, with events of amalgamation, detachment, and displacement (Ramos(1)). Available maps of terrane distribution representing their limits were originally defined by recognizing zones of the crust with similar geological features (lithology, structures, age, etc.) and specific rock associations that can be related with possible sutures. However, a graphic representation from which to obtain a more complete knowledge of the nature of the Andean basement and its geochemical heterogeneity at the scale of the entire margin is scarce. This lack of knowledge hinders a more complete understanding of the current configuration of the Andean crust and its past tectonic evolution.

There are only a few works, such as those by Mamani et al.(2,3) that, based on the systematic analysis of elemental concentration and isotopic composition of distinct types of rocks in the Central Andes, redefined the limits and established crustal domains at a higher spatial resolution. These authors show that an isotopic-geochemical characterization of the crust based on the isotopic ratios of Pb and elemental ratios of relevant elements is significant, due to it reflects the composition of the underlying basement from which there has been a periodic extraction of Pb, product of magmatic activity over time (MacFarlane et al., 1990; Aitcheson et al., 1995). Therefore, a good characterization and analysis of this variability will be especially useful to understand the diversity of the basement and its relationship with the presence of terranes of a different nature. In addition, it would contribute to cases where basement rocks outcrops attributable to certain terranes are limited, as an illustration of that, the case of Chilenia (Alvarez et al.(4))

To carry out the above, samples of igneous and metamorphic rocks from different databases that covered a time range from the Proterozoic to the Holocene were used. The main source was the open access database GEOROC (Geochemistry of Rocks of the Oceans and Continents; Lehnert et al.(5)), from which 14,773 samples corresponding to 515 papers published in the studied area (13°-43°S) were reviewed. These were verified, completed, and corrected, obtaining 10,405 samples corresponding to 368 papers. In addition, 1,674 samples were included from Loewy et al.(6), Lucassen et al.(7), Mamani et al.(2) and Oliveros et al.(8). The integrated database includes more than 2,000 present-day Pb isotopic ratio data and more than 8,000 points with Sr/Y, La/Yb and Sm/Yb ratios.

Subsequently, maps of the Pb isotope distribution of the Andean basement were made, to identify and characterize geochemically contrasting zones. The preliminary results show coherence between the three elaborated maps for the different isotopes of Pb, and distinguishable radiogenic sectors. In the north, a less radiogenic portion between 15°-22°S becomes increasingly radiogenic towards the south up to 28°S, coinciding with the Arequipa-Antofalla terrane. South of 28°S, an important less radiogenic zone is clearly denoted, which towards the Pacific coast varies to more radiogenic. Northwards of 33°S, the limit between these two domains is more or less parallel to the supposed limit between Chilenia and Cuyania, but it is displaced further to the west. South of 33°S, this boundary is more diffuse, but appears to be significantly further west. Meanwhile, south of 39°S, a non-radiogenic domain is observed, which would coincide with the terranes of Patagonia.

Finally, an analysis of the geological nature of the resulting crustal domains will be carried out, and this will be compared with the information of the proposed terranes accreted to the Andean margin, in order to refine the terranes limits and discuss their geological nature.

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Sm-Nd and Sr isotope and geochemical compositions of mantellic vs. crustal sources of clastic sediments in the Resende continental rift basin, SE-Brazil

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The Resende Basin (RB), SE-Brazil, is a 47 km long and 4.5 km wide half-graben developed during the Paleogene continental rifting event that followed the breakup of Gondwana and the opening of the South Atlantic Ocean in the Late Cretaceous. The sedimentary record of the RB comprises up to 500 m thickness of high-energy siliciclastic alluvial deposits that reflect various tectonic episodes. Its basement comprises a Proterozoic-Cambrian granite-gneiss orogenic complex intruded by Cretaceous intra-plate alkaline stocks. Previous evolutionary models for the syn-rift stage of the RB propose that sediment was either deposited in several different depocenters isolated by basement highs, or in a single depression. The isotopic contrast between old continental crust- and mantle-derived sources in the basement makes the RB an ideal natural laboratory to test sedimentary provenance models and to discuss sediment dispersal patterns along continental rifts. Major and trace element geochemical compositions were used to evaluate the potential effects of source weathering and hydrodynamic sorting during transport, in the Sm-Nd and Sr isotopic compositions. Similar trace and rare earth elements composition in sandstones and mudstones imply poorly mixed sediments. Provenance is associated with felsic and intermediate igneous compositions for the sources with a subordinate mafic component. Mudstones are enriched in elements typically associated with heavy minerals (Ti, Zr, Hf, and Y). Although detectable, weathering and mineral sorting were not so important for the chemical and isotopic composition of the RB sediments, and most of its variations are due to source area chemistry and different degrees of mixture between contrasting source components. Sm-Nd and Sr isotope results show that alluvial fan conglomerates perfectly mimic the isotope compositions of their respective adjacent basement units. Fans adjacent to Cretaceous alkaline stock and to Precambrian gneisses represent two compositional end members, respectively one juvenile and the other one with old continental crust signatures. The axial fluvial sediments display isotope signatures reflecting mixtures of different proportions of these end members. More than 60 % of alkaline-derived sediment is recorded by $\varepsilon Nd_{(40\ Ma)}$ higher than -10 and T_{DM} ages younger than 1.25 Ga, while samples with no or low alkaline-derived component have more negative values of $\varepsilon Nd_{(40\ Ma)}$, from -13 to -20, and older T_{DM} ages, from 1.47 Ga to 2.05 Ga. This heterogeneity of isotope compositions indicates that the RB sedimentary record represents very proximal sources, rather than the product of deposition of distal, well-mixed sediments. The paleogeography of the RB was then marked by its compartmentalization in at least two depocenters separated by a structural high that acted as a barrier, retaining the sediment supply coming from the Cretaceous alkaline massif, but connected by an axial fluvial system. These results are compatible with what is seen in other rift-related sedimentary environments, such as the Rio Grande and the North Sea deposits, where Nd and Sr composition of first-cycle clastic sediments reflect their parental source isotopic signature.

Financing: FAPERJ; CAPES; CNPq.

A new U-Pb detrital zircon age for the Arrayán Formation in north-central Chile. Implications for the chronological assignment of its deposition and the evolution of the Choapa Subduction Complex

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The Arrayán Fm. comprises a thick, well stratified, strongly folded rhythmic succession, exposed along the Chilean coast, between 31°30' and 32° S, interpreted as the frontally accreted portion of the Choapa Subduction Complex (CSC). The succession consists of turbiditic sandstones and dark pelitic intercalations. Sandstone layers are between 15 and 100 cm thick, and show development of Bouma features. The basal surface of the sandstones is sharp, and the upper surface grades into the next pelitic level. Sandstones consist of quartz, sodic plagioclase, muscovite, and biotite grains; zircon and tourmaline are accessory phases. The Arrayán deposits are unconformably overlain by the marine neritic and richly fossiliferous late Early to early Late Permian Huentelauquén Fm. Zircon U-Pb age determinations on pebbles of magmatic rocks from within this formation yielded ages of 332±4 Ma, 294±4 Ma and 298±11 Ma (1) in agreement with the reported paleontological age.

Some authors have indicated that the Arrayán Fm. lies unconformably on metamorphic units of the CSC. However, considering that the metamorphic units correspond to the basally accreted portion of the complex, the contact between the two portions of the accretionary prism is necessarily of tectonic origin. A 304±7 Ma U-Pb zircon age on quartz-mica schists from the CSC indicates that basal accretion occurred coevally with deposition of the Huentelauquén Fm. and, therefore, later than deposition of the Arrayán Fm.

The age assignment of the Arrayán Fm. has been attempted by means of paleontological and isotopic analyses. Poorly preserved fossil remains have been reported from: 1. The type locality (Arrayán Cove), 2. Puerto Manso locality, and 3. East of the type locality. Plant rests from the type locality were assigned a Late Devonian to Early Carboniferous age. A Late Carboniferous age was assigned to the Puerto Manso deposits and a Devonian age for those of locality ((2), (3)). At Agua Dulce Bay, metaturbidites with a mineralogical composition similar to that of the Arrayán Fm. form a stratified succession that grades N-ward into a broken formation. The metaturbidites yielded mid-Early Carboniferous maximum depositional ages of 330 ± 7 Ma, and 340 ± 5 Ma, which are similar to those obtained in the Arrayán Fm. (1).

A detrital zircon age on a turbidite of the Arrayán Fm. (PS-8; this abstract) from the north shore of Puerto Manso yielded well-defined peaks at ~342 Ma (Mississipian) and ~385 Ma (Ordovician), a barren Devonian interval, and a long tail into Early Proterozoic zircons. These and the above-mentioned isotopic ages (i) reinforce the conclusion that the Arrayán Fm. is younger than the mid-Early Carboniferous and older than the late Early to early Late Permian Huentelauquén Fm., and therefore, can be assigned a Late Carboniferous (Pennsylvanian) age (1), and (ii) indicate that the development of the frontal accretionary wedge occurred prior to basal accretion. Additionally, based on the similar maximum depositional ages from the Arrayán Fm. and the metaturbidites, we infer that (i) both deposits accumulated in a same, or a similar, sedimentary environment, probably the trench, and belong to the frontally accreted portion of the accretionary prism, and (ii) the broken formation associated with metaturbidites could represent a slump in the accretionary wedge. Finally, we conclude that the age of the Arrayán Fm. is younger than the Late Devonian to Early Carboniferous age assigned mostly on the basis of its paleofloral content. Absence of Devonian detrital zircons are probably related to the scarcity of Devonian plutons in the provenance area, in which Ordovician (Famatinian) magmatic rocks were common.

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Geochemistry, U–Pb geochronology, and Sr-Nd-Hf isotopes of a SW-NE transect in the southern Peninsular Ranges batholith, Mexico: Cretaceous magmatism developed on a juvenile island-arc crust

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The Peninsular Ranges batholith (PRB) is a North American Cordillera segment with a long record of subduction-related magmatism (177-92 Ma). However, such a record is regionally fragmented, showing broad petrologic variations challenging to integrate into a coherent geologic evolution history. This work focus on the petrogenesis of plutonic and host rocks of the southern Peninsular Ranges batholith along the Sierra El Arco-San Francisquito transect, which provides a subduction-related record from the Middle Jurassic to Late Cretaceous (166-92 Ma). The Middle Jurassic-Early Cretaceous (166-140 Ma) magmatism developed as an island arc with sedimentary rocks of intra-arc and oceanic marginal basins (between the arc and the continental margin). The Jurassic arc sequence, affected by greenschist facies metamorphism, is exposed in the Sierra El Arco. The Jurassic sequence was intruded by the Calmallí pluton of basic to intermediate composition with average values of εSr_t (-3.6, n= 6), εNd_t (+3.3, n=6), and εHf_t (+6, n=3) that suggest an origin from mantle-derived melts with a low degree of contamination. These rocks display rare earth elements (REE) patterns without heavy REE depletion suggesting fractionation under the stability field of plagioclase. The parental magmas evolved into intermediate composition through fractional crystallization and assimilation. Fractional crystallization generated subparallel REE patterns with similar εNd and εHf values, whereas magma contamination produced enrichment in the light REE and less radiogenic εNd and εHf values. Eastward of the Calmallí pluton, acidic plutonic rocks (100-92 Ma) are exposed continuously from the Piedra Blanca to the San Francisquito region. The εSr_t (average -4.7, n=9), εNd_t (average +0.8, n=9), and εHf_t (average +2.6, n=3) isotopic signatures in these acidic rocks suggest a mantle-derived melt genesis with increased contamination. Most of the acidic rocks display a characteristic depleted-HREE pattern suggesting differentiation at deep crustal reservoirs under the influence of garnet. The Jurassic-Cretaceous (166-92 Ma) magmatism of the Vizcaíno-Sierra El Arco-San Francisquito transect, perpendicular to the paleo-trench, displays an εSr_t vs. εNd_t correlation trend indicating progressive contamination of mantle-derived magmas with a recycled crust. The Sr-Nd and Nd-Hf isotopic mixing curves suggest a contaminant with the isotopic signals of Triassic paragneisses of NW-W Mexico instead of the considerably older and isotopically evolved Precambrian basement of NW Mexico. The integration of this work with data from the NW-W of Mexico suggests a continuous magmatic activity from the Middle Jurassic to the Late Cretaceous. We consider the geochemical, isotopic, and temporal variation of the PRB indicative of natural heterogeneities along the trench axis of a long-lived arc system (crustal thickness and paleogeography) as a consequence of continuous subduction of the Farallon plate below the North American plate.

Financing: This work was supported by the Consejo Nacional de Ciencia y Tecnología (CONACyT), the Centro de Investigación Científica y de Educación Superior de Ensenada, and the Universidad Autónoma de Sinaloa.

Detrital zircon geochronology as a proxy for the extension of the Devonian Chaitenia terrane, southern Chile

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U-Pb age spectra of detrital zircons of igneous origin from metasedimentary rocks from late Paleozoic to early Mesozoic accretionary complexes of the continental margin of southwestern Gondwana provide information about the chronology of the source areas. The rocks from the considered sector show a consistent detrital fingerprint: abundant Devonian population, a minor Ordovician peak, minor Precambrian peaks at ca. 550-600 Ma and ca. 1050 Ma, and a marked gap between ca. 650 and ca. 950-1000 Ma. This detrital fingerprint extends from south of the Lanalhue fault zone (~38°30'S) to north of the Chonos archipelago (~44°S). A non-parametric Kolmogorov-Smirnov test confirms that a statistically significant difference exists between the age spectra of the rocks from these latitudes and coeval geological units located immediately north and south (Western Series and Chonos Metamorphic Complex, respectively). These detrital zircons are supposed to derive from Devonian magmatic arcs, including Chaitenia, which collided with the southwestern margin of Gondwana. Fossil content and maximum depositional ages of detrital zircons constrain the depositional age to ca. 380-400, and tectonic setting analyses through cumulative distribution of detrital zircon ages reveal a transition from subduction to collision between 400 and 380 Ma.

Financing: FONDECYT 1180457.

Isotope ordering in vertebrate biominerals as a tool to reconstruct body temperatures and past environments

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^{13}C-^{18}O isotope ordering in carbonate groups in calcite, aragonite, and apatite is temperature-dependent and forms the basis of a tool for paleothermometry. Here I summarize our previous work showing that this isotope signature in teeth and eggshells reflects body temperatures of the organisms that produce them and report a new temperature calibration derived using shark and fish teeth. I show that there is potential to reconstruct the body temperatures of extinct organisms from measurements on well-preserved fossils. We have reported results from dinosaurs such as *Camarasaurus* and present new data on sharks such as *Otodus megalodon,* and in both cases we find body temperatures that are consistent with a degree of endothermy in both cases. I also discuss the potential for diagenetic alteration of isotopic ordering in vertebrate biominerals.

Tectonic relationship between the Perau and Betara formations, Southern Ribeira Belt, Brazil

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The aim of this work is to better understand the tectonostratigraphic relationship between the Perau and Betara formations, which crop out within the Apiaí Terrane, Southern Ribeira Belt, Brazil. These formations comprise metasedimentary and metabasic rocks with stratigraphic and geochronological similarities. Based on these similarities, many previous authors have correlated these two formations. Both formations overlie 1.75 Ga Paleoproterozoic metagranitoides that are referred to as the Betara and Tigre nuclei. Furthermore, they both show three stratigraphic sequences: i) a Basal Sequence, that consists primarily of quartzite; ii) an Intermediate Sequence, which is comprised of marbles and calc-silicate rocks; and iii) an Upper Sequence, that is comprised of metapelites with interlayered metabasic rocks, which have yield ages of 1.48 Ga. To test the connections between the Perau and Betara formations, we plan to use petrography, lithogeochemistry, Sm-Nd isotopic geochemistry, and U-Pb geochronology in the metabasic rocks. We will also perform a provenance analysis using detrital zircon grains in quartzites and metapelites from the Basal and Upper Sequences, for both formations. The preliminary data show that the protolith of the metabasic rocks were gabbros, which have been metamorphosed to green-schist and amphibolite facies. These data show E- to N-MORB signatures within the tholeiitic series. Possible suprasubduction zone signatures in these rocks are marked by low Nb/La ratios (less than 1) and Ti/V ratios (between 10 and 30), which occur in some samples that have high MgO content (11-14%). The preliminary provenance data are from a quartzite of the Basal Sequence of the Perau Formation. These data show ages that range from 1.58 to 3.8 Ga, with a main peak at ~2.2 Ga. The maximum depositional age based on the youngest single grain is 1585 ± 38 Ma. This age is consistent with the stratigraphic framework proposed by previous authors, which places the quartzites stratigraphically below the 1.48 Ga metabasic rocks of the Upper Sequence and stratigraphically above the 1.75 Ga metagranitoides of the Tigre basement core.

High-Precision Geochronology in the El Quemado Complex of the Chon Aike Silicic Large Igneous Province: A Short High-Flux Event within a Longer-Lived SLIP

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Silicic large igneous provinces (SLIPs) are considerably less abundant in the geological record than their mafic counterparts; therefore, these large volumes of silicic magmatism are likely generated through different mechanisms. Existing geochronology suggested an overall long lifespan for SLIPs (20-40 Myr), commonly punctuated by shorter-lived pulses of higher volcanic output (1-5 Myr), but detailed studies of individual pulses are lacking. Our study area, the Jurassic Chon Aike LIP (CASP), is a unique example where voluminous silicic magmas (>200,000 km3) (1) were generated predominately via crustal anatexis over 40 Myr.

The Late Jurassic volcanic El Quemado Complex (EQC) records the final stages of the CASP magmatism and their zircons may record a distinct pulse of volcanism. Our in-situ zircon ages for the EQC suggest a protracted duration of ~5 Myr; however, our new high-resolution CA-ID-TIMS data indicate a much shorter time span on the order of <500,000 years. The $\delta^{18}O$ compositions (>7-9‰), non-radiogenic εHf_t compositions (-2.0 to -8.0) and abundant xenocrystic cores indicate significant melting of a metasedimentary basement lithology (>70% of magma is crustal-derived) to generate the EQC volcanism. Thus, exceptional geological conditions were necessary to erupt an estimated >10,000 km3 volume (1) of explosive silicic volcanic material on such short timescales.

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Financing: This research is funded by the Swiss Nation Science Foundation (200021_175808).

$^{40}Ar/^{39}Ar$ ages of the Aguapeí Thrust Belt (SW Amazonian Craton): Crustal evolution and metallogenetic implications

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SW Amazonia craton comprises terranes formed or reworked during accretionary and collisional events coeval to the Rodinia collage related to the development of Grenvilian (Sunsás/Aguapeí) mobile belts. As a result of the collisions between older cratonic areas, the formations of the orogenic terranes define sites of important metal concentrations, mainly gold. Although a great number of ore deposits should be found within Grenvilian mobile belts, comparatively few deposits in South America are reported in the literature.

Samples from the Aguapeí Thrust belt rocks were collected at different localities from open pits and from road cut outcrops. The micaceous rock samples were crushed and sieved at 30-60 mesh, and the sericite crystals were separated from quartz and oxides by handpicking under a binocular microscope. The grains were placed into aluminum containers and irradiated at nuclear reactor. The analyses were done using the Mass Analyzer Products (UK) MAP-215-50 mass spectrometer.

This work presents $^{40}Ar/^{39}Ar$ ages from Pontes e Lacerda gold deposits located in the boundary of Bolivia and Brazil. The purpose of the $^{40}Ar/^{39}Ar$ dating method was to obtain age constraints of deformational events and of hydrothermal alteration responsible for the mineralization. New data allow to constrain the period of collisional and hydrothermal solution percolations and to approach crustal evolution and metallogenetic modeling in order to contribute to a better understanding of the end of Mesoproterozoic times in SW Amazonian craton envisaging paleocontinent reconstructions.

The $^{40}Ar/^{39}Ar$ ages of hydrothermal sericites analysis from gold deposits hosted in the Aguapeí Group yielded cooling ages from 914 to 912 Ma. We interpret the ages as result the Sunsás-Aguapeí orogenic process generated the structures that made possible the circulation of hydrothermal solutions coeval with deformation. This late-tectonic event probably was responsible for the metallic accumulation of the Pontes e Lacerda gold district. The geological mapping of gold deposits revealed that auriferous ore in a regional scale is controlled by shear zone and detachment surfaces. The $^{40}Ar/^{39}Ar$ cooling age of 912-906 Ma represents the orogenic processes and comprises an important metallogenetic epoch in Amazonian craton.

High-Mg and shoshonitic volcanism in the Transmexican Volcanic Belt front, Cahulote Graben, Michoacán, México: Geochemical and isotopical constraints

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The coexistence of shoshonitic and calc-alkaline magmatic series in volcanic arcs occurs predominantly in the back arc zones and these are rarely present in the volcanic arc front.

The Cahulote Graben (CG) represents a NE-SW extensional transtensional volcano-tectonic basin, localized in southeastern Michoacán Guanajuato Volcanic Field (MGVF). The CG is characterized by a high density of monogenetic volcanism and the coexistence of shoshonitic and calc-alkaline magmatic series. We present the geochemical, petrological, and isotopic characteristics of the CG and their relationships with the regional tectonics.

The calc-alkaline medium potassic lavas are the most abundant products (basaltic andesite and andesite), while the high potassic and shoshonitic magmas (trachybasalts and basaltic trachyandesite) are <18% of total. High-Mg calc-alkaline lavas are porphyritic (10-20% Ol+Plg±Cpx phenocrysts), whilst low-Mg calc-alkaline lavas are aphanitic (<10% phenocrysts Cpx+Opx+Plg±Ol±Amp) with trachytic, intergranular and pilotaxitic textural variation with groundmass assemblage including glass+Plg+Ox±Ol±Cpx. The shoshonitic lavas of the CG are commonly aphyric with <10% of phenocrysts and with Ol+Cpx+Plg±Phl assemblage. However, the Petembillo shoshonitic spatter cone consists of porphyritic rocks with 20% phenocrysts and Phl+Cpx+Ol+Plg+Amp mineral assemblage.

The calc-alkaline medium potassium lavas can be divided into two groups according to their MgO content: High-MgO (6-10 wt%) and Low-MgO (<5 wt%). However, both show homogeneous and similar trends in major elements. The shoshonitic and high potassic magmas have higher values of MgO (6.5-10 wt%), TiO_2 (1-1.5 wt%), P_2O_5 (0.5-1 wt%), and lower Al_2O_3 values with 14-16 wt%, as well as high LILE and slightly enrichment on immobile elements (e.g. Nb, Ta). Calc-alkaline, High-Mg, and shoshonitic lavas show the subduction-related signature of LILE enrichment. Particularly, Mesa El Burro shows high TiO_2 (~2 wt%), as Sr and Eu positive anomaly, associated with the high plagioclase phenocryst content.

Calc-alkaline lavas show $^{87}Sr/^{86}Sr$ values between 0.7038-0.7041 and $^{143}Nd/^{144}Nd$ values of 0.5127-0.5129. The shoshonitic lavas have slightly higher $^{87}Sr/^{86}Sr$ values (0.7040-7043). Particularly, the Verde and Cántaro volcanoes show similar isotopic signatures to the pre-subduction mantle composition (Northern Mexican Extensional Province type mantle) with the lowest $^{87}Sr/^{86}Sr$ values (0.7031 - 0.7034) and highest $^{143}Nd/^{144}Nd$ values (0.51295).

The CG volcanism was developed in the last 2 Ma and it can be divided into four principal periods: i) 1.7 - 1.6 Ma were emplaced the shield volcanoes and lava plateau (2.2 km^3), ii) 1-0.6 Ma the rate eruption decreased and were emplaced cinder cones (0.38 km^3), iii) 0.6-0.3 Ma rate eruption increased erupting spatter cones (3.8 km^3) with High-Mg and shoshonitic products, iv) the last 100 ka scattering spatter and cinder cones related to highest eruption volume (5.5 km^3). The shoshonitic, high-Mg and high TiO_2 lavas emplaced through spatter cones focus on the hanging wall at the intersection of two regional normal faults.

The coexistence of shoshonitic and calc-alkaline magmatic series at the CG region in the volcanic front of the MGVF is related to the concomitant extensional and transtensional tectonic systems, which assisted the ascend and emplacement magmas from different reservoirs with heterogeneous and metasomatized mantle sources and, they are also linked to complex geodynamic processes along the North and South segments of the Cocos plates subduction zone.

The strontrium isotopic composition of the mesozoic sedimentary formations of the Southern Central Andes (33°-34°S)

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We present a Sr isotopic database ($^{87}Sr/^{86}Sr$) of the main lithologies of the southern Central Andes (33°-34°S), with new chemical and isotopic analysis of sedimentary rocks. The samples were obtained in shales, limestones, and fine-grained sandstones from various Mesozoic formations in the Main Andes and the Coastal Cordillera (Río Colina, Río Damas, Lo Valdés, Colimapu, Lo Prado and Las Chilcas).

The new data on the Mesozoic sedimentary rocks show values of $^{87}Sr/^{86}Sr$ between 0.7038 and 0.7124, corresponding to three rock groups with the following ranges: a) Clastic rocks: 0.7038 - 0.7124; b) Carbonatic rocks of the Andes Cordillera: 0.7070 - 0.7081; and c) Carbonatic rocks of the Coastal Cordillera: 0.7041 - 0.7067. The signatures in most of the clastic units in both Cordilleras are related to an evolved or enriched magmatic source and indicate different sedimentary sources. On the other hand, the composition of calcareous and bituminous rocks differs between the units in the Andean and the Coastal Cordilleras. In the Andes, carbonatic units display $^{87}Sr/^{86}Sr$ ratios similar to the contemporary ocean in the late Upper Jurassic (0.7070 - 0.7074), whereas in the Coastal Cordillera do not show a relation with oceanic signatures, in all its corresponding temporalities.

Sr-isotopic compositions of the Andean carbonate units support the interpretation of its marine depositional environment in the paleo Pacific Ocean. In contrast, carbonate rock samples from the formations in the Coastal Cordillera suggest that they formed in brackish-water depositional basins made by topographic highs that partially disconnected them from the paleo Pacific Ocean. In the case of clastic rocks, their signatures provide some insight into the sedimentary contributions derived from the late Jurassic to Cretaceous magmatic arc to the clastic units.

Financing: FONDECYT 11190029.

New age constraints fr the Mamil Choique Granitoids: dating a muscovite biotite leucotonalite-granodiorite in the Sierra de Mamil Choique, SW North Patagonian Massif

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The Early Permian to Early Triassic magmatism in the W-SW margin of the North Patagonian Massif (NPM) is mainly represented by the Mamil Choique Granitoids (MCG) or Mamil Choique Formation ((1), (2), (3), (4)). These ca. 281-259 Ma granitoids ((5), (6), (7))] intrude the metamorphic Cushamen Formation (CF), the youngest detrital zircon of which is ca. 440 Ma (8). Age of the main metamorphic peak of CF is constrained by a WR Rb-Sr dating of S2-granites of ca. 370 Ma (9). The mainly weakly peraluminous calc-alkaline crustal derived MCG (3) that crop out in an area of more than 350 km^2 in the Sierra de Mamil Choique (41º 50.6'S 70º 09.0'W) consist of four units: banded biotite ± amphibole tonalite and granodiorite, foliated and banded biotite-muscovite monzogranite, porphyric biotite-muscovite monzogranite and muscovite-garnet monzogranite. In the central part of the Sierra a discontinuous ENE-EW trending belt of CF septa is made up by a parallel variable south dipping 2-20 m wide septa of different length. Granitoid facies in clear cut contact with the septa are locally deformed and, in many cases, interlayered either folded with axial planes parallel to the metamorphic fabric or boudinated. The aim of this contribution is to present the age of one of these interlayered/boudinated granites to unravel if they belong either to the metamorphic history of the CF or to the magmatic history of the Mamil Choique Granitoids. The dated sample RC78b (41º 50'S 70º 13'W) is a medium grained muscovite±biotite leucotonalite-granodiorite with overgrown muscovite blasts. Field observations indicate that this rock does not correspond to any of the main facies so far recognized in the Sierra. Thin biotite folias/schlieren next to the sharp contact with CF are represented in thin sections by disaggregated fine grained biotite±quartz folias. Zircons were dated with a MC-ICP-MS Neptune at Centro de Pesquisas Geocronológicas of the Sao Pablo University. 58 measurements were used due to the high concordance (90-110%) and low common Pb content. One or two (core-rim) 20µm spots per analyzed zircon were measured. A calculated concordia age of 272.4 ± 1.1 Ma (MSWD= 0.023) was obtained from n=24 and an inherited age of 1056.9 ± 11 Ma (MSWD= 0.47) from n=6. The remaining data (n=28), shows a pattern with smaller peaks in 509, 630, 840, 1050 and 1280 Ma. The youngest zircons are characterized by very low Th/U (~0.2) and an average of U of 790 ppm while Th/U of the Greenvilian inherited zircons is close to 1.0 with average U of 76 ppm. The new age is within the range of ages calculated for the MCG being in consequence younger than the age for the CF syn-S2 granites. Besides the main peak of 272.4 ± 1.1 Ma, age distribution pattern of sample RC78b shows smaller peaks at 509, 630, 840, 1050 and 1280 Ma which are roughly equivalent to the peaks for the CF septa located 1.5 km further north ((4), (5), (6), (10), (11)). These smaller peaks in sample RC78b might result from the incorporation of zircons from Bt folias of the host. In the zircon spectra of CF septa ((4), (5), (6), (10), (11)) the peak at 287 Ma might suggest incorporation of zircons from the banded tonalite-granodiorite of MCG. Alternatively, the smaller peaks could be considered as inherited from a source with contributions of partial melts from the Cushamen Formation. Instead of being representative of another main granite pulse of the sierra, this 272 Ma leucotonalite-granodiorite may be a highly evolved peraluminous differentiate of the 281 ±2 Ma MCG banded tonalite-granodiorite (6) or even result from partial melting of the CF due to the thermal input of the voluminous early Permian magmatic pulse. On going U-Pb dating as well as petrological research will address this issue.

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Does detrital zircon really record tectonic setting?

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The widely used model of (1) that uses differences between crystallization and deposition ages (CA – DA) from zircon is thought to be able to predict the tectonic setting in which a sedimentary sequence was formed. According to this model, extensional settings (including intracratonic ones) are characterized by (CA – DA) values > 150 Ma in the youngest 5 % of the zircon ages (step 1), and samples from convergent settings are characterized by (CA – DA) values of < 100 Ma for the youngest 30 % of zircon ages (step 2). This model has been used extensively in the last 10 years but many of us have seen results that do not match a correct tectonic setting, when our data are plotted into this scheme. In the northwest of Argentina there is an excellent example of thick Cenozoic foreland basin deposits associated with the Andean Orogeny - the Payogastilla Group clastic sequence (Eocene-Pliocene). This group is composed, from the base to the top, of the Los Colorados, Angastaco, Palo Pintado, and San Felipe formations. These strata were accumulated in a broken foreland basin, whose morphology resulted directly from the tectonic inversion of rift basin deposits of the Cretaceous-Paleocene Salta Group. We plotted 468 U-Pb provenance ages for zircon, obtained by LA-ICPMS, from the Maiz Gordo and Lumbrera formations (Salta Group encompassing post-rift deposits) and from the Los Colorados and Angastaco formations of the Payogastilla Group. The data indicate a main Silurian-Ordovician provenance with peak ages for all units around 475 Ma. Minor populations with age peaks at ~1000 Ma were also observed, mainly for the Lumbrera and Los Colorados formations from the Tin-Tin area. The main provenance is related with the Famatinian magmatic arc, located directly to the west in the Puna plateau region. A typical foreland basin will form behind a continental-margin arc system and will be filled mainly with clastic terrigenous sediments derived from a fold-thrust belt behind the arc. Conspicuous characteristics of this system include the syntectonic character of the sediments and the progressive involvement of the proximal basin margin in the propagating fold-thrust belt. The results allow us to conclude that there is practically no change between the post-rift and the foreland provenances. The respective data for the post-rift and foreland sequences are plotting erroneously into the extensional setting of the (CA – DA) vs. Cumulative Distribution field. This example demonstrates that we must be careful when using diagrams that “predict tectonic setting” for every sedimentary package of known or unknown tectonic setting. As in the case of the Payogastilla Group, mainly formed in a broken foreland basin, controlled by tectonic and climate conditions, detrital zircons will not register the real tectonic setting. Even older basin formations have likely experienced more complex histories that might obscure their true original tectonic setting. And even in cases of younger basins, such as the Devonian-Carboniferous Tarija Basin in southern Bolivia, where the tectonic history is not well constrained, can one trust the application of this provenance scheme in the absence of any further tectonic constraints? To avoid this kind of bias, more robust analysis must be carried out: at the large scale, the geometry of the basin, the accommodation space in the depocenters, or inherited structures, and at the small scale, the hydraulic sorting, weathering, and reworking or recycling of sedimentary strata need to be investigated - before a set of provenance data can be interpreted in terms of “predictive tectonic setting diagrams”. In combination with multiple provenance proxies, we can avoid incomplete or erroneous provenance interpretations.

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Financing: CAPES, under Finance Code 001LEGGAGrants No. 309878/2019-5 (CNPq)GASTRIP ProjectIRD.

Neoproterozoic magmatic arc systems of the central Ribeira belt, SE-Brazil, in the context of the West-Gondwana pre-collisional history: a review

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This synthesis presents the complex evolution of two different magmatic arc systems in the Ribeira orogenic belt, which were progressively accreted onto the southeastern and southern border of the São Francisco paleocontinent (Occidental terrane) during the Neoproterozoic. The Inner Magmatic Arc System (IMAS), presently located in the Central terrane, developed between ca. 650 and 595 Ma along the continental margin of a Paleoproterozoic microcontinent, and is equivalent to the Rio Doce Arc in the Araçuaí orogenic belt. Few inherited zircons of Tonian age, and one description of a Tonian body related with the Embú Complex in the southernmost Ribeira belt, indicate that subduction could have started earlier in this segment of the orogen. Geochemical and isotopic data point out to cordilleran setting, but also indicate some juvenile contribution. Fore and back arc sedimentary basins with bimodal provenance signature (basement+ arc) also testify the evolution of the IMAS, which collided against the southeastern margin of the São Francisco (SFC) paleocontinent between 620 and 595 Ma, resulting in syn-collisional granitoid magmatic rocks that were emplaced in both the lower and upper lithospheric plates. This first collision episode is characterized by relatively high- to medium-P metamorphism, inverse metamorphic zoning in the lower plate, and by intense transpressive deformation of the previous passive margin units.

The Outer Magmatic Arc System (OMAS), presently represented by the Oriental terrane, comprises the rocks of the Serra da Prata and Rio Negro magmatic arcs. The available geochemical, geochronological, and isotopic data of magmatic rocks indicate a two-stage evolution: an intra-oceanic arc setting between ca. 860-760; and a Japan-style tectonic setting for the ca. 640-605 Ma second stage. During both stages, geochemical polarity points to east-verging subduction, as well the coeval development of two stages of fore and back arc basins. Basins of the first stage of the OMAS point out to intra oceanic seting and provenance data indicates exclusively arc-derived sources. The basins of the evolved stage of the OMAS, conversely, have bimodal provenance in the distal facies, pointing out to arc and African sources, testifying the progressive shortening of the oceanic space behind the arc. The OMAS collided against the Ribeira belt at ca. 605-565 Ma. This renewed collisional episode also resulted in severe melting of the crust, generating both metaluminous and peraluminous granitoids, together with high-T and relatively low-P granulite facies metamorphism. Docking against the Cabo Frio terrane (African block) between 535 and 510 Ma finally closed the oceanic back-arc space during the terminal stages of Gondwana supercontinent amalgamation.

During this long period of subduction, continually or not, the OMAS and IMAS arc systems produced considerable volumes of Neoproterozoic juvenile magmatic addition to the crust. If considered together with other examples in West-Gondwana, the Neoproterozoic magmatic arc development testifies a dynamic scenario until the final docking onto the SFC paleocontinent. Finally, the pre-collisional magmatic evolution envisaged here for the Ribeira belt is very similar in time and composition to those of the Goiás Magmatic Arc, in the Brasilia orogenic belt in central Brazil, São Gabriel and Dom Feliciano belts in southern Brazil, as well in the Eastern African Orogen.

Financing: Faperj, Capes, CNPq, CPRM, Finep.

The role of geomicrobiological and physicochemical processes on carbonate deposits within Laguna Timone Maar, Pali Aike Volcanic Field, Chilean Extra-Andean Patagonia

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The Chilean Patagonia Austral is only one of few sites where carbonate precipitation proceeds in a cold environment subject to episodes of freezing and strong winds with tectonic and volcanic process interactions. One of the examples is located in the southern part of Chile, 50 km east of the Andean mountains and north of the Strait of Magallanes, a quaternary volcano-tectonic complex dominates Pali Aike Volcanic Field (PAVF), where the source of magmatism is associated with sub-slab asthenosphere flow through slab windows. The study area is Laguna Timone crater maar. The lagoon constitutes an endorheic hydrological system where the main sources fed are groundwater and rainwater. The annual precipitation about 200 mm and the strong winds are responsible for high evaporation rates per year. Laguna Timone is filled by a body of water with high salinity and alkalinity, cold, and rich in calcium, magnesium, sodium, potassium, nitrate, nitrite, sulfate, and phosphates. Microbialites, carbonate crust, mud, and microbial activity are documented near the shore of the lagoon. The carbonates, mud, and biofilm were analyzed and characterized. The mineralogy of reworked microbialites and crust was calcite and very low percentage of detrital minerals. The clay fraction of the sediment was characterized and is dominated by illite, chlorite, and smectite. HRTEM analysis shows that the amorphous Mg-clay has a relation with calcite crystals. Bacterial and fungal biodiversity was examined using Illumina sequencing of PCR-amplified 16s rRNA and ITS genes from total extracted DNA. The results show that the Proteobacteria, Bacteroidetes, Cyanobacteria and Verrucomicrobia phyla dominated the bacterial communities. Pseudomonas, Rhodobacter, Brevundimonas and Oscillatoria described in the samples have been reported in carbonate precipitation in other sites of similar environment conditions. Bacteria were isolated from biofilm and mats and a bacterial isolate capable of in vitro precipitate calcium carbonate in vitro was obtained. The precipitated crystals were analyzed and the results were consistent with the mineralogy of carbonate rocks showing the evidence of organomineral production. The $\delta^{13}C$ VPDB values (-0.43 ‰ to 2.50 ‰) suggest physico-chemical and biochemical processes during precipitation. The $\delta^{18}O$ VPDB (-6.52 ‰ to 2.28 ‰) values are associated with evaporation processes and meteoric influences. In conclusion, the combination of hydrological, biological, petrological, and climate factors play a role on carbonate precipitation. These exceptional conditions of the site offer an extraordinary scientific value in order to understand specific mineral precipitation processes.

Financing: Diagenesis Project (ANP 20257/2) (LAMIR Institute – Universidade Federal do Paraná (UFPR) – and Shell Brasil Petróleo LTDA). Fondecyt projects (1200870 and 1211906), Chile.

Provenance study of Phanerozoic rocks from the Cordillera Real of Bolivia

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U/Pb ages of detrital zircon grains from two samples of the Ordovician sediments of the Amutara Formation of NW Bolivia, collected near the Huayna Potosí and Zongo plutons of the Cordillera Real, were obtained for a provenance study. The analytical work was carried out at the Instituto de Geociências of the Universidade de São Paulo. The zircon ages for these two samples were added to similar data from the Amutara and Sandia Ordovician formations from SE Perú, and the resulting probability density plots of the $^{206}Pb/^{238}U$ ages were compared with similar density plots for the xenocrystal inheritance of most of the Triassic and Oligocene granitoids of the Cordillera Real, in order to constrain their genetic relationship and possible sources.

The granitic plutons cut through the entire thickness of the Amutara Formation, as well as through the sedimentary pile underneath, belonging to the Eastern Andes, and the age of their xenocrystals range between 300 and 2300 Ma. Many of them correspond to Gondwanide to Famatinian ages (300 to 450 Ma). However, Cambrian to late Neoproterozoic ages are abundant, together with minor older ages up to the late Archean.

The high peak of Cambrian to late Neoproterozoic ages is also recorded in the detrital zircons of the Ordovician country rocks. It is remarkable how the Ordovician samples, as well as the xenocrystal zircons within the granites, show a very compatible pattern for the older ages, with one notable peak related to very similar possible sources. The Kolmogorov-Smirnov test (K-S) was therefore employed to investigate distribution and affinity of ages, and it indicated that the probability density plots for the ages of the detrital zircon grains and those of the xenocrysts are clearly statistically correlated. Therefore, it is suggested that (1), assimilation of material from the sedimentary Ordovician units was carried out by the felsic melts, during their emplacement on the upper crust, and (2), crystallization of the magmas of the Cordillera Real of Bolivia probably occurred by means of an AFC process, with coeval crystal fractionation of several major phases, such as plagioclase.

Based on the resulting geochronological record and considering that the Ordovician sedimentary sequences from SE Peru and NW Bolivia have received zircon grains very probably from the same areas, we are encouraged to suggest potential sources of the detrital zircons, envisaging a possible picture for the paleo-relief in South America during Ordovician to Triassic times.

In a general way, more than half of the detrital zircon grains that were analyzed yielded Neoproterozoic to Cambrian ages, below 1000 Ma. The other half showed a wide age distribution, from 1000 to about 3000 Ma, with a concentration of ages producing a small peak around 2000 Ma. The older sources can be regarded as deriving from the Amazon region. They possibly reflect the existence of a large number of granitic rocks formed during the long-lived tectonic evolution of the Amazonian Craton, in which the largest area, back in Ordovician times, included the Paleoproterozoic rocks of the Central Amazonian and the Maroni-Itacaiunas provinces. Granitic rocks formed later during the successive provinces of Ventuari-Tapajós, Río Negro-Juruena, Rondonian-San Ignacio and Sunsás were also occupying large regions and contributed with somewhat smaller amounts of detrital zircons.

Coming to the largest peak with Neoproterozoic to Cambrian ages, we suggest that it was very probably produced by the erosion of the Himalayan-type mountains that emerged roughly between 900 and 500 Ma, during the formation of the West Gondwana Orogen, along the Trans-Braziliano-Kandi tectonic corridor. However, we cannot rule out sources related to the Sierras Pampeanas, Neoproterozoic belts hidden within the Central Andes, or recycled from pre-existent sedimentary units (such as the Tucavaca basin).

Constraining the location of the Meso-Cenozoic boundary using U-Pb dating in the context of the Pocuro Fault Zone in Central Chile (32-33°S)

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The Pocuro Fault Zone (PFZ) on the eastern edge of the Los Andes-San Felipe Depression in Central Chile is a North-South trending inverse fault system that marks the western limit of the Cordillera Principal. This system is believed to have contributed to the uplift of the Principal Cordillera during the last ~20 Ma ((1),(2),(3)). Previously, it was proposed that the PFZ represents the boundary between the Mesozoic units to the west and the Cenozoic units to the east in the area (4). However, new studies have identified Cenozoic rocks to the west of the PFZ (5) and Cretaceous rocks to the east of the PFZ through in situ studies (2) and interpretation of spectral and electromagnetic bands of lithological units in satellite images (6). It is also hypothesized that a Mesozoic block is overlying Cenozoic units through a series of reverse faults within the PFZ ((2),(3),(6)). However, this hypothesis could not be tested because the ages of the units in this region are not well defined due to the lack of geochronological data. Despite the large (~40 Ma) temporal gap between the youngest Mesozoic unit in the region, Formation Las Chilcas (7), and the oldest Cenozoic unit, Formation Abanico (8), lithological similarities between their facies have made it particularly difficult to accurately map and understand the regional stratigraphy (5). Because of this, coupled with the aforementioned lack of geochronological data, the location of the Meso-Cenozoic boundary in this region is not well defined.

In this study, we better constrain the ages and geographical distribution of the chronostratigraphic units in the region using the U-Pb isotopic dating method in zircons in order to better define the Meso-Cenozoic boundary. Defining the distribution of chronostratigraphic units is crucial to the development of a kinematic model of the region's tectonic history, specifically the timing and nature of the uplift of the western Principal Cordillera between 32° and 33°S.

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Financing: Funding comes from the Fondecyt Regular project N° 1200871 led by investigator Luisa Pinto Lincoñir.

Strontium isotopes applied as provenance proxy for Brazilian woods

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Geochemical proxies have been used to determine the provenance of timbers around the world. The geochemistry of strontium isotopes is relatively well known and $^{87}Sr/^{86}Sr$ ratios have been used routinely as environmental tracers in geology, hydrology, ecology, and archaeology. In Brazil, it is the first time that this methodology is applied for this type of study. The underlying philosophy is that trees uptake chemical elements from local soils and incorporate them into the wood, with strontium being absorbed by the plants as a trace element. Thus, $^{87}Sr/^{86}Sr$ ratios should provide a model system for provenance studies of trees growing on diverse substrates. To test this hypothesis the present study used *Pau-Brasil* woods, a protected and threatened species in Brazil from two different locations, the National Park of Pau-Brasil, in southern Bahia, and the Sooretama Biological Reserve in northern Espírito Santo. The rock substrate of both regions belongs to the same geological unit, the Mid-Miocene Barreiras Group. However, the sedimentary rocks that constitute the Barreiras Group in northern Espírito Santos are made up of older crystalline sediments with high $K/^{87}Rb$, when compared to the other sampling location. Two sample digestion approaches were applied to validate our method. The first used a combination of 4 mL of concentrated HNO_3 and 1 mL of H_2O_2 30 v/v in a hot plate (140 ºC) for 2 hours. In the second, one additional step of 2 mL of concentrated $HClO_4$ and 2 mL of concentrated HNO_3 in a hot plate (170ºC) was performed. In both cases, 100 mg of sample was necessary. After the digestion, the samples were evaporated and centrifugated with 2,9 $mol.L^{-1}$. HNO_3. The first approach presented visually more suspended particles in the centrifuge. The supernatant was collected and passed through a SrSpec resin (100-150µm) for the removal of Rb. The Sr was collected with an 0,05 $mol.L^{-1}$ HNO_3 solution, evaporated, redissolved with HNO_3 3%, followed by analysis in an MC-ICP-MS (Neptune Xr). Reference materials AL1515 and PN1575a (NIST) were used for the method. Values of Al1515 ($^{87}Sr/^{86}Sr$ = 0.71399 ± 0.000003) were in good agreement with reference values and values obtained for PN1575a ($^{87}Sr/^{86}Sr$ = 0.713433 ± 0.000005) were presented for the first time. Our preliminary results showed that the $^{87}Sr/^{86}Sr$ ratio do not vary within the same individual (roots, trunk and branches), confirming the absence of isotopic fractionation within the body of the tree. However, it was possible to observe a clear differentiation on the $^{87}Sr/^{86}Sr$ ratios in relation to the location of the sample (0.709651 values for *Pau-Brasil* in the National Park of Pau-Brasil, in southern Bahia and 0.710614 for *Pau-Brasil* in the Sooretama Biological Reserve, in northern Espírito Santo) different values of the $^{87}Sr/^{86}Sr$ ratio were verified in the rock substrate for each location and these values were indeed reflected in the $^{87}Sr/^{86}Sr$ ratios from the *Pau-Brasil* samples analyzed. These findings highlight the sensitivity of Sr isotopes to variations in the lithology on which trees are seated and thus can be used as an origin tracer for Brazilian woods.

New fossil flora records for Lower Miocene volcanosedimentary and volcanic successions in the Paleo-Magellan Strait Basin

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New fossil flora records have been reported for volcanosedimentary and volcanic successions exposed in outcrops within the main trace of the Magallanes - Fagnano Fault System. Radiometric U-Pb zircon dating in the sector indicate a Burdigalian age (1). The volcanosedimentary succession contains abundant remains of fossil leaves and wood fragments. The floristic associations found here denote mixed assemblage with the presence of *Nothofagus*, which could indicate a cold and rainy temperate climate, as described by (2) for the Lower Miocene successions in central and southern Chile. On the other hand, the successions found are exposed along thick subhorizontal outcrops dominated by volcanic rocks, and present alternations of sandstones, conglomerates, breccias and tuffs, where the sedimentary rocks have a strong volcanic influence. The following questions arise: Which species were dominant during the Lower Miocene in the Paleo - Magellan Strait Basin, and can volcanic events have any influence on the preservation of fossil remains? This work presents new information on the Cenozoic units and their fossil flora content in the Paleo - Magellan Strait Basin, which will provide new data on the palaeoclimate and palaeogeography of the study area.

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Financing: This contribution was funded by Fondecyt grant 1211906.

Implementation of routines for the analysis of the isotopic ratio of C and N in organic matter and for the isotopic ratio of H and O in water

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iLAMIR (Laboratory Institute for Mineral and Rock Analysis) which in the last 4 years has received infrastructure investments to expand and modernize its facilities and equipment, becoming one of the best equipped laboratories for isotopic analysis in Brazil. Developing analytical studies in geochemistry isotope of multi proxy data, where the application of isotopes of H, O, C, N can provide relevant information for the understanding of the most varied geological, geochemical, hydrogeological, biological, metabolic processes, etc. Our main objective was the implementation of a methodology for the analysis of carbon and nitrogen isotopes in organic matter, isotopes of oxygen and hydrogen in water. During this period, it was possible to implement, calibrate and routinely analyze analyzes for $\delta^{13}C$ and $\delta^{15}N$ in organic matter, using fingernail and hair samples. The implementation of the methodology of analysis of water by isotopic equilibrium, also, reached its objective, putting this methodology in routine in iLAMIR. The samples collected were analyzed by the following analytical procedures: Isotopic analysis of H and O in water by gas source mass spectrometry (GasBench II + Delta V Advantage Spectrometer). Determinations in water were performed using the isotopic equilibrium method; for C and N isotopic analyses, by gas source mass spectrometry sampler (Thermo Scientific™ MAS Plus Autosampler + Thermo Scientific™ EA IsoLink™ + Delta V Advantage Spectrometer) by the combustion and chromatographic separation method. For the $\delta^{13}C$ and $\delta^{15}N$ analyzes in organic matter, samples of nails and hair from 16 children aged between 3 months and 12 years were used, collected for 5 months, from July to November 2021. In this case, international standards were used and a secondary benchmark. All values for $\delta^{13}C$ were reported in ‰ units (per mil) in relation to the PDB standard and for $\delta^{15}N$, too, were reported in ‰ units in relation to Air nitrogen (Nair). In implementing the methodology for analyzing $\delta^{18}O$ and δD in water, by isotopic equilibrium, international standards provided by the IAEA were used, the results reported in units ‰ V-SMOW. With this it is understood that it is of paramount importance to create laboratory standards, in the production of these standards it was proposed to use a volume of purified water in the laboratory (~25L), with characteristics of a surface water and another of bottled water of defrost, branded Evian (~25L), produced in Switzerland, already used by other laboratories. The results, for $\delta^{13}C$ and $\delta^{15}N$ for nail and hair samples, are unprecedented and will contribute to the understanding of the isotopic signal for the region of Curitiba, and feed a database, for public consultation and to produce isoscapes. Also, it was possible to differentiate between different diets, which can help in understanding the eating habits of populations. This result is important because it qualifies iLAMIR to offer this methodology both for forensic sciences and for isotopic geology, such as in the analysis of oils, or by-products such as kerogen. The value was determined for both $\delta^{18}O$ and δD, for the two internal standards prepared, called iLAMIR-1A ($\delta^{18}O$ = -10.4‰ ±0.3‰ e δD = -73.0‰ ±1.5‰) and iLAMIR-2A ($\delta^{18}O$ = -3.8‰ ±0.1‰ e δD = -18.7‰ ±1.3‰). The errors obtained for both $\delta^{18}O$ (±0.3‰) and δD (±1.5‰) analyses are within the expected parameters. It should be noted that the isotopic equilibrium method presents greater errors for the values of δD, this is mainly due to the 50% mass difference between mass 2 and mass 3, causing greater fractionation between isotopes. With this, iLAMIR now has the possibility to offer analyzes of $\delta^{13}C$ and $\delta^{15}N$ in organic matter, $\delta^{18}O$ and δD in water and in liquids containing water.

The Roboré microcontinent, SW Amazonian Craton: new insights on the Orosirian-Ectasian crustal evolution from U-Pb geochronology and isotopic constraints

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We present new and compiled U-Pb zircon ages and Nd and Hf zircon constraints for rocks of the Roboré microcontinent, the Eastern Precambrian Shield of Bolivia, located in the SW of the Amazonian Craton. The database together with updated geologic information provides new insights into the Proterozoic evolution. This microcontinent, subdivided into the San Diablo and Paraguá terranes, comprises the following lithostratigraphic units: The oldest San Diablo terrane comprises amphibolite facies gneissic rocks (1941 ± 40 Ma), intruded by the Correreca, Santo Corazon, and Santa Terezita plutons with documented ages between 1874 and 1849 Ma. The Paragua terraine comprises the Lomas Maneches Granulite Complex (1820 Ma), the Chiquitania Gneiss Complex (1750-1690 Ma), and the San Ignacio Schist Group (1690 Ma). This basement was intruded by the Yarituses suite (1683-1610 Ma) and the Pensamiento Granitoid Complex (1440-1270 Ma) which consists of the syn- to late-kinematic granites and the late- to post-kinematic granites.

Seven zircon U-Pb datings determine that the continental crust underwent a long-lived tectonic-magmatic history, during three successive events: 1941-1849 Ma, 1690-1610 Ma, and 1430-1340 Ma. Eventually, the Roboré microcontinent experienced crustal shortening, magmatism, and overprints due to the Sunsás/Greenville (1100-1000 Ma) orogeny that marks the Amazonia-eastern Laurentia collage. The oldest San Diablo terrane comprises amphibolite facies gneissic rocks (1941 ± 40 Ma), which were intruded by plutonic bodies of 1874 and 1849 Ma. The country rocks yield Sm-Nd T_{DM} ages and ε_{Ndt} values from 1.96 to 2.29 Ga, and +1.76 to -2.73 respectively, suggestive of derivation from short-lived protoliths. The Correreca intrusion is as young as 1874-1862 Ma with zircon Hf model ages (T_{DM}) of 2.68 Ga and 2.29 Ga with ε_{Hft}values varying from -4.63 to +2.76. The bulk isotopic signatures for the San Diablo crust are consistent with magma genesis in a juvenile-like accretionary arc, have a calc-alkaline character, and it shows a subduction-related tectonic.

The northern Paraguá terrane contains a granulitic crust dated at 1820 Ma. The available Sm-Nd T_{DM} model ages spread from ca. 1.7 to ca. 2.2 Ga and ε_{Ndt} values range from +3.0 to -2.9, with Paleoproterozoic protoliths. The basement rocks are crosscut by the Yarituses Suite (1683-1610 Ma) located to the west. The latter includes the following granites: La Cruz, Refugio, San Pablo, San Miguel, and Rosario. These granites exhibit Sm-Nd T_{DM} model ages of 1.8 to 2.5 Ga and ε_{Ndt} of +4.06 to -3.8. From a tectonic point of view, these units characterize the Suruquiso accretionary orogeny characterized here that coalesced the San Diablo and Paraguá terranes. Eventuallly, the Paraguá crust is crosscut by the San Ignacio granitoids, collectively known as the Pensamiento Granitoid Complex (1440-1270 Ma). These rocks show Sm-Nd T_{DM} model ages between 1.6 and 2.4 Ga, and predominantly crustal-like isotopic signatures of +5.2 to -4.0 akin to a convergent arc setting. On a broader scale, the granitoids are products of the Alto Guaporé orogeny in the Brazilian counterpart, distinguished by an accretionary phase (ca. 1440 Ma) and a collisional one (ca. 1330 Ma). The San Ramón and Coronación granodiorites (1429-1423 Ma) are pre- to synkinematic to the collisional phase, whereas the La Junta (ca. 1380 ± 17 Ma) and San Martin (1409 ± 17 Ma) granites are syn-to late kinematic. The Diamantina granite (1357 ± 19 Ma) is coeval with the collisional phase, while the San Andrés granite (1289-1275 Ma) is a post-kinematic pluton. The Pensamiento Granitoid Complex documents the Roboré microcontinent collision against the active margin of the proto-Amazonia at the Ectasian. The polycyclic evolution of the Microcontinent ends with the Sunsás/Grenville collision leading to the tectonic stability of the Amazonian Craton.

Financing: CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior). CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico, Brazil.Universidad Mayor de San Andrés, La Paz, Bolivia.

Alunite supergroup minerals for the understanding of the landscape evolution in the southern segment of the Precordillera, Atacama Desert

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The southern area of the Potrerillos District, located in the southern segment of the Chilean Precordillera (above 3000 m a.s.l.), displays several outcrops characterized by the occurrence of alunite supergroup minerals that are of hydrothermal and supergene origin. The isotopy of D, O, and S combined with $^{40}Ar/^{39}Ar$ geochronology of these minerals provide a powerful tool to understand the fluids source, paleo-environment, and changes in the landscape evolution. In this study, we seek to understand the evolution of both hydrothermal and supergene events and figure out the landscape evolution in the southern segment of the Precordillera. Sulfur stable isotopes indicate that jarosite and natrojarosite are of supergene origin while alunite has both hydrothermal and supergene provenance. The geochronology of the hydrothermal minerals indicates two hydrothermal events at 37 and 28 Ma. The δD and $\delta^{18}O$ signatures indicate a predominance of magmatic water and sulfate coming from SO_2 disproportionation in these minerals. The supergene minerals expose a variable record of hydrogen and oxygen isotopes suggesting different events and conditions for their precipitation. In addition, the wide range of hydrogen isotopes combined with the geochronology exposes changes in the paleo-meteoric water isotopy through the history of this area, suggesting uplift events and/or climate changes. Our data indicate relative humid conditions between Eocene to Middle Miocene, favorable for the supergene alteration processes, then, lighter deuterium waters are indicative of an uplift period in the middle Miocene, that coincides with the formation of Asientos Pediplain, a hanged surface with a local base level in the Preandean Depression. Finally, a heavy deuterium signature after 10 Ma indicates a new change in the weather or hydrological conditions that can be related to the rain shadow effect during the summer period that produces precipitation of water coming from the Atlantic during the seasonal “Altiplanic Winter”, which also is responsible for the canyon incision downstream of the area. Older ages of supergene alteration, open the possibility of other hydrothermal events before 42 Ma. Therefore, this system was submitted to supergene alteration at least from 42 Ma until 3 Ma. The wide distribution of ages in the area and the conservation of minerals from supergene alteration events suggest that the erosion was concentrated in the canyons, conserving most of the relict hydrothermal system, hanged surfaces, and canyons at higher altitudes of the Precordillera.

Financing: This work was funded by the scholarship ANID program Doctorado Beca Chile No. 21180114 (J. Morales), FONDECYT Project No.1170992, and COPEDIM joint research laboratory.

Isotopic variability recorded in basalts from the East Pacific Rise (15.6°N): A chronological reading of mantle source composition and ridge-seamount interaction spanning the last 320,000 years

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A high-resolution sampling profile constituted of 52 basalt samples from across the East Pacific Rise (EPR) was investigated. These samples provide a unique opportunity to study the coeval recording of isotopic signals derived from sub-marine eruptions at a fast-spreading ridge over a time interval of ~320 kyrs, marked by two recent ridge jumps caused by the presence of a neighboring seamount chain. Our new data (Sr-Nd-Hf-Pb) confirm the extremely heterogeneous nature of the mantle under this restricted region, as suggested by previous studies ((1), (2), (3), (4)). We also established a first-order chronology between analyzed samples and have reconstructed the evolution of basalt compositions as the ridge and seamounts advance and finally merge. Our chronological interpretation of the data reveals two different modes of coexisting variability within the samples (5). One that has a low amplitude and low frequency and is accounted for by the continuous melting of the ambient mantle, indicating a process with a ~125 kyrs periodicity. The other, of higher amplitude, is discontinuous in time, and likely reflects the seamounts source influence on the ridge. Our results support a two-step hotspot-ridge interaction including a first stage (≥ 600 ka) of regional enrichment of the depleted ridge mantle by hotspot material; and a second, more recent (≤ 300 ka) event wherein ambient mantle melts mixed with proximal melts from heterogeneous seamounts sourced nearby. Finally, the preservation of such high isotopic variability in such a small area, despite fast-spreading ridge settings, also argue for a short crustal residence time of erupted magmas.

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Financing: Work supported by: CNRS-INSU "PARISUB+"; Institut National des Sciences de l'Univers; Conseil Régional de Bretagne; PAPIIT IA101519 & IA101521, and Conacyt-Ciencia de Frontera N° 26396.

Chemical and Sr-Nd characteristics of Oligocene-Miocene magmatism in the Maule profile (~35.7°S), Andes of Central Chile: Tracking the arc magma genesis

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In Central Chile the western Andean flank is dominated by exposures of Cenozoic units comprised by arc volcanic rocks with subordinated sedimentary intercalations (1). Along the Maule river profile (~35.7°S) such Cenozoic swath widths ~60 km and records arc magmatism developed mostly between late Oligocene to middle Miocene, with scarce older and younger units which remain uncharacterized. The main oldest magmatic pulse is mostly present in the westernmost outcrops and covers an age range between ~26-21 Ma (Colbún Fm. and similar deposits immediately to the east of it) (2). As shown in this and previous studies ((3), (4)), these arc rocks show tholeiitic affinities, markedly juvenile isotopic compositions (ƐNd(i): +5.7 to +7.2; $^{87}Sr/^{86}Sr$(i): 0.7039 to 0.7035) and derive from at least two magmatic families showing indistinguishable Sr-Nd isotopic signatures. One of these families is remarkable in showing low degrees of enrichment, or even depletion, as evidenced in flat to LREE depleted chondrite normalized REE patterns. In addition, results from age determinations and stratigraphic studies in the Colbún Fm. ((2), (5)) indicate a high rate of deposit accumulation and tectonic subsidence for accommodating the deposition of this series in a relatively short period of time. Altogether, the geochemical and field evidence suggests that the arc volcanism of this area developed in conditions of intense crustal attenuation, being this more developed than that recorded in Cenozoic deposits further north.

Immediately to the east of the ~26-21 Ma deposits, and variably covering the remaining swath of Oligocene-Miocene arc rocks, a following main magmatic pulse is recorded at ~20-17 Ma ((6), (7)). This is represented by calc-alkaline rocks, most of them showing a range of moderately juvenile compositions (ƐNd(i): +3.9 to +5.7; $^{87}Sr/^{86}Sr$(i): 0.7036 to 0.7039) and a Sr-Nd isotopic signature inversely correlated within that range. The latter indicates that depleted and enriched components are involved in magma genesis, which is also supported by the geochemical composition of these rocks. Particularly, those rocks of this episode distributed along the easternmost area show comparatively more enriched Sr-Nd signatures (ƐNd(i): +2.2; $^{87}Sr/^{86}Sr$(i): 0.7044) and geochemical patterns suggesting an important role of crustal contamination in magma genetic processes. Following the later episode, another main magmatic pulse is recorded at ~14-12 Ma, mainly at eastern portion of the ~20-17 Ma swath. Overall, these rocks are similar to the preceding ones, both in composition and the described variations in space.

For the area and time span discussed, results show a contrasting evolution early dominated by intense arc magmatism during late Oligocene-early Miocene, which developed along with strongly extensional/subsiding conditions, and whose igneous products are devoid of crustal contamination processes by evolved components. This episode is followed by an eastern migration of the main magmatic activity and in this new arc area enriched and depleted components are involved in magma genesis. In particular, crustal contamination processes are evidenced in the easternmost magmas of this area.

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Financing: This work was funded by the project Fondecyt 1210475. Additional support by project Fondecyt 11140012 and project DI-07-19/R (UNAB) are gratefully acknowledged.

Magma source variations of the Zarao metavolcanic rocks and their relationship with the back-arc marginal basin of Chaitenia

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The Devonian magmatism in the north Patagonian segment of SW Gondwana (40°-43°S) was generated in two partly coeval belts (1); an older one located inboard of the continental landmass (the San Martín Arc), and another emplaced in a peri-Gondwanan position (the Chaitenia Island Arc). This tectono-magmatic configuration resulted after the opening of a marginal back-arc basin between both arcs in late Lower Devonian, whereas its subsequent closure probably occurred before Upper Mississippian (2). The Zarao metarhyolite is a subvolcanic body located in the eastern slope of the Coast Range (c. 41°18'S), has a U-Pb SHRIMP age of c. 393 Ma and is one of the older igneous units of the Chaitenia Island Arc (3). The metarhyolite body is tectonically interleaved with metabasaltic rocks with similar metamorphism and structure, and thus grouped as the Zarao Metavolcanic Rocks (ZMR). Although the crystallization age of metabasalts is unknown, the Devonian detrital zircon component is dominant in metasedimentary rocks in the area (3). Whole-rock major and trace element analysis together with Sr-Nd-Pb isotope determinations were performed in one metarhyolite and four metabasalts of the ZMR. The metabasalts show sub-alkaline affinities, resembling enriched and depleted MORB-like types, and display Nb negative anomalies, these are more subtle in the depleted MORB-like metabasalts. The metarhyolite is alkaline, has a flat chondrite-normalized HREE pattern together with a marked Eu negative anomaly, and Nb-Ti negative anomalies. The Nd-Pb isotope composition (t=393 Ma) show an Enriched Mantle 1 (EM1) source-type for the enriched metabasalts and the metarhyolite, wheras a mantle source change towards Depleted MORB Mantle (DMM) composition, signaled by depleted metabasalts. We interpret that the ZMR was formed during different stages of lithospheric thinning over a supra-subduction zone. During the onset of extension, the stretched continental lithosphere located in the forearc of the San Martín Arc melted under low pressure conditions and generated enriched basaltic magmas that reached the surface (enriched MORB-like metabasalts); stagnant magma batches within the attenuated crust underwent fractionational crystallization processes causing the formation of rhyolitic magmas (metarhyolites) at c. 393 Ma. The mature stages of the back-arc marginal basin are represented by the depleted MORB-type metabasalts, which formed due the partial melting of a DMM source in the expansion center located at the rear of the Chaitenia arc. Geophysical surveys have identified a dense block below the Cenozoic cover located to the east (4), and Devonian U-Pb detrital ages have been reported in metasedimentary rocks cores recovered from boreholes ((1), (3)). Thus, the tectonic slice comprising the ZMR might represent scraped fragments of this buried block.

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Financing: This research was funded by Consejo Nacional de Investigación Científica y Tecnológica (presently ANID) through Project Fondecyt N°1180457.

Hydrogeochemical processes in arid closed volcanic basins: isotopic approximation of Li, B and Sr in the Salar del Huasco and Lagunilla, Altiplano, Chile

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The Salar del Huasco and Lagunilla basins are located in Precordillera and Western Cordillera of the Andes. These adjacent and closed basins receive limited precipitation that allows the development of evaporitic environments with saline lakes. Surface geology is dominated by Miocene to Pliocene ignimbrites and volcanic units. The climate and geological setting of these closed basins are similar along the Andes in northern Chile, where different hydrogeochemical processes have been reported in order to explain the water composition (e.g., geothermal waters influence; water-rock interactions; ancient brine influence). However, these processes can vary locally. This work aims to determine the origin of solutes in natural waters by linking geochemical and isotopic data to elucidate the hydrogeochemical processes acting in arid volcanic closed basins.

We analyze geochemical and isotopic data (Li, B and Sr) in natural waters in addition to trace elements, and Li and Sr isotopic data in sediments and volcanic rocks. The measured $\delta^{7}Li$ values range from +5.47 to +36.09‰ in waters. The $\delta^{7}Li$ of the waters are similar to those of the surrounding rocks (from +5.48 to +10.51‰), while the $\delta^{7}Li$ values measured in sediments present a wider range, including negative isotopic ratios (from -6.59 to +19.66‰). The $\delta^{11}B$ values vary between +1.05 and +13.28‰ in waters, and the $^{87}Sr/^{86}Sr$ values range between 0.7060 and 0.7066 in waters, and between 0.7061 and 0.7079 in volcanic rocks.

The $\delta^{7}Li$ and $^{87}Sr/^{86}Sr$ values evidence the relevance of water-rock interaction as a dominant hydrogeochemical process. Lithium and B isotopic values also indicate the formation of secondary minerals related to volcanic rock weathering, reflecting that sorption of these metals occurs in secondary phases (e.g., clays and hydroxides). Evapoconcentration in the basins is consistent with increase in Li and B concentration while increasing salinity in waters. Mix diagrams for isotopic systems also show geothermal waters, sedimentary brines, evaporites, and diluted water involves in water compositions.

Subsequently, the multi-isotope approach carried out in this study suggests that the processes responsible for the concentration of solutes are evaporation and water mixing, which occur throughout the studied area, and the precipitation of secondary minerals, which tends to occur in salt lakes. The origin of solutes in the catchment area is mainly derived from the volcanic and volcanoclastic rocks, with no significant evaporite dissolution influences.

Field and O-C stable isotope data of (early?) carbonate precipitation in the endorheic basins of Lago Sarmiento and Laguna Amarga, southern Patagonia (51°S)

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Lago Sarmiento and Laguna Amarga are endorheic lakes located in southern Chile. They are bounded to the east by moraine ridges formed during the Antarctic Cold Reversal glacial advance (c. 14.1 ka) (1) and are emplaced over the deformed (meta) turbidites of the Cerro Toro Formation (Upper Cretaceous). An outstanding feature of the area is the presence of microbialites, thus, constituting a unique natural laboratory for the study of the interplay between exogenous and endogenous forcings and precipitation of continental carbonates at low-temperatures.

Lago Sarmiento is a sub-saline and alkaline lake. Above the lake level (77 m a.s.l.), an 8 m-thick section of microbialites is exposed along most of the coastline. Four distinctive microbialite levels (L_1 to L_4) placed from 77.5 to 85 m a.s.l., are interpreted as different paleo-levels of the lake [2]. On top on the uppermost microbialite level (L_4) the metasedimentary rocks bear vein-like structures filled with carbonate, mostly parallel to stratification, as well as through E-W and NE-trending fractures and N-S cleavage planes. The thicker (5-15 cm) carbonate veins are porous and contain abundant mm-sized fragments of black shale placed in a micrite cement, and a later stage of calcite precipitation is represented by botryoidal sparite cement that partly fill the porosity. At microscale, the shale fragments and grains show angular fractures filled with micrite, suggesting fluid overpressure during vein formation; at mesoscale, undoubtful evidence of hydrofracturing during cm-scale veining and carbonate precipitation is reported at one locality. Laminated veins are less common: they are thinner (< 0.5 cm thick), and at mesoscale show lower porosity and detrital grains content than the thicker veins. Stable isotopes analysis in the carbonate cements of the veins show homogeneous compositions of $\delta^{13}C$ and $\delta^{18}O$ (VPDB) (around +4 and -2, respectively) like those measured in carbonates cementing a pebbly conglomerate at the base of L_4, and in a reworked carbonate crust between the microbialite levels. Similar isotopic ratios have been reported in microbialites (2) suggesting that the Lago Sarmiento was hydrologically closed during microbialites formation. On the other hand, distinct values of $\delta^{13}C$ and $\delta^{18}O$ were obtained in the calcareous cement of veinlets formed by hydrofracturing. It is suggested that the latter could be like the compositions of deeper-sourced fluids that fed the paleo-lake during the early-stages of hydrochemical evolution of the lacustrine system.

Laguna Amarga is a saline and alkaline lake with two active hydrothermal travertine vents, as well as microbialites located on its shoreline. The minimum age of the endorheic system, attained when the paleo-lake level dropped below 125 m a.s.l., and 103 m a.s.l., has been constrained by the c. 7.1 Cal kyr Bp (2) radiocarbon age obtained in a thrombolite located bellow 100 m a.s.l. Reworked glaciolacustrine sediments with thin carbonates veins, and pebbly para-conglomerates cemented by carbonates were found between 120-130 m a.s.l., which might be suggesting that carbonate saturation in the Laguna Amarga sub-basin could have been achieved before its endorheic stage was stablished. Also, in-situ glacial sediments in the area do not contain carbonates, and the latter seem to be restricted to zones affected by mass remotion processes during post-glacial times.

The here enounce observations and data open the possibility that carbonate saturation in these lakes was not purely reached through surface processes and suggest that the addition of deeper-sourced carbonate-saturated fluids could have triggered the onset of the hydrochemical character that allowed the microbial colonization.

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Financing: This research is part of the Diagenesis Project (23075.193990/2017-07), funded by Shell and developed at Instituto LAMIR – UFPR. Fondecyt Project 1211906.

Stratigraphy and provenance of sediments from late Pleistocene paleodunes in the central coast of Chile (31°-35°S)

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The aeolian stratigraphic record on the coast of central Chile (31°-35°S) includes Pleistocene, Holocene, and actual generations with paleodune sequences separated by interstratified paleosols. Previous work has associated these units with paleoclimatic changes linked to the oscillation and intensification of Southern Westerly Winds (SWW). Paleosols have been related to humid conditions (SWW shifted to the north) and paleodunes with arid conditions (SWW shifted to the south). Therefore, these eolian deposits are direct proxies of the paleoclimate of central Chile, where we lack a complete understanding of the Pleistocene. The current dune fields have been mapped north of the mouth of important rivers that would transport sands to the sea, where the coastal drive would take them to the north, eventually deposited on the beaches and then deflated into dune fields. This spatial distribution of the dune phenomenon leads to relating the origin of the sands to fluvial processes as the source of sediments. However, these approaches have not been investigated in detail, and questions remain: When do coastal dunes in central Chile form? What rock formations provide the sediments that constitute the dunes? What role do Andean glaciations play in dune morphogenesis? Therefore, a central focus of our research is to understand and determine the source of the sands that form the paleodune fields and their paleoenvironmental implications. We present our methodological approach together with preliminary research results for the Aconcagua (32°S) and Rapel (34°S) river basins. The prospected units correspond to paleodunes, present-day dunes, and fluvial terraces in each basin to satisfy a geographical criterion that links fluvial, marine, and aeolian processes. Our study sites include the paleodunes of Ventanas II, Ritoque dunes, and the lower fluvial terrace of the Aconcagua River. Ventanas II exposes a detailed stratigraphic sequence of 15 m with 13 well-developed units overlying the Horcón Formation (Miocene-Pliocene). For the Rapel basin, the paleodunes of the Brisas de Santo Domingo, the Santo Domingo dunes, and the lower terraces of the Rapel River are studied. In these units, we have collected detailed stratigraphic information (to understand the sedimentary processes), dated sands by Optically Stimulated Luminescence (to determine the age of formation of paleodunes and to estimate the age of paleosols), and U-Pb dating in detrital zircons (to determine the source of sediments). Based on our results in stratigraphy and U-Pb dating, we observe not only an Andean affinity but also other main sources of sands in the hinterland that change their relative importance with time. Our results indicate that the sands come mainly from rivers located immediately south of the dune fields. We discuss our preliminary results regarding the source and supply of sands and the paleoenvironmental implication of the paleodune records of the coast of central Chile.

Financing: FONDECYT: 1200935.

Sr-Nd isotopic composition of gabbronorites from the Miocene Punta Camden Sill in southern Patagonia: petrogenetic and tectonic implications

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The Punta Camden Sill (53°13'S - 71°40'W) is a tabular body of ca. 4x3 km^2, which intrudes the Paleogene sedimentary successions of the Magallanes foreland basin in the southernmost South America. It is located ca. 60 km to the NE from the eastern limit of the South Patagonian Batholith (SPB) and about 250 km from the trench (present-day coordinates). Their mafic members correspond to medium-grained porphyritic olivine-gabbronorites, with late hornblende and biotite. A whole-rock K-Ar age of ca. 20 Ma was reported in Morello et al. (1) and emplacement depth of about 2 km have been proposed (1). Rocks with SiO_2 contents of ca. 55 wt% and relatively high contents of K_2O+Na_2O (ca. 7 wt%) show low $(La/Yb)_n$ values (ca. 8.0 – 8.2), $(Dy/Yb)_n$ values (ca. 1.2) and subtle Eu anomalies (Eu/Eu* ca. 0.8). These features and a marked depletion of Nb when is normalized to primitive mantle, indicate the influence of subduction processes during its formation, as is also reported in the Neogene plutonic rocks of the SPB. Initial Sr and Nd isotopic ratios (calculated at 20 Ma) yielded $(^{87}Sr/^{86}Sr)_t$ values of ca. 0.7041 and εNd_t values of +2.2 to +2.5. A similar isotopic signature with relatively high alkalis was reported for coeval plutonic rocks to East in the SPB (2) and Miocene plutonic rocks from Torres del Paine (51°S), dated at ca. 12.5 Ma ((3),(4)). It is thus considered that primitive basaltic magmas were generated over a wide zone in the mantle wedge (>60 km), at relatively low degrees of partial melting, diachronously precluding the opening of the slab window related to the incoming Chile spreading ridge during Miocene times.

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Financing: This contribution was funded by Fondecyt grants 1161818 and 1211906.

Late Devonian anatectic magmatism in the North Patagonian foreland: mechanisms and regional implications

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The Pacific margin of South America represents an excellent example of crustal growth, since accretional and collisional events occurred throughout late Neoproterozoic and Phanerozoic times, involving various deformation and magmatic events, and thus different crustal differentiation mechanisms ((1),(2),(3),(4),(5),(6)). In particular, an understanding of the timing and P-T conditions of crustal anatexis related to crustal thickening events is crucial to constrain proposed geotectonic models.

Our study area is located in the North Patagonian foreland and forms part of a Middle to Late Paleozoic igneous-metamorphic belt of several hundreds of kilometers long ((7),(8)). Migmatites are widely distributed and are commonly related to medium- and high-grade metamorphic rocks. However, the migmatization event(s) are still not well characterized.

Our new U-Pb zircon data from syntectonic granitoids (Taquetren Range, Central Patagonia) indicate a ~360 Ma crystallization age. These granitoids have a peraluminous character and are part of a migmatized metapelite sequence. Metamorphic ages (using monazites) range from 390-330 Ma. Our data place the crustal melting process into the Late Devonian, a time of protracted high-grade metamorphism in this region. Our P-T- determinations (e.g., using MAD) yield 7.5 to 8.5 Kbar and 710-750°C. Additional information comes from stable isotope data and detrital zircon studies, the latter showing main peaks of Meso- to Neoproterozoic, late Cambrian-early Ordovician, Silurian, and late Devonian times.

We will discuss the possible implications for the geotectonic evolution of the area, given that, for mid-late Paleozoic times, several geodynamic models have been strongly debated ((9), (10),(11)).

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Financing: A part of the work was carried out thanks to a Swiss Government Scholarship to E.M. Additional financial support from the SNF (fund 200021_175808 to BP) and UNIL is gratefully acknowledge.

San Diego Curucupatzeo Plutonic Assembly, Michoacán, México: Petrology and gechronologic constraints

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Medium-Late Jurassic auriferous plutonic rocks such as Cuale, San Diego Curucupatzeo y Macías-Tumbiscatío are one of the main tectonic features in southwestern Mexico. In this work, the goal is the petrological, geochemical and geochronological study of San Diego Curucupatzeo Plutonic Assembly (SDPA). This region contains large outcrops, but they have been poorly studied.

The SDPA shows heterogeneous lithologies such as monzogranite, quartz-monzonite and granite, coeval with syenite and andesitic dykes. The SDPA shows many xenoliths of metamorphic rocks from the Triassic Arteaga Complex which are partially assimilated. However, deformation structures and textures are characterized by deformation-duplex type shear zones linked to late-orogenic time and then Laramidic system associated with σ1, ENE-SSW. Plagioclase- quartz- potassium feldspar-biotite ± muscovite is the main mineral assemblage. Geochemical date displays calc-allkalic signatures with variations of 60 to 70.6 wt.% SiO_2 and peraluminous with corundum normative ~2 – 4.5 values. SDPA could be classified as S-type granite. The peraluminousity is consistent with H, Q3, E, J1 typology zircons with ratios of 100 until 200 in Al/(Na+K). Trace elements display enriched LREE patterns and Y+Nb/Rb ratios suggest a relation to a magmatic arc system. However, some within-plate signatures have also been found. As a result of U-Pb isotopic analyses carried out in zircons we have obtained an age of 164.64 ± 0.34 Ma, which is considered as the crystallization age of SDPA. Low pressure-high temperature mineral assemblages (e.g,. andalusite) were described at the contacts of SDPA with the basement rocks which indicates lower pressures <4 kbar and temperatures >700- 800 °C for the emplacement conditions. However, considering the amphibole absence and the Qz-Plg-Kfs-Bt±Ms main assemblage of SDPA, as well as Ti-in zircon thermometry, subsolidus cooling conditions and ≤700°C could be assumed for the SDPA. Finally, synorogenic, peraluminous and S-type geochemical signatures of SDPA allow correlate it with other Jurassic plutonic bodies in the Cordillera of the western margin of Mexico and, it could be correlated with a fast subduction event associated with a collisional process during Late-Jurassic in the Guerrero Terrane.

Unravelling polycyclic events in high-grade Archean supracrustal rocks in northeastern Brazil

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Archean supracrustal rocks represent a small percentage of the rock record about the primitive Earth, whereas siliciclastic sedimentary rocks represent the upper sections of greenstone belts and are considered as a proxy for the composition and age of adjacent continental crust blocks, being mostly composed of plutonic Tonalite-Trondhjemite-Granodiorite (TTG) orthogneisses and mafic/ultramafic volcanic rocks. In the extreme northeastern Brazil, the São José do Campestre Massif is a small (6000 km²) Archean nuclei that preserves a wide range of highly metamorphosed rocks and two supracrustal sequences displaying different provenance sources. U-Pb and Lu-Hf in zircon through LA-ICP-MS unraveled the depositional age of high-grade metasedimentary rocks, as well as multiple episodes of metamorphism. The first one shows depositional ages older than 3.0 Ga and another one the detrital zircon suggest a Neoarchean deposition. Supracrustal rocks comprise spinel-sillimanite-garnet paragneisses, clinopyroxene-titanite ± scapolite calc-silicates rocks and garnet-bearing leucogneisses. U-Pb in zircon constrained maximum depositional ages from 3005 ± 7 Ma (2σ) to 3052 ± 7 (2σ) for the paragneisses. Calc-silicate rocks are probably coeval with siliciclastic rocks, with maximum depositional ages from 2950 ± 10 Ma (2σ) to 2957 ± 9 Ma (2σ). Garnet-bearing leucogneisses record zircon populations that mimic the populations of the paragneisses, with maximum depositional ages from 2957 ± 4 Ma (2σ) to 2971 ± 8 Ma (2σ). Low Th/U grains reveal that these rocks were partially melted during the Neoarchean at ca. 2735 Ma. Metamorphic zircon grains are also found throughout the Paleoproterozoic (2100-1900 Ma) and the Neoproterozoic (600-575 Ma). Lu-Hf in zircon isotopes confirm that metamorphic grains formed from the dissolution of detrital grains along a $^{176}Lu/^{177}Hf$ ratio of 0.06. Collectively, the data shows that U-Pb and Lu-Hf isotopes in zircon can be used to assess the origin and evolution of complex rocks, retrieving detrital and polymetamorphic ages and intense crustal reworking processes.

Financing: CNPq PhD scholarship 140015/2022-1; INCT Estudos Tectônicos.

History of the Easter mantle plume based on U-Pb-Hf isotopic data from detrital zircons in an isolated sedimentary system

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The ca. 0-3 Ma Easter basaltic volcanism is generated by a mantle plume located in the Pacific Ocean ca. 3800 km away from the nearest South American continent. A field survey in October 2019, documents the presence for the first time of zircon grains recovered from soils and beach sands in the island. The huge number of zircons found in this detrital material results from erosion of the lavas and pyroclastic deposits. While most of the dated zircon constrain the age of the magmatic systems in the island (Pleistocene; <2.5 Ma), plume activity can be dated back to, at least, Late Jurassic time (~164 Ma), similar to the Galapagos plume. The data define what we called the Easter Pacific Plume Array (EPPA) defined by mantle εHf(t) values in the range ~0-164 Ma. Furthermore, the presence of older zircons (up to Paleoproterozoic in age; ~2.5 Ga) place questions on their provenance. The origin of such zircons is enigmatic due to the fact that Easter is a very young active volcanic hotspot located adjacent to a mid-ocean ridge with no evidence of a hidden continental source below the volcanos. In order to identify the potential source of these old zircons, we suggest one or a combination of several processes such as (a) zircons transported by strong currents in Pacific pumice raft, (b) strong trans-oceanic atmospheric dust clouds from the continent, (c) contamination of the asthenosphere by subducted material, (d) magmatic assimilation of detrital oceanic sediments, e) zircons transported by volcanic super eruptions and f) anthropogenic contamination.

A method for separating zircon crystals from rocks and detrital zircon grains from sedimentary strata

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Many methods for zircon separation are used at different laboratories throughout the world. There are subtle differences among the procedures; however, it is notable that detailed descriptions of these methodologies are typically retained as internal documents. In this contribution, our aim is to present the routines that are used for zircon separation at Instituto LAMIR, Universidade Federal do Paraná, Brazil (UFPR). The objective of this contribution is to share the details of these mineral separation routines with the broader scientific community. The details of the routine used at LAMIR are as follows. (1) Approximately ~5-7 kg of bedrock or strata are collected as fist-sized pieces during fieldwork. In the laboratory, the sample is thoroughly washed using water and a small scrub brush. The sample is dried overnight using a very low-temperature oven, which is set to ~40°C. (2) The fist-sized pieces of sample are next passed through a jaw crusher with the aim of reducing them to gravel-sized particles. Before and after processing, an extensive cleaning process is followed. This includes using an electric drill with a wire brush attachment on all metal surfaces that will be in contact with the sample, which helps to remove any particles from the small pits on the surface of the metal plates. After, the plates are washed with soap and water, wiped with an alcohol-soaked paper, and dried using compressed air. (3) The gravel-sized particles are passed through a disc mill to reduce them to sand-sized particles. The same cleaning procedure that was used to clean the jaw crusher is followed. (4) The sand-sized particles are separated by density using a Wilfley Table. A thorough cleaning process is followed before and after use of the table. Cleaning includes compressed air, an initial rinse, a non-abrasive sponge, neutral soap, a soft toothbrush for the riffles, a bottle brush for the spouts, and a second rinse. As the table shakes, the sample is separated into five containers, which are lined with disposable plastic bags. After separation, the sample is transferred to folded filter paper and dried using an assembly that consists of a 150 mm diameter Büchner funnel, a 2000 ml Erlenmeyer flask, and a vacuum pump. (5) The concentrated, densest fraction of the sample is next passed through a dry sieve. This sieve consists of a modified 750 ml water bottle, which is fitted with a 10x10 cm square of a <350 µm disposable mesh. The coarser fraction is packed away, whereas the finer fraction is prepared for the next step. (6) The <350 µm fraction of the sample is subjected to a rapid free-fall magnetic separation. For this step, an L-1 Isodynamic Frantz magnetic separator is used in a vertically oriented position. It is fitted with a funnel assembly, the front of the magnet is lined with a piece of printer paper, and a paper boat is placed beneath the magnet to collect the sample. As the sample stream passes by the magnet, grains with a high magnetic susceptibility are pulled from the sample and collected on the paper. This step is repeated multiple times with increasing magnetic intensity. (7) The remaining non-magnetic grains are next subjected to a more sensitive, slower, inclined chute magnetic separation. For this step an L-1 Isodynamic Frantz magnetic separator is equipped with the vibrating sample tray and sample collection buckets. This step is also repeated multiple times with increasing magnetic intensity; however, may vary based on sample character. (8) Finally, a heavy liquid separation is performed on the remaining non-magnetic fraction of the sample using Methylene Iodide (SG ~3.3). This step is performed under a chemical hood using extensive personal protective equipment. After the separation is complete, the heavy and light fractions of the sample are thoroughly rinsed with acetone to remove any remaining Methylene Iodide. The heavy and light sample fractions remain in the chemical hood to dry for ~24 hours.

Residence times of thermal waters from the Southern Volcanic Zone of Chile: the role of the tectono-volcanic domains on water age

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The Southern Volcanic Zone (SVZ) of the Chilean Andes is an excellent natural laboratory to study high enthalpy geothermal systems hosted in subduction environments (1). The sector between 38°-40° S of this volcanic chain is populated with hydrothermal manifestations located along two big fault systems: the Liquiñe Ofqui Fault System (LOFS) and the Andean Transverse Faults (ATF). In this zone the circulation of hydrothermal fluids and magma is suggested to be controlled by the interaction between tectonics and volcanism (2). Several studies have investigated (1) the role of these structures in the circulation and composition of hydrothermal fluids. However, the residence times of thermal waters, and the mixing rates and recharge times of meteoric fluids remain unconstrained. In this study, we sampled waters from ten geothermal springs along the SVZ for $\delta^{13}C$, radiocarbon, and tritium dating with the goal of unraveling the main factors controlling water residence and recharge times in hydrothermal manifestions in the SVZ. Uncorrected radiocarbon ages range between 5056 ± 32 y BP and >44000 y BP. The youngest age corresponds to the Palguin springs located in a segment of the LOFS, whereas the oldest age corresponds to a perpetual spouter from the Alpehue geyser field at the intersection between structures from the LOFS and the ATF. Furthermore, $\delta^{13}C$ contents range from -6.2‰ to -15.8‰, correlating to the oldest and youngest radiocarbon ages in the Alpehue geyser field and Palguin springs respectively. The curved relationship between ^{14}C - $\delta^{13}C$ indicates that the reaction or process which causes the rising of $\delta^{13}C$ content progresses while ^{14}C decay occurs (3). This increase can result from the addition of $\delta^{13}C$ enriched carbonate either by carbonate dissolution or addition of geogenic CO_2, which is common in geothermal and volcanic systems (4). Our data suggest that slow recharge characterizes long-lived geothermal systems, as the Alpehue geysers. On the other hand, springs linked to the LOFS, present shorter fluid residence times occurring due to either faster circulation times or to dilution with meteoric waters.

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Financing: Proyecto FONDECYT Regular 1201219. Proyecto FONDECYT Iniciación 11220777. Proyecto FONDECYT Iniciación 11200656. Proyecto FONDAP 15200001.

Reconstructing the paleolandscapes of the Curitiba microplate, Southern Ribeira belt, Brazil: Provenance, geochemistry of protoliths and paleogeographic interpretations

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The reconstruction of ancient continental margins encompassed in continent-continent collision is a complex task. The continental blocks generally record a multiphase evolution with interaction of tectonic settings, plate polarities, basins, and their depositional architecture. In this context, the study of a paleolandscape through the integration of sedimentology, stratigraphy and geochemical analysis can contribute to the understanding of the paleogeography of a given territory.

The Ribeira belt (Southeast-Southern Brazil) resulted from the juxtaposition of several crustal blocks during the Brasiliano/Pan-African tectonic events (800 - 490 Ma), leading to the amalgamation of Western Gondwana. During orogenesis, a series of pre-Brasiliano blocks underwent variable rates of tectonic reworking – one of these blocks is referred to as the Curitiba microplate. Some of the metasedimentary strata on the Curitiba microplate are representative of Late Meso- to Neoproterozoic basins which bordered this pre-Brasiliano continental fragment: the Capiru Group.

The Capiru Group is a low-grade unit that records passive to active continental margin stages in which six formations were identified - termed from oldest to youngest as: Santana (proximal to distal marine shelf), Juruqui (proximal to distal deltaic), Rio Branco (carbonate platform), Morro Azul (lagoonal to shallow marine), Morro Grande (proximal to distal deltaic/ marine) and Bocaina formations (estuarine to shallow-marine). The paleoenvironmental interpretations indicate climate changes during the Capiru Group deposition, under a far-field or “Phantom Glacial” influence related to regional unconformities. Chemical and mineralogical Fe- and Al-rich protolith compositions suggest continental denudation during the passive continental margin stage, with low sediment input rates from a relatively low-gradient relief, highly weathered continental source, and stable since Mesoproterozoic times.

The recognition of unconformities in this stratigraphic record coupled with the presence of high-Al (meta-)pelites have brought discussions regarding the nature of the sedimentary precursors. One of the most reasonable explanations for the high-Al (meta-) pelites was the effects of leaching and consequent Al-enrichments promoted in weathered profiles that were later metamorphosed during the Brasiliano/Pan-African orogenies. Subsequently, during the deposition of the Bocaina Formation, the arkosic composition of sandstones and lithic conglomerate lags suggest source rejuvenation during the syn-orogenic stage.

The provenance data (U-Pb geochronology of detrital zircon) of the Capiru Group show Paleoproterozoic contributions (2000 – 2185 Ma) and slightly different Mesoproterozoic populations (1508 – 1100 Ma), suggesting mainly local sources (derived from the Curitiba microplate basement). These signatures were compared to the other chrono-correlative continental margin units of the region (Lajeado and lower Itaiacoca groups). Through the evolution of Capiru, Lajeado, and Itaiacoca groups, we suggest that the Capiru Group was deposited on the Northern margin of the Curitiba block, with Mesoproterozoic “exotic” contribution possibly derived from the Western Angola craton. On the other hand, the Lajeado and Itaiacoca groups were deposited on the East-Southeastern margin of the Paranapanema continental block, representative of a slightly different source-composite.

Financing: This research is sponsored by the Diagenesis Project (ANP 20257/2): A scientific collaboration between LAMIR Institute - Universidade Federal do Paraná (UFPR) - and Shell Brasil Petróleo Ltda.

Baddeleyite $^{206}Pb/^{238}U$ age change as a function of crystallographic orientation analyzed by SHRIMP

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Baddeleyites (ZrO_2) are found in ultramafic and alkaline rocks and suffer low Pb diffusion compared to zircon and therefore, they are extremely favorable for dating by U-Pb method. For these experiments were utilized Phalaborwa baddeleyite - Africa (donated by Wingate, M.T.D - Australia) and Kovdor - Russia (donated by Radionov, N.V). $^{206}Pb/^{238}U$ ratio measured in baddeleyite by ion microprobe change significantly (up to ±10% or more) and systematically with the relative orientation of the baddeleyite crystal structure, therefore, the $^{206}Pb/^{238}U$ age change significantly (1). According to crystallographic orientation, normal or reverse discordance may occur. Therefore, it is difficult to establish a baddeleyite standard by ion probe due the $^{206}Pb / ^{238}U$ ratio variation with the crystallographic orientation. Here, in this experiment, Temora zircon standard will be used to obtain mass bias correction factor. For baddeleyite, like zircon, $LN(Pb^+/U^+)$ correlate with variations $LN(UO^+/U^+)$ by discrimination factor. Data fit reasonably well to calibration lines (with mean slope = 2.12) that relate the natural logarithms of radiogenic $^{206}Pb^+/U^+$ and UO^+/U^+ (Wingate and Compston.,2000), therefore this value is very close for zircon that slope = 2.0. On the other hand, the $^{207}Pb / ^{206}Pb$ ratio fractionation is very small and therefore age doesn't need correction.

Methodology: To study the behavior of the variation in the $^{206}Pb / ^{238}U$ ratio according with baddeleyite crystallographic orientation, it will be analyzed by four steps. Step (a): the mount will be marked north-south direction and after analyzes set done, the mount will be repolished with 3 microns diamond paste; step (b): before starting 2nd analysis session the mount will be rotated 90 degrees in relation step 1 position; step (c) mount repolishing and rotating 270 degrees relative step (a); step (d): mount repolishing and rotating 180 degrees. For each rotation step, U-Th-Pb isotopes are analyzed for baddelyite sets by SHRIMP and thus we can to compare $^{206}Pb / ^{238}U$ ratio values in different crystallographic orientations.

After hundreds of analyzes performed in different crystallographic orientations, we observed that the $^{206}P/^{238}U$ and $^{207}Pb/^{235}U$ ratios fit along the same discordia line. Age with reverse discordance of a given crystallographic orientation may have normal discordance age after rotating the crystal, but aligned on the same discordia line. If $^{207}Pb/^{206}Pb$ age is constant and does not change with crystallographic orientating, this implies that the discordia line crosses the concordia curve at the same point for random orientation. For the Palaborwa baddeleyite standard the discordia line intersects with the concordia curve always close to 2063 ± 2 Ma age, therefore close to TIMS value (2060 Ma). The slope value = 2.0 ($LnPb^+/U^+$) x LN (UO^+/U^+) was obtained by Temora zircon standard and applied $^{206}Pb/^{208}U$ ratio matrix correction at baddeleyite. The correct value of this slope should be obtained through several analyzes of baddeleyite. For Kovdor baddeleyite from Russia, the concordia age obtained indicated an age of 375 ± 6 Ma, therefore very close for concordia age = 379 ± 3.7 Ma (2). Reverse discordance also may occur at high U zircon (>2000ppm) and in this case it is not related to crystallographic orientation, but may be associated for metamitic crystal with U loss/add (3).

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Financing: CNPQ – Conselho Nacional e Desenvolvimento Científico e Tecnológico. Bolsa de PQ.

The Mexican Cordilleran magmatic arc: Complex emplacement, complex petrology, but helpful isotopic fingerprints

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From Sonora to the north down to Chiapas at the Guatemala border, Cordilleran Mexico shows a large geochronological and petrogenetic variation of igneous rocks. Several arcs could be recognized, ranging from Jurassic to Neogene. Plutonic rocks are by far the most abundant lithology, ranging from M-type, I-(Cordilleran)-type to some S-type granites. Autochtonous as well as allochtonous formations are observed, accompanied by different accretion mechanisms. Margin truncation and displacements of forearc elements is a common feature in the overall Mexican arc, frequently accompanied by subduction erosion processes.

Some plutonic bodies are batholith-sized, others are dispersed in multiple smaller intrusions. During the last decades, a large isotopic and geochronological database was established, proving the potential of the combination of multiple isotopic methods to resolve intrusion ages, metamorphic overprints, and thermal history of a large number of arc granitoids. Interesting observations were obtained when petrological processes, such as magma hybridization, completely rehomogenize the original isotopic fingerprints of more silicic rocks during the scenario of gabbroic intrusions. The combination of geothermo(baro)meters with geochemical and isotopic data shows excellent results to constrain P-T conditions and emplacement depths. The isotopic results of some representative plutonic bodies of the Mexican Cordillera (e.g., Puerto Vallarta and Los Cabos, Manzanillo, Acapulco) provide examples for the heterogeneous character of this arc and additionally show advantages but also limits and restrictions of the U-Pb, Rb-Sr, Sm-Nd, and K-Ar and ^{40}Ar-^{39}Ar methods applied.

Financing: UNAM Support.

Elemental survey of a drillcore piercing the Kuruman banded iron formation, South Africa

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The Kuruman Formation is a well-developed and preserved Paleoproterozoic banded iron formation (BIF) as a part of the thick Transvaal Supergroup, located in the Griqualand West Basin, South Africa. It is among the youngest BIF before the irreversible loss of mass-independent fractionation of sulfur in the Kaapvaal Craton, that defines the Great Oxidation Event, and is considered to be a high-quality archive to understand the chemistry and the dynamics of late Archean and Paleoproterozoic seawater. Our samples were extracted from the UUBH1 drillcore located nearby Kuruman, which is unique because it is constrained by a high-precision age model with a time resolution of ~±3 Ma for any given depth (1).

We will present preliminary results from a major and trace element survey as well as stable isotope measurements ($\delta^{34}S$, $\Delta^{33}S$, $\delta^{98}Mo$) of organic rich horizons within this BIF, with the intention to improve our understanding of the redox state of Paleoproterozoic seawater. Interestingly for the matter, we find that oxygenation pulses occur faster than a few million of years. We will discuss the newly obtained chemical data in combination with the well constrained sediment ages, with the aim to better understand the pace, frequency, and duration at which seawater redox changes have occurred in near surface environments just before the Great Oxidation Event.

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Clumped isotope constraints on changes in hydroclimates since the Last Glacial Maximum in the Willcox Basin: Lake Cochise, Arizona

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During the Last Glacial Maximum and subsequent deglaciation, the southwestern United States experienced cooler and wetter conditions, which supported the existence of an extensive system of pluvial lakes occupying closed basins in the Northern and Southern Basin and Range. Today, the climate in this region is predominantly arid and water sensitive; therefore, the stark transition from cold and wet during the Late Pleistocene to warm and dry today implies a large shift in the regional water balance. Recent work has used hydroclimate reconstructions to examine possible thermodynamic and dynamic mechanisms that influence the hydrologic cycle in the American Southwest; however, limited work has been done to understand climate fluctuations using smaller closed basin lakes in this region due to a lack of preserved shoreline features and paleoclimate proxy data. Here, we examine the Willcox Basin, one of the only hydrographically closed basins in Arizona, which has intermittently been home to Lake Cochise from the Late Pleistocene to present. The Willcox Basin allows us to explore the magnitude and possible extents of various hydroclimate mechanisms responsible for moisture delivery to the southwestern United States by constraining lake levels over the past ~20,000 years using carbonate-rich sediments recovered from the shoreline of Lake Cochise. We report thermodynamically derived estimates of changes in temperature, precipitation and evaporation rates, and the isotopic composition of lake water using carbonate clumped isotope thermometry.

Financing: This material is supported by the NSF GRFP under Grant No. (DGE-2034835) and the NSF Award No. (NSF-ICER-1936715).

Late Holocene paleohydrological reconstruction from the physical and isotopic study of a speleothem from central Chile

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The character of climatic transition that characterizes central-north Chile (30-34°S), together with the influence of the El Niño-Southern Oscillation (ENSO) system, make this area of great interest for the recording of Holocene climatic changes. In particular, the oceanic and climatic behavior of the subtropical coast of this Chilean region is strongly determined by the activity of the Subtropical Anticyclone of the Southeast Pacific ((1),(2)). More specifically, the semi-arid coast of Chile, located on the eastern limit of that Anticyclone influence, is a key place to determine what was its role in the paleo-hydrological variations that have affected this region.

The knowledge of the ocean-climatic conditions in the coast of the northern part of Chile during the Holocene has increased considerably at different time scales through the study of alluvial deposits along the coast and of laminated marine sediments ((2),(3),(4),(5)). Further south, the oceanic-climatic conditions on the semi-arid coast of Chile during the Holocene have only been addressed on a millennial scale based on geomorphological and pedological studies (6), on pollen analysis ((7), (8)), and in the sedimentological and foraminiferal study of marine cores ((9),(10),(11)).

Taking into account the limited number of records that cover the late Holocene time period in this region, this work seeks to clarify, in a first approximation, the paleohydrological variation during a millennium of the late Holocene through the study of the physical and chemical properties of a stalagmite extracted from the coastal cave of Tanumé (34°13 S; 71°58 E), which is emplaced in quite particular conditions (non-karst) for the formation of speleothems.

The high resolution U/Th chronology of the stalagmite covers the time period between 2300-1300 yr BP (part of the late Holocene). The low-resolution chemical results throughout the stalagmite ($\delta^{18}O$; $\delta^{13}C$; trace elements) and the monitoring of the current environmental variables of the cave for one year, allow us to argue that the predominant agent in its variation is related to the hydrological variability in the cave, and therefore is probably affected by the changes of the amount of rainfall in that time. The color parameters in the stalagmite allow us to visualize, with high precision and at different time scales, the variation between light and dark laminations. These results are remarkably well correlated with the isotopic and trace element results in the stalagmite, potentially allowing the observation of paleohydrological variations throughout the record at high resolution.

To conclude, the innovative very high resolution speleothemic record of the Tanumé cave is a valid archive in the reconstruction of humidity changes in the region during part of the late Holocene. This and other results from caves in that area will to better comprehend the notorious desertification that currently exists in central Chile.

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Paleo- and Mesoarchean TTG-sanukitoid to high-K granite cycles (subduction-collision) in the southwestern São Francisco craton, Southeast Brazil

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This study integrates petrological data, major and trace element compositions, zircon U-Pb LA-ICPMS geochronological results, and zircon Hf and whole-rock Sm-Nd isotope data for orthogneiss and amphibolite samples from the Campos Gerais complex (CGC), an Archean granite-greenstone association that occurs in the southwesternmost portion of the São Francisco craton (SFC), SE-Brazil ((1), (2)). The CGC south of Alpinópolis town can be referred to as a granite-greenstone terrain with a variety of variably deformed granitoid rocks and isolated greenstone keels intruded by elliptical plutonic bodies. A deformation gradient is observed, where strain is low or absent in the northeastern portion, and higher to the southeast. To the northeast, the CGC orthogneisses display a weak foliation dipping moderately to the SE, which however does not completely obliterate the primary igneous features. The orthogneisses become progressively more deformed to the southeast, where an anastomosed network of sinistral NW-trending mylonite to ultramylonite zones defines lens-shaped orthogneiss domains. The latter display a pervasive foliation, commonly protomylonitic. Four lithological associations were mapped: a) grey banded biotite (±hornblende) tonalites and granodiorites of TTG affinity predominate; b) greenstone belt type supracrustal associations, outcropping as deeply weathered patches of chlorite-tremolite schists and serpentinites; c) biotite (±muscovite) leucogranites and gneissic varieties. The frequent biotite-rich lenticular residue is consistent with the geochemical signature of hybrid and peraluminous crust-derived granites; and d) several intrusive elliptical stocks of homogeneous, undeformed tonalite. The CGC records a complex Archean crustal evolution, where ($^{207}Pb/^{206}Pb$ age) 2.97 Ga TTG tonalites and trondhjemites ($\varepsilon Nd_{(t)}$ = -4.7; T_{DM} = 3.24 Ga) were followed by 2.89 Ga sanukitoid tonalites ($\varepsilon Nd_{(t)}$ = -1.9; T_{DM} = 3.02 Ga), broadly coeval with the development of greenstone-belts. Nearly concordant zircon grains from the Neoarchean sanukitoid sample yield initial εHf from -1.69 to + 3.31. Initial $^{176}Hf/^{177}Hf$ varies from 0.28087 ± 0.00005 to 0.28093 ± 0.00005, and Hf (T_{DM}) model ages vary from 3.12 Ga to 3.42 Ga. We interpret these events as representing the initial stage of an important subduction-accretion tectonic cycle, which ended with the emplacement of 2.82-2.81 Ga high-K leucogranites and migmatization of the TTG-sanukitoid crust, with hybrid and two-mica, peraluminous compositions ($\varepsilon Nd_{(t)}$ = -8.0 to -8.6; T_{DM} = 3.57 to 3.34 Ga). The presence of inherited zircons in all studied samples, with $^{207}Pb/^{206}Pb$ ages of 3.08 Ga, 3.29 Ga, 3.55 Ga, and 3.62 Ga indicates that the Mesoarchean tectonic processes involved the reworking of Meso to Eo-archean crust. Renewed TTG magmatism took place at ca. 2.77 Ga represented by intrusive juvenile tonalite stocks ($\varepsilon Nd_{(t)}$ = +1.0 to -1.5; T_{DM} = 2.80 to 2.88 Ga). Crustal stabilization was attained by 2.67 Ga, allowing for the emplacement of within-plate tholeiitic basaltic magma ($\varepsilon Nd_{(t)}$ = -3.1; T_{DM} = 2.87 Ga). The CGC shows important tectonic diachronism with respect to other Archean terrains in the southern São Francisco craton, including an independent Meso- to Neoarchean crustal evolution. The CGC is an important segment of Paleo- to Mesoarchean continental crust to be integrated into paleogeographic reconstructions before the transition into the Paleoproterozoic.

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Financing: CNPq, CPRM Serviço Geológico do Brasil.

Provenance and protolith sedimentation age of the Patagual-El Venado unit, Coastal Cordillera, Biobío Region, Chile

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The Patagual-El Venado unit corresponds to metasedimentary rocks (1), specifically shales, phyllites and metapelites rocks, which outcrop in the northern part of the Nahuelbuta Cordillera (~36°50'-37°S) and show a marked lithological similarity with the triassic overlying sequence (Santa Juana Formation) and the Eastern Series (ES) of the Paleozoic Metamorphic basement. Compared to the latter, the Patagual-El Venado unit shares the nature of the sedimentary protolith but exhibits a lower degree of metamorphism and an absence of post-tectonic porphyroblasts typical of the ES in the area.

As part of the Concepción-Talcahuano geological map (Sernageomin), U-Pb LA-ICP-MS ages were determined in a hundred detrital zircons from a slate of the Patagual-El Venado unit. The sample contains at least 10 age populations, with the two largest at 500-460 Ma and 1150-1035 Ma. The oldest zircons are Archean (>2.5 Ga) together with other population of more than 25 zircons with a Mesoproterozoic age (1600-1000 Ma), whose source could be attributed to the recycling of large cratons located eastwards (Greenville-Sunsas belt or Cuyania basement). Zircons with ages between 650-550 Ma (n=12) could derive from magmatic sources related to the Brasilian/Pan African Orogenic belt. Zircons of this age group are common in the Western Series (WS) rocks of the Paleozoic Metamorphic basement, as well as in the North Patagonian Massif (2). A weak peak at ca. 520 Ma (n=6) relates to sources attributed to the Pampean Orogeny (550-500 Ma). The marked population of 490-460 Ma ages (n=16) may relate to the Famatinian Orogeny (500-420 Ma). There are no Devonian zircons, except for two zircons of 384 and 372 Ma, which may suggest that the Devonian continental arc had scarce development north of 39°S. The youngest zircons have ages between 344-335 Ma, which is considered to close the maximum depositional age of the protoliths of Patagual-El Venado unit, which has been calculated at 339.4±2.8 Ma (Middle Mississippian). The origin of these zircons is difficult to trace since no igneous sources have been reported at the latitude of this study. However, Devonian-Early Carboniferous plutonic rocks outcrop in the Sierras Pampeanas in Argentina (3) so, the robustness of this statistical population may suggest the occurrence of a magmatic event of that age further south, linked to the Chanic Orogeny of Middle Devonian-Early Carboniferous age. The absence of Upper Carboniferous zircons could indicate that the magmatic arc (Coastal Batholith) was not exhumed at the time of the sedimentation of the protolith of the studied unit. The absence of zircons of this age is a characteristic of metasedimentary sequences north of 39°S (4), whereas to the south they are abundant, as well as Permian ages related to the Choiyoi Province.

Both the WS and the ES protoliths were deposited before the intrusion of the Upper Carboniferous Coastal Batholith. In the Coastal Accretionary Complex (33-38°S), the ES has maximum Early Carboniferous depositional ages (4). In fact, there are similar depositional ages in the Northern ES (*e.g.,* Playa Chivilingo 340 Ma) as in the Southern ES (*e.g.*, Purén 350 Ma) with 50-60% Proterozoic detrital zircons. On the other hand, the pattern for the WS presents a range of depositional ages from Silurian to Permian, with Permian zircons and no Proterozoic detrital ones, mainly south of the Mocha-Villarrica lineament ~ 39°S (2). The Patagual-El Venado Unit was originally interpreted as an Early Permian retro-wedge basin (1) due to the low degree of metamorphism and its protolith. However, our results are in accordance with the provenance and maximum depositional ages obtained for the ES protoliths. Therefore, we hypothesize that the Patagual-El Venado unit is part of the ES, but its low metamorphic grade, denoted by the absence of Al-rich porphyroblasts, may suggest that Coastal Batholith dynamics affected the paleo-Carboniferous margin in a partitioned way.

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Financing: This research was funded by the Plan Nacional de Geología of SERNAGEOMIN. U-Pb ages were obtained at CODES Analytical Laboratories, University of Tasmania.

SPECIAL SESSION

The Rio de la Plata Craton and its importance for the amalgamation of West Gondwana

A quick review of the Rio de La Plata Craton

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The Rio de la Plata Craton (RPC) within the South American Platform, is located in the western portion of Uruguay, as well in some regions of Argentina and southern Brazil. It was proposed in 1973 by Fernando de Almeida and others, based on some ages of Proterozoic rocks collected near Montevideo. The craton is mostly covered by Phanerozoic sediments and is formed by two large tectonic units, the Piedras Altas Terrane (PAT) and the Nico Perez Terrane (NPT), separated by the large scale NNW-SSE Sarandí del Yí shear zone.

The PAT is the major component and “core” of the RPC. It is a large granite-migmatite domain, dated close to 2.0 - 2.2 Ga, which includes a few concordant volcano-sedimentary belts with similar age. Ages older or younger than the Paleoproterozoic were not found in this domain and there is no record of Neoproterozoic tectono-thermal activity. The NPT is made up by a mosaic of small tectonic blocks with different ages, including Archean and Paleoproterozoic, with varied lithologies, such as granitoids, gneisses, amphibolites, BIFs, schists, among others.

The NPT is bounded to the North with the Neoproterozoic São Gabriel Block. To the East it has a tectonic contact made through the large Sierra Ballena Shear Zone and related thrust faults, with the Dom Feliciano Belt of the Brasiliano orogenic cycle. There, it was affected by an important tectono-thermal activity and strong reworking of its rocks.

To the west, in Argentina, below the sedimentary cover, the PAT is limited by the southern extension of the Transbrasiliano-Kandi (TBK) tectonic corridor, bounded partly with the Mid-Proterozoic Pampia Terrane and partly with the Neoproterozoic Eastern Pampean Belt. To the south, the limit of the PAT is located at the Sierra de La Ventana, with Phanerozoic rocks of the North Patagonian Massif.

West Gondwana was formed by means of the convergence between the Amazonia-West Africa- Pampia and the São Francisco-Sahara- Kalahari continental plates. The collision, in the Ediacaran, occurred along the TBK tectonic corridor and closed the huge Goiás-Pharusian Ocean (GPO). The coherent cratonic block that was at the Eastern part of this collision included the São Francisco-Congo, Saharan, Kalahari, Paranapanema and Rio de La Plata cratons. Since they have a close affinity in terms of tectonic evolution, they were possibly forming a united continental plate, that was called Central African Block (CAB) by D’Agrella Filho and Cordani. In it, the RPC and the Kalahari cratons were united.

In the early Neoproterozoic, while the GPO was declining in its course of action to form West Gondwana, the CAB was affected by some extensional tectonic corridors which led to the formation of the Adamastor Ocean. From a bridge linking Bahia in Brazil and Gabon, within the São Francisco-Congo Craton, these portions of the continental lithosphere started opening toward the South, allowing the emergence of an oceanic lithosphere, and separating the RPC from the Kalahari in both sides of that ocean. However, the life of the Adamastor Ocean was short. In many places, like the Araçuai, West Congo, Ribeira, Gariep, Saldania and Dom Feliciano folded belts, rapid processes of basin filling of volcano-sedimentary formations occurred, followed by metamorphism, granite formation and folding. In this way, the ocean concluded a completed Wilson Cycle and went back roughly to its original position within the plate. Such tectonic evolution occurred more or less concomitantly with the formation of West Gondwana, between 700 and 500 Ma, during the Brasiliano-Pan African Orogenic Cycle. Moreover, belonging to this same orogenic cycle, within the CAB, similar processes also affected the Sergipano-Oubanguides and the Damara tectonic corridors, that builded concomitant Wilson Cycles.

Later, when Pangea was disrupted, the Atlantic Ocean was formed and the Rio de La Plata Craton was definitively separated from its counterpart in Africa, the Kalahari Craton.

Financing: The authors thanks to FAPESP 2015/03737-0 for the financial support.

Update of the cover of the Piedra Alta Terrane (Uruguay): Geochronology

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The western cratonic area of the Rio de la Plata craton in Uruguay was defined as Piedra Alta Terrane. It is constituted dominantly by Paleoproterozoic gneissic-migmatitic rocks with intercalations of two volcano-sedimentary belts of varied metamorphic grade. Granites, granodiorites and mafic bodies intrude this unit. The last igneous manifestation is characterised by a conspicuous basic dyke swarm with ages around 1.75 Ga and another one represented by lamprophyric dikes with Ar/Ar ages of 1.42 Ga. The volcano-sedimentary belts are San José and Arroyo Grande belts. Associated with them, is recognised a granitic-gneissic complex and related migmatites with magmatic intrusives emplaced at different crustal levels. The Arroyo Grande Belt (AGB) is located in the NW limit of the Piedra Alta Terrane. Different plutons with ages ranging from 2.05 to 2.10 intrude this belt. The main area of metamorphic rocks shows an EW trend and it extends from Paso de Lugo in the west to some kilometres to the east of Arroyo Malo del Yí. Some primary sedimentary structures are preserved in the metasediments (e.g.,crossed stratification) suggesting that the base of the series is towards the north. The detritic rocks predominate near the base of the sequence, whereas varied amphibolites are in the top. Basic metavolcanic rocks predominate throughout the south border of the belt. Towards the east, the detritic sequence has been intruded by several granitoids showing mylonitic contacts. The U-Pb detrital zircon ages of all three samples from Arroyo Grande Fm indicate a sharp peak ranging from 2.06 to 2.25 Ga. This interval is in good agreement with the available ages for the basement and intrusive granites.

This scenario demonstrates a very short interval for basement formation and erosion, deposition of volcanosedimentary sequences, deformation and metamorphism of these units and subsequent intrusion of the granitoids that cut them.

New data from San José Belt (basement, Cerros San Juan and Montevideo Formations) were obtained. The basement of Montevideo Formation shows U-Pb ages ranging from 2.3 to 1.8 Ga with very little Archean inheritance. Around 1.75 these rocks were affected by the extensional event of Florida dikes. On the other hand, the Montevideo Formation shows ages from 2.0 to 1.1 Ga, with two peaks in 1.7 and 1.4, consistent with the ages of Florida dikes and recently dated lamprophyric dikes in 1.42 Ga.

Although more data is needed, the Archaean heritage might question whether the RPC is indeed an entirely juvenile Paleoproterozoic unit.

Ultrabasic rocks from Isla Martín García (Argentina): A post-500 Ma magmatism in the Rio de la Plata Craton

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The occurrence of ultrabasic (UB) rocks in the Río de la Plata Craton has been scarcely cited in the literature. In the Piedra Alta Terrane (Uruguay), UB rocks were described in the Ojosmín Complex and were related to a Proterozoic obduction process (1). In the Tandilia System (Argentina), lamprophyric ultramafic dykes were considered as precursors of the Paleoproterozoic calc-alkaline rocks of the Buenos Aires Complex (2). At Isla Martín García (IMG), located between the coasts of Argentina and Uruguay, (3) described small outcrops of 'alpine-type' UB rocks assigned to an obduction process. These rocks were included in the Martín García Complex (*op. cit.*), together with amphibolites, gneisses, granitoids, and acidic and basic dykes. (1) and (4) considered the UB rocks from IMG as the continuation of those from the Ojosmín Complex. Recently, magnetic surveys carried out in IMG allowed to establish that the UB rocks constitute subcircular bodies intruding the Proterozoic basement (5). In this work, we present the first coupled LA-ICP-MS U-Pb and Lu-Hf isotopic data in zircons from the UB unit of IMG. Concentration, separation, and U-Pb and Lu-Hf analyses of zircons were done at the Centro de Pesquisas Geocronológicas (CPGeo) of the Universidade de São Paulo, Brazil. The analytical data were obtained with a Thermo Fisher Neptune LA multicollector ICP-MS equipped with a 193 Photon laser system, following the analytical method described by (6).

The studied sample (M90) is an undeformed serpentinized peridotite with cumulate texture (#Mg = 69; Cr = 3720 ppm) composed of olivine ($Fo_{84-85\%}$), Cr-spinel, orthopyroxene ($En_{83-86\%}$), clinopyroxene ($Wo_{43-48\%}$), and scarce plagioclase ($An_{71-73\%}$). Zircons from this sample are very scarce and have different sizes and internal structures, as well as Th/U values between 0.18 and 1.17. They are interpreted as inheritance. Sixteen spots gave the following ages and Lu-Hf isotopic data: ca. 2051-2049 Ma ($\varepsilon Hf_{(t)}$ = +3/+6, T_{DM} = 2.4-2.2 Ga); ca. 1100 Ma ($\varepsilon Hf_{(t)}$ = –1, T_{DM} = 1.9 Ga); ca. 1014-931 Ma ($\varepsilon Hf_{(t)}$ = –13/–11, T_{DM} = 2.5-2.3 Ga); ca. 763 Ma ($\varepsilon Hf_{(t)}$ = +1, T_{DM} = 1.5 Ga); ca. 622 Ma ($\varepsilon Hf_{(t)}$ = +6, T_{DM} = 1.1 Ga); ca. 520-503 Ma ($\varepsilon Hf_{(t)}$ = –8/–5, T_{DM} = 1.8-1.6 Ga). The middle Cambrian age of 503 ± 6 Ma provides the maximum crystallization age for the peridotite. These new data indicates the emplacement of a post-500 Ma UB magmatism into the Río de la Plata Craton and allow to reject a genesis related to a Paleoproterozoic obduction process for the IMG peridotite. Studies currently underway will allow defining its origin and age.

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U-Pb Detrital Zircon Ages and Nd Isotopes of the Cerro Figurita Formation, Piedra Alta Terrane (Río de la Plata Craton, Uruguay)

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The Piedra Alta Terrane (PAT) is constituted by the Andresito and the San José Belts, which are mostly composed of low-grade metamorphosed volcano-sedimentary units striking approximately East-West, which are intruded by calc-alkaline, late to post-orogenic granites dated between 2.05 and 2.09 Ga; these belts are separated from each other by extensive areas of calc-alkaline granites, gneisses, and migmatites (Florida Belt) which represent a 2.1 to 2.2 Ga magmatic arc ((1), (2), (3)). In the easternmost area of the San José Belt, the Cerro Figurita Formation (CFF) comprises coarse polymictic conglomerates, interbedded with volcanoclastic conglomerates at the base, feldspathic arenites at the middle of the sequence, and pelites and wackes resembling turbidites at the top of the section (4). Paragenesis of the volcanoclastic conglomerates and pelites of the CFF indicate lower greenschist metamorphic condition: Chlorite+Epidote±Albite for the coarse-grained and Moscovite+Chlorite+Qz for the fine-grained facies. Facies analyses of the CFF record a deepening-upward sequence, suggesting evolution from an alluvial fan and braided fluvial-dominated environment to marine turbiditic conditions. The abundance of unstable lithoclasts, immaturity of the sandstones, and the thickness of conglomerate deposits point to a steep paleorelief (4).

Three samples of the CFF display U-Pb detrital concordant ages dominated by a zircon population ranging from 2120 Ma to 2230 Ma. Noteworthy is the presence of subordinate concordant peaks at 2772, 2935 and 3222 Ma indicating an Archean felsic crust source in the Río de la Plata Craton. Additionally, it is worth to mention that an important population of discordant Archean zircon grains of our data displays Pb-loss, presumably due to the metamorphism that affected the crust during the Paleoproterozoic continental collision in the PAT.

The CFF displays $\varepsilon Nd_{(t=2.0\ Ga)}$ between 0.1 to 3.5 with T_{DM} ages ranging from 2001 to 2269 Ma and $f_{Sm/Nd}$ values from -0.32 to -0.46. $\varepsilon Nd_{(t)}$ versus Th/Sc indicates a derivation from an andesitic arc component. The relationship between $f_{Sm/Nd}$ and $\varepsilon Nd_{(t)}$ confirms a derivation from an arc-type component. Nd isotopes suggest that the detrital sedimentary mix is mainly derived from Paleoproterozoic juvenile sources.

A multi-approach to provenance analyses integrating geochemistry, petrography, U-Pb zircon ages and Nd isotopes indicate ongoing active tectonism during the Orosirian in the PAT whereas a retroarc foreland basin geotectonic setting is suggested for the CFF basinal deposition.

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Financing: This work is supported by the Laboratorio de Geología del Departamento de Geociencias, CURE, Universidad de la República and PEDECIBA Geociencias.

New insights into the evolution of southern Dom Feliciano Belt through U-Pb and Lu-Hf isotopic data

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The Dom Feliciano Belt comprises the southern segment of Mantiqueira Province in southeastern Brazil and eastern Uruguay, whose tectonic evolution is regarded as part of the Brasiliano Cycle during the Neoproterozoic. Which comprises the amalgamation process of the cratonic blocks from South America platform (Luíz Alves and Rio de la Plata cratons) and southwestern Africa (Congo and Kalahari cratons), which culminate in the formation of West Gondwana. The eastern portion of the Dom Feliciano Belt is composed of Pelotas Batholith and Punta del Este Terrane. The first consists of several calc-alkaline to alkaline granitic suites with subordinate mafic bodies, which represent a magmatism aged between 640-550 Ma and formed by processes of crustal assimilation, mixing and mingling between acidic and basic magmas. Xenoliths of metasedimentary rocks are recognized within this granite belt, whose most expressive exposure is the Matarazzo Complex that is composed of marbles and schists with meta-igneous rocks occurring as fragments and irregular intrusive bodies. The Punta del Este Terrane comprises a basement complex of granites, gneisses and migmatites formed between 1000 and 670 Ma, and supracrustal units of metavolcano sedimentary rocks and alkaline granitoids with ages between 650 and 570 Ma. The zircon analyses in a single outcrop of granitoids with different compositions from Pelotas Batholith provided U-Pb crystallization ages at 691.5±7 Ma (granodioritic gneiss), 645.9±3.7 Ma (microdiorite), 634.4±4.4 Ma (monzogranite), 620.1±4.7 Ma (syenogranite) and 609.6±2.2 Ma (pegmatite). Lu-Hf analyses constrained a main interval of model age range between 1.9 to 1.3 Ga, with εHf(t) varying from slightly positive to strongly negative (+2 to -33). The isotopic dataset implies a multi-stage magmatism, possibly related to flare-up episodes within the batholith formation, where also present isotopic signatures with strong contribution from mixed juvenile and crustal sources with Mesoproterozoic and Statherian-Orosirian ages. U-Pb data from the Matarazzo Complex were acquired from samples of amphibolite and diorite, which yielded crystallization ages at 750±5.8 Ma and 602±5.6 Ma, respectively. A U-Pb zircon analysis was also acquired from an injection of garnet-muscovite granite in the Cerro Complex, which yielded a crystallization age at 748±10 Ma. The Tonian U-Pb ages obtained in the Matarazzo and Cerro Olivo complexes are similar to the found in the Kaoko and Gariep belts in southwestern Africa, kindred to the first stages of the evolution of Brasiliano/Pan-African cycle, also regarded as the rifting process of the blocks from Columbia paleocontinent. The Cryogenian-Ediacaran U-Pb ages obtained from the granites of the Pelotas Batholith and from the intrusive diorite in the Matarazzo Complex are related to the accretionary and collisional settings of formation of the West Gondwana tectonic framework.

Isotopic Evolution of the Jaguarão Terrane, Southeastern Dom Feliciano Belt in southern Brazil

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The Jaguarão Terrane, located in southeastern Brazil and northeastern Uruguay, is a tectonostratigraphic terrane placed in the southeastern Dom Feliciano Belt, the southern segment of Mantiqueira Province. The terrane is constituted by metamorphic complexes of medium-grade metamorphism, intruded by subalkaline peraluminous granitoids. Lithological and structural aspects indicate its continuity to the south, to Uruguay in connection with the Punta del Leste Terrane. LA-ICPMS U-Pb and Lu-Hf zircon data were acquired from key samples from the Arroio Telho and Arroio Grande metasedimentary complexes, which are the main units of the Jaguarão Terrane. Its detrital zircon data showed ages in the range between 3.2 to 0.7 Ga, with main age peaks at 2.2-1.7 Ga, 1.5-1.0 Ga and 1.0-0.7 Ga, and a minor number of older ages (3.1-2.6 Ga). The samples from the subordinate Herval Complex, a metasedimentary sequence placed above the Pelotas Batholith but related to Jaguarão Terrane, indicated a similar detrital zircon provenance with two main intervals in the range 1.5-1.1 Ga and 1.0-0.7 Ga, and minor Paleoproterozoic (2.0-1.7 Ga) and Archean ages (2.8-2.4 Ga). The depositional age of the supracrustal complexes is constrained to populations aged ~ 700 Ma and the youngest detrital grains from all the samples are ~ 630 Ma. The Neoproterozoic metamorphic zircon overgrowths range from 620-570 Ma. The Lu-Hf isotopes from the Meso- to Paleoproterozoic zircons have εHf(t) values ranging from -10 to +10, with dominant slightly positive results, and Hf(t) model ages from Paleoproterozoic to Archean. The Neoproterozoic zircons show εHf(t) values dominantly negative (-15 to +5) and Meso- to Paleoproterozoic Hf(t) model ages. U-Pb geochronology data acquired on zircon from the granites present crystallization ages ranging between 580 and 570 Ma, which point to a widespread Ediacaran magmatism in the Jaguarão Terrane.Considering the restricted source of Mesoproterozoic rocks in the Mantiqueira Province and nearby cratonic areas, the obtained data allowed inferring that the source of these detrital populations was mainly located in Southwestern Africa, probably related to the Namaqua Belt. The main source area for the Paleoproterozoic and Archean detrital zircons is likely to be the Congo/Kalahari cratons (Africa). The geological context of the investigated supracrustal complexes and intrusive granites based on the results of isotopic zircon data indicate an origin related to an extensional basin forming by the Gariep rift, starting in the Tonian (~800 Ma), with regional deformation and metamorphism linked to the accretionary and collisional stages (630-570 Ma) of the Dom Feliciano Belt. These episodes of tectonic evolution took place during the amalgamation process of the cratonic blocks from South America platform (Luíz Alves and Rio de la Plata cratons) and southwestern Africa (Congo and Kalahari cratons), leading to the formation of West Gondwana.

Paired residual deformation and post-orogenic exhumation of the Kaoko and Dom Feliciano belts – impacts of the migrating orogenic front during the assembly of western Gondwana

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The reactivation of shear zones under brittle conditions during exhumation due to extensional collapse of the thickened continental crust is a common feature of post-collisional settings. New illite K-Ar analyses and (U-Th)/He data help establish the timing of exhumation and residual deformation during the final stages of orogenic activity in the Kaoko Belt. Dating of clay-sized white mica from fractionated samples can be used to estimate late-stage deformation in shear zones and constrain the transition from the ductile to the brittle regime. XRD characterization of the dated material indicates epizonal conditions (>300°C) for its crystallization, and the lack of correlations of illite crystallinity and polytype composition with age in fractionated samples are suggestive of protracted mineral growth. This supports the interpretation that K-Ar ages concentrating at 510-480 Ma in the analyzed samples set a maximum limit for the end of ductile activity in different structural domains of the Kaoko Belt, after which brittle faulting is interpreted to have been the predominant deformation mechanism. This observation is in accordance with new and published zircon thermochronological data, which typically record a fast cooling towards temperatures below 200°C shortly thereafter. This pattern is also in accordance with geological evidences in the Brasiliano equivalents of the Kaoko Belt in South America. Previous studies in the Dom Feliciano Belt have shown how late crystallization of illite in mylonites can occur synchronically to the initiation of brittle deformation during a retrograde trajectory, and a new compilation of geochronological data highlights how periods of pronounced fault activity coincide with regional exhumation events as constrained by thermochronological modelling. This process was most intense after the post-orogenic denouement of the Dom Feliciano Belt between ca. 550 to 400 Ma. A comparison of the timing of the main tectonic stages in South America and Africa reveals that, while the peak orogenic stage of the Dom Feliciano Belt (650-570) took place many tens of Myr earlier than in the Kaoko Belt (580-550 Ma), the transition from ductile to brittle deformation (535-465 Ma and 510-480 Ma, respectively) and rapid exhumation into upper crust conditions (550-400 Ma and 500-350 Ma, respectively) has much more significant overlaps. This observation suggests that, with the progression of the main deformation front from present-day South America to Africa at the time of the collisional process in the Kaoko Belt after ca. 580 Ma, the late-stage deformation and eventual post-orogenic exhumation of the Dom Feliciano Belt may have been controlled by the far-field tectonic influence of the continuing orogenic activity in the Kaoko Belt. The late stages of the former were, on its turn, also influenced by a continuation of the progressive migration of the orogenic front towards the Damara Belt, thus highlighting the interconnected character of deformation and exhumation within the entire orogenic system.

Financing: FAPESP - grants 2015/03737-0 and 2019/06838-2.

New U-Pb LA–ICPMS geochronological evidences of a Neoproterozoic arc along the easternmost Pampean ranges sequences

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The Eastern Pampean Ranges show a north-south trend along the northeast of San Luis, west of Córdoba and the south of Santiago del Estero provinces, in the centre of Argentina. They are composed of sets of old and strongly deformed metamorphic rocks that arise from the Chacopampeana plains recording a complex tectonic history developed during the assembly of the Gondwana west margin. The genesis of these rocks is still controversial, some authors proposed that they are part of an allochthonous terrane called Pampia that was assembled to the Amazonian Craton during Rodinian times (1), and later on to the Rio de La Plata Craton (RPC) in the early Cambrian (2). Others supports that these units constitute sedimentary sequences accreted to the RPC southwest margin that were exhumed in the Cambrian after the collision between the Craton and the Western Sierras Pampeanas, as part of the Arequipa Antofalla block (3), or as proposed by other authors, during the collision of Mara block (4). Currently, the collision between the Pampia terrane against the RPC is still under debate. (5) grouped the existing hypotheses into 3 main interpretation lines: a) Island arc collision against the RPC, b) Ridge subduction under a Cambrian accretionary prism, and c) Oblique collision of a large Paleoproterozoic age continental basement to the Kalahari Craton, later displaced by a transform fault.

According to (3), the Eastern Pampean Ranges were built by two temporarily lagged orogenic cycles. The first occurred in the Neoproterozoic, linked to the Goiás ocean closure during the Brazilian II cycle, and the second in the Cambrian, associated with the Puncoviscana ocean closure and the Brazilian III cycle (or Pampean orogeny). Based on detrital zircons distribution patterns and Sm-Nd ages, (6) proposed the emplacement of an island arc on the western margin of the RPC between 700 and 600 Ma ago. This arc, obliterated by the Pampean deformation, would have acted as a source for the Puncoviscana basin, constituting the southern end of a larger scale orogen.

Preliminary isotopic evidence from amphibolites, biotite gneisses and silicate-rich metacarbonate outcrops, supports the docking of a magmatic arc against the RPC during Neoproterozoic times (7). We present here new U-Pb isotopic data from some of those units, reinforcing those hypotheses.

LA-ICPMS analysis on zircon performed at Centro de Pesquisas Geocronológicas – USP, added 54 and 80 spots from amphibolites located north from El Sauce village (ES) and west from Falda del Carmen (FC), respectively. Backscattering and cathodoluminescence images show for the Neoproterozoic population a mixture of euhedral and subhedral crystal morphology and absence of fractures, suggesting a probable igneous source. Multifaceted *football shaped* crystals and wavy extinction are also present as well as rim development, indicating that these rocks underwent through a pervasive metamorphism during the Pampean and Famatinian cycles. Dated spots from ES showed a new maximum crystallization age of 675 Ma and a Concordia age of 591 ± 8.1 Ma, being in total 18 spots older than 550 Ma, 10 of these exceeding 590 Ma. FC outcrops, previously dated in 564 Ma, yielded a maximum crystallization age of 597 Ma, adding other four Neoproterozoic ages to database.

Obtained ages reinforce previous published amphibolite data, being also consistent with prevailing Neoproterozoic and Cambrian ages from two biotite gneisses outcrops from Sierra Chica (7). We propose that all these units were part of the same Oceanic Arc Depositional System (8) developed along the west margin of the RPC during the Neoproterozoic.

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New data from Neoproterozoic Dom Feliciano Belt and its Archean and Paleoproterozoic inheritance

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We present new LA-ICPMS U-Pb ages of detrital zircons from metavolcanosedimentary rocks of the Lavalleja Group (Minas, Fuente del Puma and Zanja del Tigre formations), a member of the Dom Feliciano Belt (DFB) in Uruguay linked to the Brazilian/ Pan-African orogenic cycle occurring in southeastern Uruguay and southern Brazil.

The Lavalleja Group is composed of volcano-sedimentary sequences that range from lower greenschist facies in the Minas Formation to upper greenschist-lower amphibolite facies in the Fuente del Puma and Zanja del Tigre Formations. Formerly, Zanja del Tigre Formation was considered as basement inliers of the DFB based on scarce isotopic data. Three representative samples of Minas, Fuente del Puma and Zanja del Tigre Formations have been dated by U-Pb.

Based on the results obtained, the following findings were made: the three formations that make up the Lavalleja Group have different U-Pb detrital zircon age patterns. For the Zanja del Tigre Formations two peaks are observed with ages of 2.0 - 2.3 Ga and 2.6 - 3.2 Ga. A single crystal was aged around 500 Ma. Fuente del Puma was the only one that showed a strong presence of Mesoproterozoic crystals between 1.3 and 1.5 Ga, with the other populations occurring in the intervals 2.0 - 2.3 Ga and 2.8 - 3.1 Ga. The Minas Formation metamorphites, unlike the previous ones, presented a distribution in a single peak between 2.3 and 2.5 Ga.

With the exception of the Mesoproterozoic peak, the other ages observed would have Archean and Paleoproterozoic rocks from the basement of the Lavalleja Group as possible sources.

The new results show an abundance of Paleoproterozoic detrital zircons (2500-2330 Ma) in the Minas Formation while Fuente del Puma and Zanja del Tigre Formations shows mainly Paleoproterozoic and Archean inheritance zircon ages, 3257-1337 Ma and 3216-652 Ma respectively, suggesting that the basement of the Dom Feliciano Belt would be correlated with Piedra Alta and Nico Pérez Terranes basements, both members of the Río de la Plata Craton.

SPECIAL SESSION

New applications and findings in $^{40}Ar/^{39}Ar$ geochronology of igneous and metamorphic rocks

Combined U-Pb and ^{40}Ar-^{39}Ar thermochronological and structural approach to unravel basin evolution and inversion during landward arc migration

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At 24°-26°S latitudes, the Domeyko range in northern Chile comprises Paleozoic to Neogene plutonic, volcanic, and sedimentary units. Carboniferous to Early Permian igneous rocks represent arc-related magmatism (Gondwana period), and Upper Triassic volcano-sedimentary and marine successions represent rifting followed by the incipient manifestations of the Early Andean back-arc environment that developed from the Late Norian to the Early Cretaceous. As the Andean arc evolved and subduction erosion started to dominate the margin´s evolution, resulting in an eastward migration of the arc front, the area of the former back-arc basin underwent several deformation and thermal disturbances. Thus, Andean orogenic building and magmatic activity, which includes the thin and thick-skinned deformation of the Triassic successions, seems to have been strongly influenced by tectonic fabrics acquired during Gondwanic and Early Andean stages (accretion and rifting) and, in turn, partially obscured such processes.

In order to disentangle the Gondwanic and Early Andean deformation history from that responsible of the building of the western Andean slope, we combined the high and medium temperature thermochronometers of U-Pb in detrital zircon (DZ) and ^{40}Ar-^{39}Ar in detrital muscovite (DM) from five samples distributed along strike of the Triassic basin successions.

U-Pb data indicate the Triassic rift occurred in two stages: a first from ca. 240-225 Ma opening the Sierra Exploradora sub-basin (SESB) and a second from ca. 217-200 Ma, opening the Sierra de Varas sub-basin (SVSB) and reactivating the SESB through a fault-linkage process. DM results show striking differences between both sub-basins. At the SESB, the DM ages peak (260-265 Ma) is slightly younger than the crystallization age of the Permian sources (DZ ages peak spanning 280-270 Ma). The small difference between both peaks, suggests a rapid cooling of plutonic sources at ca. 260-265 Ma, penecontemporaneous to, or shortly postdating, the San Rafael orogeny in South America. On the other hand, DZ ages from the SVSB reveal a predominant Cisularian source (DZ ages peak at ca. 292 Ma), and minor ages ranging 250-210 Ma. In contrast, DM show a complex age distribution spanning 192-243 Ma with the main peak at ~202 Ma. The broad distribution of younger peaks in the SVBS compared to the age of the primary source suggests a gradual uplift of a slowly exhumed terrain since ~243 Ma, without recording the 'San Raphael' event. Additionally, the main DM peak in the SVSB is younger than the depositional age of the succession (~213-210 Ma), suggesting partial resetting of the Ar system due hypothetic thermal event, perhaps related to the initial stages of the Andean back-arc magmatism. Another thermal event is recorded further south of the Domeyko range, in the La Ternera Basin where a broad distribution of small peaks of ^{40}Ar-^{39}Ar ages spanning ~110 to 70 Ma indicates thermal reset due to a "Mid Cretaceous" event. We speculate that the "Peruana phase" may have induced slow cooling of the volcano-sedimentary beds that must have been heated above 300°C during the back-arc stage. These thermal variations did not completely obscure the previous thermal history since Triassic and Permian age peaks are recorded in the analyzed micas.

We explain the different cooling histories of the Domeyko sub-basins sources by the existence of a major NW-striking structure segmenting the basement during the Upper Paleozoic. This crustal structure later defined the position of a structural high separating the two rift sub-basins. Later on, during the Eocene rift inversion, the Triassic rift architecture determined the overall structural style of the western Andean slope (shortening rates, thick- versus thin-skinned deformation and vergence). Our results show that the combination of medium-high T° thermochronometers is a useful tool to study basin evolution in a thermally complex region.

Financing: Fondecyt 1120715ANID Doctoral grant 21140774 NC160025 "Millennium Nucleus CYCLO."

A glance on the tasking to reestablish the K-Ar and $^{40}Ar/^{39}Ar$ dating equipment at the University of Brasília

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The Argon Isotope Laboratory at the Institute of Geosciences of the University of Brasília was created in the early 2010s, when a Nu Instruments Noblesse mass spectrometer (MS) was installed. Professor Koji Kawashita leaded the laboratory until he sadly passed away in 2020. Since then, the laboratory has been non-operational: many components were damaged and required replacement. This abstract aims to detail the efforts of researchers at the Institute of Geosciences to resume operations at the Argon Isotope Laboratory by fixing components of the Noble Gas mass spectrometer and performing several tests to certify laboratory performance. We show the first results of stability and sensitivity tests performed at the laboratory using the Nu Instruments Noblesse mass spectrometer.

Initially, the CO_2 laser tube and its DC power supply were recovered, several leaks on the sample preparation line (prep-system) were detected and repaired, and the prep-system ion pump was replaced. The DC power supply of the pneumatic valves, ion pumps, and the turbo molecular vacuum pump was replaced by electrical failure. Later, several system bake-outs of the spectrometer system were performed until it gave an excellent background signal in the flight tube and a good background on the prep-system. Finally, we are planning to replace a few ion counters running out of life soon, aiming to increase the signal stability and considerably reduce the numbers of interventions on the high voltage and discriminator control.

Although the Noblesse MS can analyze all noble gases, the prep-system described here is specially designed for argon gas; other noble gases would require alternative specific configurations. As a standard, at least two fusion options ensure gases entrance: a tantalum resistance furnace and an optical sample chamber transparent to CO_2 laser (New Wave MIR-10). The two volumes of gas entrance (optical chamber and furnace) are interconnected with a SAES PG-50 getter working at 400°C to clean active gases (N_2, CO and CO_2). Then, gases are exposed simultaneously to a NP-10 getter at room temperature to remove H_2 and to a cold finger (PolyCold P102) to trap residual CO_2 and interstitial humidity.

Here we describe the initial stability, sensitivity tests of the equipment, as well as discuss the methodology and system preparation. We focus on the K-Ar method by total fusion of samples, testing different options to set up the data acquisition on the spectrometer, like gas cleaning timing and signal integration. We have worked with two weighed sets of mineral standards to simulate a dating experiment. First, several grains of the standard (Pala Lepidolite KA-86 – 97.9 Ma) were measured to obtain a calibration curve. Then, we measured a set of another standard (Sanidine ACR-2 – 1.18 Ma), aiming to compare measured sanidine ages with reference standard values. We obtained twelve measured values in concordance with reference standard values (1.16 Ma). Other analysis (n=14) did not yield satisfactory results, which we attribute to loss of grains as we were performing fusion tests to find appropriate laser power and timing. These are promising preliminary results that encourage us to keep our efforts to make our Argon Isotope Laboratory operational again in order to resume the K-Ar and the $^{40}Ar/^{39}Ar$ dating techniques at the Institute of Geosciences.

Intercalibration of Servicio Nacional de Geología y Minería (SERNAGEOMIN), Chile and WiscAr $^{40}Ar/^{39}Ar$ laboratories

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Accurate and precise dating of Quaternary lavas and pyroclastic flow or fall deposits is essential for understanding the evolution of active volcanoes and providing context for future eruptions and hazard assessment. The $^{40}Ar/^{39}Ar$ method is commonly employed to date these volcanic materials, however, dating young (<150 ka) K_2O-poor materials can be challenging owing to low radiogenic $^{40}Ar^*$ contents that can be difficult to distinguish from trapped atmospheric argon. To address this challenge, a collaborative intercalibration exercise involving the University of Wisconsin-Madison WiscAr Laboratory and the $^{40}Ar/^{39}Ar$ Laboratory of the Servicio Nacional de Geología y Minería (SERNAGEOMIN), Chile, was conducted on a common set of samples with the aim of refining our methods and optimizing precision and accuracy of age determinations. Groundmass and plagioclase samples were analyzed on a 5-collector Noblesse ion counting mass spectrometer in the WiscAr laboratory, whereas measurements in the SERNAGEOMIN lab were performed using an ARGUS VI spectrometer equipped with faraday detectors and one compact discrete dynode electron multiplier. Samples for the intercalibration were collected jointly from three Andean Southern Volcanic Zone volcanoes to evaluate the capability of each laboratory to date different materials. Samples from lava flows with 1.0 – 3.2 wt. % K_2O from Planchon-Peteroa volcanic complex and with < 1.0 wt. % K_2O from Calbuco Volcano that are the focus of ongoing geological studies were measured in both laboratories. Single crystals of plagioclase (0.6 – 1.0 wt.% K_2O) were measured from the voluminous Diamante (Pudahuel) ignimbrite sourced from the Diamante Caldera. Multiple rounds of experiments were conducted including co-irradiation of samples at Oregon State University, as well as irradiations using the CCHEN reactor in Chile to investigate differences in neutron fluence parameters. As a result, SERNAGEOMIN has modified protocols for the CCHEN reactor that have been in place for decades so that Quaternary samples may be irradiated for periods of time most appropriate for their age. Although less precise than plateau ages, the isochron ages generated in the two laboratories agree at 2σ for all the co-irradiated samples. Six of six co-irradiated samples from Planchon-Peteroa yield plateau ages that also show inter-laboratory agreement at 2σ. The low K_2O lavas from Calbuco proved more challenging with only three out of five plateau ages in agreement between laboratories. Differences in the variability of the measured ^{36}Ar blanks between the two laboratories may explain the discrepancy. Analysis of single plagioclase crystals from the Diamante Ignimbrite show excellent agreement between laboratories for both weighted mean apparent ages and isochron ages. We favor an isochron age for the ignimbrite of ~132 ka, however, the contrasting apparent ages of the samples from three different outcrops present an interesting geochronologic problem that warrants further study. Overall, the consistency of the results between laboratories is promising. These new precise age determinations significantly improve our understanding of the temporal evolution of these active volcanoes.

Financing: NSF EAR-2121570, Collaborative Research: Ice Forcing in Arc Magma Plumbing Systems (IF-AMPS).

Evolution of magma storage conditions spanning the last glacial-interglacial transition, Mocho-Choshuenco Volcanic Complex, Chile

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The Mocho-Choshuenco Volcanic Complex (MCVC) in the Southern Volcanic Zone (SVZ) comprises ≥75 post-glacial explosive eruptions and is among the most hazardous volcanoes in Chile. The Patagonian Ice Sheet (PIS) reached its maximum thickness and buried the MCVC and other SVZ volcanoes under ≥1500 m of ice during the local last glacial maximum (LGM) at 18 ka. By 15 ka the volcanoes were nearly ice-free. Post-LGM changes in the compositions of 75 explosive eruptions at MCVC suggest a 3-phase response to unloading of crustal stress due to rapid retreat of the PIS. However, the Pleistocene record of the edifice and the magma storage conditions from early Holocene to Recent are unconstrained. We present 15 multi-collector $^{40}Ar/^{39}Ar$ ages, coupled with 82 whole-rock major and trace element compositions, as well as mineral and glass compositions from pre-, syn-, and post-LGM eruptive products to more fully address the impact of ice loading and rapid unloading on volcanic outputs at SVZ volcanoes.

Obtaining precise ages from young (<100 ka) mafic lavas is challenging due to the limited quantity of radiogenic $^{40}Ar^{*}$ that is difficult to distinguish from large amounts of trapped atmospheric argon. However, new $^{40}Ar/^{39}Ar$ data suggests that much of the edifice is younger than previous ages indicate with volcanism spanning from 130 ka to Recent.

Pyroxene-liquid and amphibole barometry, coupled with plagioclase hygrometry and glass chemistry suggest that the early post-LGM eruptions (14 – 11 ka) originated from magmas stored at greater and narrower range of pressure (2.7 – 3.2 kbar) with much higher water content (2.5 – 4.8 wt. %) compared to the pre-LGM and Late Holocene magmas of similar composition (1.7 – 2.3 kbar and 1.4 – 2.0 wt. % H_2O). We infer that rapid reduction of crustal stress by ~9 MPa, associated with ice retreat between 18 and 16 ka, promoted dike ascent and eruption of H_2O-saturated rhyolitic magma that segregated from the silica-rich portion of an amphibole-bearing crystal-rich magma reservoir ponded at ~11 km depth. The reduced lithostatic stress since ~16 ka allowed amphibole-free magma to traverse from deep crustal MASH zones through remnants of the early post-LGM magma reservoir to erupt as basaltic andesites and andesites.

Financing: This research is supported by the U.S. NSF grant EAR-2121570 IF-AMPS. Moreno-Yaeger holds a Chilean ANID grant 72200330 (Chilean Agency for Research and Development).

Expanding the EARTHTIME initiative into Chile: Challenges and achievements in $^{40}Ar/^{39}Ar$ geochronology

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EARTHTIME is a community-driven initiative that aims to improve the precision and accuracy of the U-Pb and $^{40}Ar/^{39}Ar$ geochronometers with the goal of improving the resolution of earth history. A key component has been the intercalibration of isotopic measurements of tracer solutions and standard minerals, and analytical procedures in several laboratories. EARTHTIME efforts have been active in the United States and Europe since 2003, and in China since 2014.

Chile's National Geology and Mining Survey (SERNAGEOMIN) invested in 2013 in a Thermo Scientific Argus VI mass spectrometer as part of a program to complement the existing MAP 215-50 based $^{40}Ar/^{39}Ar$ facility. One goal is to provide more accurate and precise age determinations for Quaternary lavas and pyroclastic flow or fall deposits, as they are essential for understanding the evolution of many active volcanoes in Chile, and to provide context for future eruptions and hazard assessment.

The $^{40}Ar/^{39}Ar$ method is commonly employed to date many types of volcanic materials, however, dating young (<100 ka) K_2O-poor samples can be challenging owing to low radiogenic $^{40}Ar^*$ content, that is difficult to distinguish from trapped atmospheric argon. To address this challenge, a collaborative intercalibration between the UW-Madison WiscAr and SERNAGEOMIN laboratories was conceived in 2016 and has been underway since 2017.

The collaboration has involved the training of a graduate student at UW-Madison who now works in the SERNAGEOMIN laboratory full time, an extended visit by the SERNAGEOMIN lab manager to the WiscAr lab, and several visits by WiscAr lab staff to the SERNAGEOMIN lab. In-depth interrogation of each procedural step from preparation of samples to irradiation, to mass spectrometry, has led to improvements in both laboratories. This level of collaboration and discussion has led SERNAGEOMIN to modify several aspects of irradiation and measurement procedures. In particular changes in procedures in the SERNAGEOMIN lab have increased the accuracy and precision of age determinations and enable the lab to address new scientific problems that were previously intractable. The improvements have enabled the SERNAGEOMIN lab to play a larger role in research presented at scientific congresses, publications, and projects.

The evolution of this collaboration has fostered a new level of administrative engagement and technical support within SERNAGEOMIN. The SERNAGEOMIN $^{40}Ar/^{39}Ar$ lab is now better positioned to engage with geologists from across Chile, and throughout South America, to address many challenging earth science problems.

The role of radioisotopic and cosmogenic geochronology in understanding ice forcing in arc magmatic plumbing systems

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To address the question of how changes in the climate system on Earth's surface interact with magma reservoirs within its interior, we are blending field observations, lab measurements, and numerical model simulations in an integrated study of links between changes in glaciers and topography, and the behavior of six active volcanoes in southern Chile. These volcanoes were mostly covered by the northern Patagonian ice sheet until it melted rapidly beginning ~18 cal. ka. Utilizing new and existing geochronologic, geochemical, glacial and erosion/deposition observations within the southern sector of the Andean Southern Volcanic Zone (sSVZ), we aim to couple a suite of numerical models to test and refine three hypotheses: (1) Over short timescales (<100 ka), the composition, volume, and timing of eruptions are strongly influenced by climate-driven changes in surface loading. These short-term responses modulate the long-term (>100 ka) eruptive characteristics, which are governed by mantle melt flux, (2) Crustal stress changes associated with the local onset of rapid deglaciation and erosion at ~18 cal. ka promoted eruptions by enhancing volatile exsolution that in turn pressurized stored magma and propelled dike propagation to the surface, and (3) Responses to rapid unloading will vary among volcanoes, reflecting contrasts in the composition, volatile contents, and compressibility of stored magma, as well as the rate at which crustal reservoirs are recharged from depth.

To evaluate these hypotheses, our goals include: (1) Generating high-resolution records of cone growth, eruptive behavior, and geochemical evolution of six sSVZ volcanoes during the last ~50 ka, and (2) Building new records of ice retreat and landscape evolution owing to the erosion, transport, and deposition of sediment adjacent to these volcanoes. We are developing chronologies for each volcano that span the transition from maximum ice loading through rapid deglaciation 18-14 cal. ka, and into post-glacial time. Because these volcanoes comprise mainly low-K_2O basaltic andesitic eruptive products, our approach involves acquisition and integration of $^{40}Ar/^{39}Ar$ ages of latest Pleistocene lava flows, ^{3}He surface exposure dating of Holocene lavas and parasitic cones, and ^{14}C dating of late last glacial to early post-glacial tephras. Dating lava-ice contacts and moraines will constrain glacier extents over time on these volcanoes. The lateral extent of the Patagonian ice sheet (PIS) during the last glacial maximum (LGM) at ~18 cal. ka is well known from extensive ^{14}C dating of terminal moraines impounding several large open-basin lakes in a tectonic depression (Valle Central) located west of the volcanoes. To address the lesser understood retreat of the PIS from these terminal moraines we are sampling glaciated peaks and erratic boulders deposited at elevations between 500 and 2000 masl and measuring cosmogenic ^{10}Be to determine the duration of surface exposure that followed loss of ice at each location. The aim is to develop an elevation dependent chronology of ice retreat since the LGM across this region that can be used to ground truth numerical models of PIS retreat. Moreover, we aim to obtain new ^{14}C dates in cores from several small, closed lake basins to refine proxy records of the climate changes that drove retreat of the PIS.

E-POSTERS

Nd isotopes of the Paleoproterozoic Arroyo Grande Formation, Piedra Alta Terrane (Uruguay), Río de la Plata Craton

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The Piedra Alta Terrane (PAT) is a Precambrian tectonostratigraphic unit of the Río de la Plata Craton (RPC), developed in Uruguay and separated from the Nico Pérez and Tandilia Terranes by the Sarandí del Yí and Colonia-Pavón Shear Zones, respectively (1). It comprises two East-West extended orogenic belts known as San José and Andresito, which like the Ojosmín unit that develops between them, are composed of metamorphosed volcano-sedimentary sequences intruded by post-orogenic TTG granitoids and are in tectonic contact with granites, gneisses, para-amphiboles and migmatites of the Feliciano, Florida, and Ecilda Paullier Belts ((2), (3)).

All of these igneous rocks have Paleoproterozoic (Transamazonian) ages. The PAT is also distinguished by the intrusion of a mafic dyke swarm dating 1786±2 Ma (3). The Andresito Belt is limited by vertical faults and comprises outcrops of the Arroyo Grande Formation (AGF) intruded by the Marincho Plutonic Complex (with ages between 2139±20 and 2076±18 Ma). The AGF is a sequence of metasedimentary rocks with interlayered basic and acidic metavolcanic rocks; the latter show U-Pb ages of 2113±8 Ma (3), but since older ages were determined for some magmatic rocks intruded in the AGF, its age is still not accurately defined. Sm-Nd isotopic data were obtained as a robust proxy for a multitechnique approach to understand the provenance of AGF and give insights into the tectonic evolution of the PAT to elucidate the accretional history of the RPC.

The metasedimentary record of AGF comprises metaconglomerates, quartzites, metarenites and metapelites, preserving finning upwards and other pre-metamorphic sedimentary structures. Paleocurrents indicate a transport southward (present coordinates). Quartz veins were identified, sometimes accompanied by calcite and opaque minerals. Petrographic analyses indicate foliated stretched crystals, predominantly polycrystalline quartz with wavy extinction. K-feldspars and plagioclase are found, with the predominance of sanidine at the sequence base (indicative of a felsic volcanic source). Oriented biotite (sometimes in nests) was identified, encompassing muscovite and chloritoid; there is also reddish euhedral garnet. Intense albitization is observed, with overgrowths enclosing muscovite, biotite and garnet. The paragenesis preliminarily indicates a medium greenschist facies metamorphism. Geochemical analyses confirm the contribution of a felsic source and also indicate a subordinate mafic source component (4).

The AGF displays εNd(t=2.15 Ga) between -2.4 and 6.0 with TDM ages ranging from 1.98 to 2.62 Ga and fSm/Nd values from -0.35 to -0.55. εNd(t) versus Th/Sc indicates a derivation from a felsic arc component. The relationship between fSm/Nd and εNd(t) confirms a derivation from an arc-type component. Nd isotopes suggest that the detrital sedimentary mix mainly derived from Paleoproterozoic juvenile sources, although Archean protoliths are also evident. TDM crustal residence time range from 2.28 to 1.76 Ga in the PAT (2), though TDM ages of 2.99 Ga were obtained in an horblendite of the Arroyo Grande Belt (5) support the existence of an Archean crust, likewise elsewhere the RPC. Detrital zircon dating will shed light on the provenance and paleogeographic setting of the AGF (work in progress) and will contribute to understand the tectonic evolution of this part of the RPC.

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Geochemical characterization of the Vega Verde travertine system (Quaternary), Puna Argentina

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Travertines are non-marine carbonate deposits produced by degassing of hydrothermal waters and the influence of biotic factors. The economic and scientific interest in non-marine carbonates have been growing in recent years because they are considered as hydrocarbon reservoirs in the pre-salt plays of Brazil and Angola. Expanding knowledge of these systems allows predicting better exploration targets for potential oil plays. In this work we describe for the first time the Vega Verde travertine system- Botijuela, located at the Argentina South Puna. The system was described using multiscale approaches: megascopic, mesoscopic, and microscopic. In conjunction with the multi-scale approach mineralogical analysis with X-Ray diffraction, geochemical composition of major oxides and trace ions with X-Ray fluorescence and stable isotopes of C and O. Three deposition zones in the system were recognized based on the distance from the spring, slope, and lithological features: proximal, intermediate, and distal. Meso and micro scale analysis of carbonate samples in bafflestones and framestones facies showed shrubs, botroidal shapes and oncoids morphologies which suggest evidence of biological activity. Mineralogically, the deposits are mainly composed of calcite and Mg-bearing calcite. The proximal area of the Vega Verde travertine system shows a marked enrichment in As, Pb, Fe_2O_3 and trace elements compared to the intermediate and distal areas. These geochemical characteristics occur in association with the presence of ferruginous carbonates, globular silica, and fibrous calcite suggesting evidence of geysserite facies. The impoverishment of those components and the increment of Si throughout the system is accompanied by the increasing influence of sedimentary processes related to siliciclastic deposits that gradually increase from proximal, through intermediate to distal in the direction of the Salar de Antofalla basin. Isotopic analysis revealed a vast enrichment of $\delta^{13}C$ (1.97~10.84) and negative $\delta^{12}O$ values (-0.67 - -8.91) that in conjunction with Sr and Ba analysis indicated a hydrothermal origin for the distinct sedimentary facies.

Financing: Diagenesis Project (SEI 23075.193990/2017-07).

U-Pb zircon provenance analysis of the Yacoraite Formation, Tres Cruces sub-basin, Salta Group, Eastern Cordillera, Argentina

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A U-Pb age provenance analysis on detrital zircons was carried out in the Cretaceous calcareous rocks of the Yacoraite Formation, the most relevant economic unit of the Northwest Argentina. The Yacoraite Formation is the oil-source rock and main reservoir of the Salta rift basin, as well as a host for relevant U, V, Cu mineralizations.

This abstract proposes to establish the location of the source areas of the sedimentation of the clastic levels of the Yacoraite Formation (Balbuena Subgroup). The studied area is in Tres Cruces sub-basin in the northern part of the Eastern Cordillera. In this area, the Yacoraite Formation is composed of limestones, laminate pelites, calcareous sandstones and stromatolitic limestones with traces fossils and dinosaur tracks. It transitionally overlays the Lecho Formation (Maastrichtian). The deposits of the Balbuena Subgroup (Maastrichtian-Danian) are lying unconformably dipping towards to the west, above the quartz sandstones of the Mesón Group (middle-upper Cambrian). The thickness of Yacoraite Formation in the Maimará section is 55 m, where the base of the Lecho Formation is composed of a fining-upward succession of matrix supported conglomerates and coarse to fine sandstones. The conglomerates are composed of angular and poorly sorted fragments of rocks with a clear provenance from the Mesón Group.

We present U-Pb detrital ages of two samples analyzed in the LA.TE. ANDES Laboratory. The first sample is from the base of the unit, a calcareous sandstone (Y1) and the second sample is a calcareous oolite (Y2) from the top of the Yacoraite Formation.

Sample Y1: One hundred and seven (107) spots on single zircon grains of the base of the Yacoraite Formation (BM) were analyzed. Frequency data shows a unimodal zircon age distribution with a main mode Neoproterozoic, U-Pb age between 542 Ma to 891 Ma (77%), and a second mode with Paleoproterozoic ages (11%). The Cambrian ages were found, Lower Cambrian (6%), Middle Cambrian (3%) and a tail with Mesoproterozoic and Archean ages (2%, 1%).

Sample Y2: Ninety-six (96) analyses were spotted on single zircon grains from a sample taken from the top of the unit. It shows a frequency data conforming a polymodal zircon distribution, with a main population of Cambrian (22% of grains) and Neoproterozoic (53% of grains) ages. Others zircon ages were found: Paleoproterozoic (16% of grains), and four (4) zircons of Mesoproteorozoic age and two zircons of Archean age were recognized. Finally, three (3) grains with Ordovician ages were found.

Both datasets show that the main sources of detrital zircons in the Yacoraite Formation correspond with the Paleozoic rocks of the region. In the Maimará section, the main sources are Neoproterozoic and Cambrian rocks (i.e., Puncoviscana Complex and Meson Group). At the top of the sequence, ordovician zircons were found, suggesting a change of the provenance.

The sedimentation of the Yacoraite Formation occurred near an active volcanic front. Different tuffaceous levels were identified with provenance from the chilean arch. The depositional ages of the tuffs vary between 60 to 68 Ma. However, in the provenance analysis of the Yacoraite Formation, these younger zircon ages are absent. Therefore, we conclude that the influence of the paleorelief (basement) in the sedimentation of Yacoraite Formation in the Tres Cruces sub-basin played a major role in the compositional variability of the unit.

Financing: UBACYT 2020 Proyecto 20020190200404BA (Universidad de Buenos Aires).

U-Pb and Lu-Hf data of a Late Devonian granite from Bajo de la Leona, eastern Deseado Massif, Southern Patagonia (Argentina)

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The middle to late Paleozoic orogenic evolution of Patagonia is well-documented by Devonian to Permian magmatism in the North Patagonian and Deseado massifs, and further west along the Andes. This evolution has been explained by collisional or accretionary models (*e.g.*, (1), (2)). In particular, Devonian intrusions are mainly exposed in the North Patagonian Andes and the western North Patagonian Massif along a NNW-SSE-striking belt, though relics of coeval, mainly juvenile magmatism are also recorded to the west in Chile (*e.g.*, (2), (3)).

In the eastern sector of the Deseado Massif, high- to medium-grade metamorphic rocks, gabbro-diorites, and granites were included into the Río Deseado Complex. These rocks crop out in Bajo de la Leona and the Dos Hermanos, Tres Hermanas, El Sacrificio, and El Laurel farms. SHRIMP U-Pb isotopic dating of zircons from granites of the Río Deseado Complex yielded ages between *ca*. 450 Ma (Dos Hermanos Granite) and *ca*. 344 Ma (Mina La Leona Granite) (*e.g.*, (4)). In Bajo de la Leona, migmatites, gneisses, schists, and granitoids of the Río Deseado Complex (pre-Permian) crop out. In addition to the Mina La Leona Granite, another Paleozoic granite crops out in the area, whose coupled LA-ICP-MS U-Pb and Lu-Hf isotopic data in zircons are here presented. Concentration, separation, and U-Pb and Lu-Hf analyses of zircons were done at the Centro de Pesquisas Geocronológicas (CPGeo) of the Universidade de São Paulo, Brazil. The analytical data were obtained with a Thermo Fisher Neptune LA multicollector ICP-MS equipped with a 193 Photon laser system, following the analytical method described by (5).

The studied sample is a high-K calc-alkaline and peraluminous granite mainly composed of quartz, K-feldspar, biotite, and Na-plagioclase. Twenty-three zircons from this granite were analyzed. They are mainly prismatic and show magmatic oscillatory zoning. The best estimate U-Pb concordia age for the crystallization of the studied sample (24 spots) is *ca*. 362 Ma (Famennian). Regarding the Lu-Hf isotopic data, results show variable subchondritic ($\varepsilon Hf_{(t)}$ = –15/–1; $T_{DM\text{-}Hf}$ = 2.0-1.3 Ga) to suprachondritic ($\varepsilon Hf_{(t)}$ = 0/+6; $T_{DM\text{-}Hf}$ = 1.3-0.9 Ga) compositions. Results show a geochemical and isotopic fingerprint comparable to coeval intrusions exposed between the North Patagonian Andes and the North Patagonian Massif, thus indicating that the Bajo de la Leona magmatism might have represented the southernmost expression of the Devonian continental magmatic arc.

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Lead isotopes coupled to magnetic separation allow deciphering the geochemical background and pollution sources in arsenic and metals polluted areas

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Soil pollution by arsenic and metals is a global concern due to the high impact on the Environment and the high risk for human health. To determine the degree of pollution in an area, soil sampling and chemical analysis are usually performed. As a part of this monitoring activity, it is necessary to define the geochemical background. The geochemical background for each pollutant corresponds to the element concentration which is presented in the soil by the geogenic source (natural contribution), thus higher concentrations than this level could reveal the presence of pollution. However, this value usually remains unknown, although several approaches were developed for deciphering it, such as multivariate statistical analysis or the chemical analysis of the geological parent materials. In this work, we propose a novel method for determining the geochemical background in soils from polluted areas by the combination of lead isotopes and magnetic separation. To this end, a highly polluted soil was sampled in an affected area by smelting activities where the geochemical background was already known through the analysis of parent material (sampled rocks close to the area) and the pollution source was also identified through the characterization of slags and fly ashes. The soil was subjected to magnetic separation at different magnetic fields using a wet high-intensity magnetic separator (WHIMS) and obtained soil fractions (magnetic and non-magnetic ones) were subjected to analysis using ICP-MS for determining As and metals concentration, and also the Pb isotopic ratios. The measurement of Pb isotopes allows to identify that the non-magnetic fraction obtained at the lowest magnetic field reveals a similar Pb isotopic ratio to the parent materials, thus As and metals concentrations of this sample could be identified as the geochemical background from the site. On the other hand, the magnetic fraction obtained at the same magnetic field showed a similar fingerprint to the pollution source, thus this method could also be used for identifying pollution source fingerprints in soils, especially in cases of multiple pollution sources.

Financing: Funding:European Union-NextGenerationEU, Ministerio de Universidades, and Plan de Recuperación, Transformación y Resiliencia (MU-21-UP2021-030 32892642).

Earth's new regime at the dawn of the Paleoproterozoic: Hf isotope evidence for efficient crustal growth and reworking in the São Francisco Craton, Brazil

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A robust dataset of zircon Hf isotopes in magmatic rock assemblages from SE-Brazil is interpreted as evidence of accretionary and collisional plate tectonics at least since the Archean-Proterozoic boundary. During the Phanerozoic, accretionary, and collisional orogenies are considered the end members of different plate tectonic settings, both involving pre-existing stable continental lithosphere and consumption of oceanic crust. However, mechanisms for the formation of continental crust during the Archean and Paleoproterozoic are still debated with the addition of magmatic rocks to the crust being explained by different geodynamic models. Hf isotopes can be used to assess the proportion of magmatic addition into the crust: positive εHf values are usually interpreted as indications of magmatic input from the mantle, whereas crust-derived rocks show more negative εHf. We show that the crust of the amalgamated Paleoproterozoic tectonostratigraphic terranes that make up the southern São Francisco craton were generated from different proportions of mantle and crustal isotopic reservoirs. Plate tectonics processes are implied by a consistent sequence of events involving the generation of juvenile subduction-related magmatic arc rocks, and subsequent collisional phases of the orogen, whereby re-melting of older crust and post-collisional bimodal magmatism related to gravitational collapses were predominant mechanisms.

Petrogenesis of Granites from the Ediacaran Socorro Batholith, SE Brazil: Constraints from Geochemistry and Sr-Nd-Hf Isotopes

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Whole rock elemental and Sr-Nd isotope geochemistry and *in situ* zircon Hf isotope geochemistry was used to identify the sources of the Neoproterozoic granites from the Socorro Batholith, Socorro-Guaxupé Nappe (SGN), South Brasilia Orogen, Brazil. Ti-in-zircon thermometer, zircon and apatite contents and trace element concentrations provided information about crystallization conditions. Three main types of granites built the bulk of the batholith, beginning with probably pre-collisional ~640–630 Ma charnockites, and ending with ~610 Ma voluminous post-collisional high-K calc-alkaline (HKCA) I-type granites (Bragança Paulista-type). The interval from collisional to post-collisional period was marked by the generation of several types of leucogranite (SiO_2>72 wt.%) that occur in the southern portion of the batholith and have a range of geochemical and isotope signatures, reflecting melting of different crustal sources in between ~625 Ma (Bocaina Pluton) and ~610 Ma (Bairro da Pedreira Pluton). The leucogranites have strongly negative εNd(t) (-16.2) and average zircon εHf(t)= -16 and high $^{87}Sr/^{86}Sr_t$ (0.7156-0.7171), consistent with relatively old ortho and paragneiss sources similar to those which generated regionally abundant migmatites and anatectic granites in the collisional to post-collisional setting. Two main charnockite bodies occur in the study area: the ~640 Ma Socorro charnockite has remarkable chemical similarities with Bragança Paulista-type granites, but less negative εNd(t)= -6.1 and average zircon εHf(t)= -9.1 and lower $^{87}Sr/^{86}Sr_t$ (0.7093), indicative of a more juvenile water-poor source. The ~633 Ma Atibaia charnockite has distinct geochemical signature (lower Mg# and Sr content; higher Zr), more negative εNd(t)= -14.1, similar average zircon εHf(t)= -8.9, and much higher $^{87}Sr/^{86}Sr_t$=0.7197, probably reflecting a larger component from old crust. The predominant ~610 Ma Bragança Paulista-type granites were emplaced in a post-collisional setting, and correspond to porphyritic biotite-hornblende monzogranites of high-K calc-alkaline character with 61-67 wt.% SiO_2, high Mg# (39-42), high LILE (K, Ba, Sr) and low HFSE (Zr, Hf, Nb). They show very negative εNd(t) (-12.3 to -12.9) and zircon εHf(t) (-12 to -17) and $^{87}Sr/^{86}Sr_t$=0.7119–0.7131. The Zr saturation and Ti-in-zircon temperatures of the HKCA Bragança Paulista granites are low (TZr=730-780 °C) while TAp yields are much higher (950–1.000°C). Strongly fractionated REE patterns with weak negative Eu anomalies and high Sr/Y (19-40) ratios are consistent with melt equilibration in a thickened crust with residual garnet. A contribution from (enriched) mantle is suggested by high mafic mineral content, presence of mafic microgranular enclaves and apparently high liquidus (apatite saturation) temperatures. These melts from enriched mantle sources emplaced in the lowermost crust, heated host old continental crust rocks (gneisses and granulites) and partially mixed with their melting products.

Financing: FAPESP - Fundação de Amparo à Pesquisa do Estado de São PauloCAPES - Coordenação de Aperfeiçoamento de Pessoal de Nível Superior.

Isotopic variations in Amazon Basin precipitation

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From Atmospheric General Circulation Models and $\delta^{18}O$ data, the relationship between the South American Monsoon System and $\delta^{18}O$ in precipitation was determined by (1). They found a negative correlation over the entire continent, except for the region along the Brazilian east coast between 10°S and 20°S. The most significant negative correlations are evident over the Amazon Basin, the Central Andes (from ice cores), and over southeastern South America. These models use as input data the information available from the Global Network of Isotopes in Precipitation project. In the Amazon region, there are few points available in the central area of the basin. This work will densify the sampling network in this sector and analyze the interannual variation of stable isotopes of $\delta^{18}O$ and δD in precipitation. We will try to interpret this set of results from the Amazon region in terms of temperature variation, precipitation amount, and possible source area of moisture.

Isotopic analyzes were initially done by collecting 145 rainwater samples, in six cities: Manaus, Coari, Itacoatiara, Belém, Porto Velho and Tefé. The collections were made during the period from May/2016 to May/2017 in the city of Tefé and from July/2013 to September/2015 in the other cities. The samples were sent to the city of Porto Alegre to perform the isotopic analyses by the Cavity Decay Time Spectroscopy method, available in the glaciochemistry laboratory of the Polar Center. The data on total precipitation, average temperature, and relative humidity of all cities are available in the open database of National Institute of Meteorology in Brazil.

The climatology of the Amazon region essentially showed a strong correlation with the stable isotopes in precipitation, especially the average maximum temperature. In the cities of Itacoatiara, Manaus, and Tefé, precipitation resulted in a strong inverse correlation (ρ between -0.68 and -0.74), Belém, Coari, and Porto Velho, a weak to very weak positive inverse correlation (ρ between 0.018 and -0.20). Maximum temperature resulted in a strong to very strong positive correlation for the central and western regions in the cities of Manaus, Tefé, Porto Velho, and Itacoatiara (ρ between 0.60 and 0.93), moderate in the city of Coari ($\rho = 0.5$) and very weak in the town of Belem, the eastern region of the Amazon basin ($\rho = -0.008$). Excess deuterium is used in the identification of moisture sources. Precipitation from air masses with considerable incorporation of evaporated water shows these higher values. It was identified that the western and central regions in the Amazon region (Tefé, Itacoatiara, Manaus, and Porto Velho) are areas where water recycling varies annually. This confirms the importance of evaporation in this area as a source of water vapor to the atmosphere. The city of Belém is the only one that presents values above 10‰ throughout the year due to its proximity to the Atlantic Ocean. The town of Coari does not present values high enough to indicate a local water recycling, contributing to interpretations that the city is located in an area where the nearby body of water may supply precipitation at the Coari Lake.

The results indicate the importance of lakes as a source of water evaporation to the atmosphere in the Amazon region. The Amazonian climate is very complex, and several factors not studied in this work influence the region's climatology and isotopic fractionation. Further research, with more sampling sites and more significant numbers of samples, can be conducted. However, the interpretations point to a strong dependence between temperature/precipitation and humidity coming from the Amazon rainforest, making the protection of this biome essential for preserving the climatic system of the entire region.

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Financing: The Brazilian National Council for Scientific and Technological Development (CNPq).

Isotopic signature of carbon ($\delta^{13}C$) of the underground flow through the Paranoá Dam-DF

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The total impermeability of an earthen and rockfill dam is not possible due to the existence of permeability of the materials and limitation of the construction methods used. Therefore, these structures have internal drainage systems to capture the underground flow of water that crosses them. The heterogeneity of the materials used can lead to preferential flow paths that are not captured by internal drains. These preferential flows can trigger internal erosion problems and compromise dam safety. The investigation and monitoring techniques of physicochemical characteristics (HAIZHOU DONG et al., 2016; TAO WANG et al., 2019; G. KIM and J. PARK, 2014) and isotopes of D and $\delta^{18}O$ (NOBLE, J. ANASRI , ARZOO, 2017; T.; A. RATIAT et al., 2020; P. YI et al., 2018) and δ^{13}CDIC and δ^{13}CDOC, $\delta^{34}SO_4$, $^{87}Sr/^{86}Sr$, $\delta^{11}B$, $\delta^{37}Cl$ and $\delta^{81}Br$ (BIRKS et al., 2019; MOHAMMADADEH, H and HEYDARIRZAD, M, 2020).

This work presents an approach integrating physicochemical and $\delta^{13}C$ isotopic signature data from the flow through the Paranoá Dam-DF, Brasília, Brazil. The dam crest is about 600 m long and was built on fractured quartzites.

The samples were collected in the reservoir, in the internal drains and in the right abutment. In the reservoir, they were collected at 2 points of the reservoir, with a sample every 7.0m of depth. At Point 01, the maximum depth of the water column was 34.5m (6 samples). At Point 02 the maximum depth of the water column was 28.0m (5 samples). Internally, in the center of the dam, 05 samples were collected from each of the 05 drains that have their outlets in this location. The position, extent and diameters of these drains on the busbar are unknown. On the right abutment, 02 samples were collected, 01 in a piezometer and 01 in a horizontal drain built to capture and divert water from the fractured aquifer.

The results of the physicochemical parameters indicate a pH ranging from 6.7 to 7.3, an alkalinity from 21 to 27ppm, conductivity from 84 to 89µS and TDS from 40 to 42mg/L in water columns 01 and 02. In the piezometer and in the drain external values are, respectively, 4.7 and 4.9 for pH, 4 to 4.7ppm for alkalinity, for conductivity from 10 to 15µS and 4.5 and 6.6mg/L for TDS. In internal drains the pH varies from 5.1 to 6.3, the alkalinity from 4 to 29ppm. conductivity from 5 to 76µS and TDS from 2 to 36mg/L. The major elements in columns 1 and 2 show NO_3^-, SO_4^-, Ca, Cl^- and Na^+ from 1.63 to 0mg/L, 7.38 to 3.49mg/L, from 8.40 to 4.33mg/L, from 6.74 to 6.41mg/L and from 7.4 to 8.7mg/L, in the piezometer and in the external drain, from 2 to 4mg/L, from 0 to 0.4mg/L, 0mg/L, 0.7 to 1.2mg/L and 0.8 to 1.6mg/L, in the drains 0.3 to 0.6mg/L, 0.3 to 1.9mg/L, 0 to 10.2mg/L, 0.4 to 4.0mg/L and 0.2 to 4.5mg/L. The δ^{13}CDIC values of the surface water column showed a decrease in values with increasing depth, with values from -5 to 7m and -11 after this depth. The samples related to the internal drains, piezometer and external drain are under laboratory analysis for δ^{13}CDIC.

According to the observed data, the lake water is neutral, with higher values of TDS, conductivity, Na^+, Cl^- and Ca^{2+}, there is an increase in Total Carbon and Inorganic Carbon and a decrease in NO_3^-, SO_4^- and δ^{13}CDIC with the increase deep. At the foundation, both external drain and piezometer present similar physicochemical values, with low values of TDS, conductivity, pH, Na^+, Cl^-, and Ca^{2+}, as expected for groundwater in the region. The data also show that internal drains 2, 3 and 4 have higher values of TDS, alkalinity, conductivity, pH, Na^+, Cl^- and Ca, closer to surface water, while drains 1 and 5 have lower values, close to the piezometer. Therefore there is a likely and significant contribution of groundwater in these drains. However, we still await the isotopic and REE data for further conclusions.

Financing: UnB Geochronology Lab and CAPES.

Hf isotope determinations on U-Pb SHRIMP dated zircons from Mesozoic units of the northern Patagonian batolith in the Lake Fontana area, Chubut province, Argentina

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Hf isotope determinations have been carried out on some of the zircons previously dated using the U-Pb SHRIMP method by (1),(2), sampled from Mesozoic igneous rocks of the northern Patagonian batolith exposed in the vicinity of the Fontana lake.

The rock units referred to above comprise: 1) the Lower Jurassic Muzzio Gabbro (dated at ca. 195 Ma), 2) the Upper Cretaceous Dedo Chico Granodiorite (dated at ca. 99 Ma), 3) the Upper Cretaceous ´1173´ Monzogranite (dated at ca. 96 Ma) and 4) the Upper Cretaceous Teta Granodiorite (dated at ca. 82 Ma).

In the Lower Jurassic Muzzio Gabbro, the single zircon crystal dated at ca. 195 Ma derives from reworked Paleoproterozoic crust (Tdm-Hf 1.91 Ga, Orosirian; εHf -10.7). This is the one and sole Jurassic zircon crystal that provided the crystallization age of the Muzzio Gabbro; otherwise, most remarkably, the remaining 15 zircon crystals analyzed are inherited, as follows: a) Paleoarchean: 3355 Ma (Tdm-Hf 3.73 Ga, εHf -0.68), 3342 Ma (Tdm-Hf 3.81 Ga, εHf -2.16), and 3282 Ma (Tdm-Hf 3.71 Ga, εHf -1.3); b) Neoarchean: 2727 Ma (Tdm-Hf 3.35, εHf -2.3), 2693 Ma (Tdm-Hf 3.40 Ga, εHf -3.46), 2688 Ma (Tdm-Hf 3.49 Ga, εHf -4.99), 2681 Ma (Tdm-Hf 3.45 Ga, εHf -4.42), 2679 Ma (Tdm-Hf 3.38 Ga, εHf -3.42), 2679 Ma (Tdm-Hf 3.38 Ga, εHf -3.42), 2669 Ma (Tdm-Hf 3.46 Ga, εHf -4.7), and 2584 Ma (Tdm-Hf 3.56 Ga, εHf -7.34); c) Paleoproterozoic: i) Rhyacian: 2131 Ma (Tdm-Hf 2.36 Ga, εHf +5.92), 2127 Ma (Tdm 2.44 Ga, εHf +4.61), 2117 Ma (Tdm-Hf 2.44 Ga, εHf +4.60), and 2100 Ma (Tdm-Hf 2.45; εHf +4.12); ii) Orosirian: 1962 Ma (Tdm-Hf 3.17 Ga, εHf -8.77).

In the Upper Cretaceous Dedo Chico Granodiorite, 4 out of 9 zircons are inherited. The Cretaceous zircons derive from juvenile Neoproterozoic crust, as follows: a) 3 Tonian, average Tdm-Hf 863 Ma, average εHf +4.75; and b) 2 Cryogenian, average Tdm-Hf 695 Ma, average εHf +7.14. Inheritance is as follows: a) juvenile Rhyacian (2105 Ma-2085 Ma, with Tdm-Hf 2.47 Ga-2.45 Ga and εHf +3.93-+4.05, respectively); b) juvenile/slightly reworked Paleoarchean (3408 Ma-3207 Ma, with Tdm-Hf 3.81 Ga-3.50 Ga and εHf -1.42-+1.15, respectively).

In the Upper Cretaceous ´1173´ Monzogranite, all of the dated zircons derive from juvenile crust, as follows: a) 2 from Ediacaran, Tdm-Hf 600-550 Ma and εHf +8.72-+9.65, respectively; b) 4 from Cambrian (3 Miaolingian, i.e. Tdm-Hf 500 Ma, average εHf +10.34, and 1 Series 2, i.e. Tdm-Hf 520 Ma, εHf +10.00); c) 1 from Upper Ordovician Tdm-Hf 450 Ma, εHf +11.09; and d) 1 from Middle Devonian Tdm-Hf 390 Ma, εHf +12.13.

In the Upper Cretaceous Teta Granodiorite, the 7 dated zircons derive from juvenile Neoproterozoic crust, as follows: a) the 6 crystals dated at 78-88 Ma have a Cryogenian Tdm-Hf ranging 770-640 Ma and εHf values ranging +6.05-+8.04, and b) the one crystal dated at 73 Ma has a late Ediacaran Tdm-Hf 540 Ma and εHf +9.39.

Whereas further dating and Hf (plus O) determinations are needed in the study area for a better understanding of its early evolution, the present Hf determinations tend to confirm (1),(2) suggestion of the occurrence of an ancient, underlying unexposed crust in the study region. This viewpoint has been further elaborated by (3) and (4). Additionally, (5), in their firstly proposed Devonian double subduction model (double magmatic arc, i.e. east and west) for the Patagonian region, also indicated that the western magmatic arc may have been built over an old continental fragment (Archean-Paleoproterozoic); otherwise, (6) have later envisaged a different interpretation (island arc) for the latter arc.

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U-Pb SHRIMP and Hf isotope study of the Ordovician Cerro de los Viejos Granite, La Pampa province, Argentina

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The Cerro de los Viejos (CLV) Granite is exposed as small outcrops in the southeastern region of the La Pampa province, Argentina. The most outstanding feature of this body is its pervasive shearing and mylonitization, thoroughly described by (1).

The latter authors firstly dated the CLV Granite as Permian (ca. 261 Ma) using the muscovite K-Ar method, identified the peraluminous character of this body and suggested its possible derivation from melting of clastic sediments.

We have now carried out the zircon U–Pb SHRIMP dating of the CLV Granite, which has yielded a concordia age of 468.0 ± 2.7 Ma and determined the average Hf TDM model age of the dated zircon grains at 1491 Ma (Lower Mesoproterozoic; Calymmian), with an average εHf value of -3.13.

Given the Ordovician crystallization age newly obtained for the CLV Granite, the previously known muscovite K-Ar Permian age of ca. 261 Ma is, in all likelihood, bound to represent the age of the conspicuous shearing/mylonitization of this granitic body.

Otherwise, whereas, in a broader context, the latter event of deformation could possibly be related to the regional compressive effect of the proposed frontal collision of the Patagonia composite terrane against Gondwana (e.g., (2,) (3)), the tectonic setting of the truly Ordovician crystallization of the (originally) undeformed, peraluminous, CLV granitic body is less well known.

As regards the latter tectonic setting, it is worth noting that also in the southern portion of the La Pampa province of Argentina, not far from the CLV Granite, there are exposures of other –probably equivalent– roughly coeval, undeformed peraluminous granitoids (Curacó Granite, ca. 475 Ma and Río Colorado Granodiorite, ca. 475 Ma; as dated by (4)) that should need to be viewed in conjunction with the CLV Granite. Notably, (4) also reported Lower Mesoproterozoic crustal derivation for the Curacó Granite (Nd TDM 1614 Ma; εNd -5.3) and for the Río Colorado Granodiorite (Nd TDM 1565 Ma; εNd -4.7), both having high initial $^{87}Sr/^{86}Sr$ ratios (0.7114 and 0.7121, respectively). Also worth of note is that both the Curacó Granite and the Río Colorado Granodiorite skipped the Permian shearing/mylonitization whose exposed width is quite restricted (its full shape is inferred from aeromagnetics).

Additionally, whereas both the Curacó Granite and the Río Colorado Granodiorite are intruded in the Pampia terrane side of the suture between the Pampia terrane and the Río de la Plata craton, the CLV Granite is intruded in the (southwesternmost portion of) Río de la Plata craton (see e.g. Fig. 1, in (5)). The latter assertion is herein reinforced by the occurrence of Rhyacian inheritance (2116 ± 15 Ma; average Hf TDM model age 2400 Ma, average εHf value +4.23) in the CLV Granite. Therefore, the peraluminous and undeformed Ordovician magmatism of the southern La Pampa province, Argentina, straddles the Cambrian tectonic boundary between the Pampia terrane and the Río de la Plata craton.

As regards the possible partial melting of the precursor clastic sediments of the CLV Granite, firstly envisaged as a Permian event, this actually Ordovician event could have taken place either at 1) a collisional/post-collisional setting causing a sufficient crustal thickness to enable the actual melting of precursor sediments, or 2) at a hot backarc setting (with or without extension), either framework being capable of yielding S-type granites (e.g., (6)). Further discussion of this subject goes beyond the scope of the present abstract.

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The rise and fall of the giant stromatolites of the Lower Permian Irati Formation (Paraná Basin, Brazil)

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Giant stromatolites are meter-scale laminated carbonate biosedimentary deposits formed by the action of benthic microbiota under very specific conditions. Although occurrences of giant stromatolites are relatively common in Precambrian deposits, the Phanerozoic record is rare and sparse. During the Kungurian, the Paraná Basin was part of a very restricted epeiric sea with local development of confined low-gradient mixed carbonate platforms. In a small area along the northern paleomargin of this interior sea, conditions were optimal for the development of giant stromatolites. Here, we carried out an integrated analysis of the Lower Permian Santa Rosa de Viterbo giant stromatolite field (Irati Formation, Paraná Basin, Brazil). Using available and new descriptions of associated facies and stromatolite morphology, we applied a multi-proxy approach based upon sedimentological, paleontological and geochemical (C and O isotopes, XRF, XRD and ICP-MS) data to develop a detailed paleoenvironmental model for this particular occurrence. The NE-SW elongated giant stromatolites – of > 3 m in height, > 7 m in length, and > 1 m wide, forming a close-packed biostrome – have variable external shape and internal lamination, indicating continued changes in growth strategy due to changes in the hydraulic regime, bathymetry, and terrigenous input. The peloidal composition points to *in situ* microbially-influenced carbonate precipitation as the main accretion factor, besides suggesting an exclusively coccoidal microbial community. This last characteristic, $\delta^{18}O$ values, the smooth aspect of the lamination, the extremely low diversity and concentration of invertebrate fossils and the presence of vertebrate taxa resistant to high salinity (mesosaurids), point to deposition under high (possibly hyper) salinity, decreasing towards the upper part of the succession. High salinity, coupled with strong currents that shaped the elongated giant domes, were responsible for keeping away possible mat-grazers, protecting the living stromatolites from predation. Higher $\delta^{13}C$ values towards the top of the sampled succession are related to intense microbial activity, increased nutrient supply, and enhanced primary productivity, besides suggesting a gradual reduction in the restriction of the basin, as the highest $\delta^{13}C$ values at the top of the biostrome match the global Permian seawater signal. Y/Ho and $La/La^*_{(SN)}$ ratios also indicate a less restricted setting towards the top of the succession, which is consistent with the lower $\delta^{18}O$ values and increasing water depth, as recorded by the stromatolite morphology. After that, the smothering of most of the biostrome due to marl deposition, a drastic drop in $\delta^{13}C$ values and the transition to isolated, steep-sided domes, suggest the increase in terrigenous input as a result of a basin-scale transgression. Continued deepening of the basin and the great terrigenous entry finally brought on the demise of the microbial activity in the upper isolated domes, marking the downfall of the giant stromatolite saga that flourished and perished in the last epeiric sea of SW Gondwana.

Financing: This study was funded by FAPESP (grant n. 2019/00515-7). JO acknowledges the financial support provided by PRH-40 and FINEP. LVW and MGS are fellows of the CNPq.

Facies-dependent $\delta^{13}C_{carb}$ variations in the terminal Ediacaran Tagatiya Guazu formation, Paraguay

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The end of the Ediacaran Period and its transition to the Cambrian encompass some of the biggest changes ever occurred in Earth's history. The final Gondwana assembly, the striking carbon anomalies in the ocean, as well as the emergence of complex life, are some of the main environmental turnovers that characterize this interval. In order to understand such phenomena, several successions around the world have been studied regarding their sedimentological, geochemical, and paleontological features. Considering this context, the terminal Ediacaran Tagatiya Guazu Formation (Itapucumi Group, Paraguay) is a key unit to understand depositional and paleobiological aspects of the SW Gondwana. The presence of *in situ* specimens of *Cloudina* sp. and *Corumbella* sp., as well as complex trace fossils, attests the terminal Ediacaran age at least for part of the unit. However, unlike well-studied successions in China, Namibia and Russia, the Tagatiya Guazu Formation still lacks detailed studies on important paleoenvironmental aspects such as bioproductivity, redox condition and carbon reservoir during the deposition. Considering this, we carried out a high-resolution sedimentological, stratigraphic, and geochemical analysis in two columnar sections of the upper Tagatiya Guazu Formation (PL-I and PL-III) containing terminal Ediacaran fossils. Facies analyses suggests a typical association of lagoonal peritidal carbonates organized in high frequency shallowing-upward cycles. In general, the cycles comprise subtidal deposits dominated by cross-stratified grainstone, followed by thrombolites deposited in the lower intertidal zone. Upward, planar stromatolites, impure mudstone and marl complete the intermediate to upper intertidal deposits. No evidence of subaerial exposure was observed. Petrographic and geochemical analyses suggests that the original isotopic signal is preserved. The $\delta^{13}C_{carb}$ values fit the globally observed constant positive plateau between +1 and +5 ‰ for successions containing *Cloudina*, reinforcing the terminal Ediacaran age. High-resolution sampling made it possible to identify high-frequency cyclical variations in $\delta^{13}C_{carb}$ values directly related to facies changes in tidal cycles. That is, the $\delta^{13}C_{carb}$ curves show a characteristic increasing-upward pattern from depleted values related to subtidal facies to enriched values in intervals dominated by intertidal facies. This feature is reflected in the absolute $\delta^{13}C_{carb}$ values, where intertidal facies show $\delta^{13}C_{carb}$ values between +1.77 and +4.61 ‰ CDB, with an average of +3.26 ‰, while subtidal facies show values between +1.16 and +3.82 ‰, with an average of +2.75 ‰. This pattern is also reflected in the two distinct columnar sections, reflecting a strong relation between facies, bathymetry and $\delta^{13}C_{carb}$ data. These high-frequency variations in $\delta^{13}C_{carb}$ values suggests the existence of an isotopic gradient probably generated by the shallow redox stratification of the water column. This interpretation is corroborated by a similar facies arrangement related to a comparable $\delta^{13}C_{carb}$ gradient observed in the coeval Tamengo Formation (Brazil) and, although more pronounced, in Doushantuo, Dengying (China), and Wonoka formations (Australia). Thus, the pristine preservation of the high-frequency isotopic signal in the peritidal cycles of the Tagatiya Guazu Formation, configure an unprecedented opportunity to study the isotopic gradient and redox stratification conditions in the shallow seas of the western part of Gondwana.

Financing: This study was funded by FAPESP (grant n. 2020/00483-5). JO acknowledges the financial support provided by PRH-40 and FINEP. LVW is fellow of the CNPq.

Surface water analysis of the Federal District (DF): Development of methodology and isotopic survey

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Water is an essential natural resource not only in relation to life, but also necessary to ensure economic and social development, in this way it is necessary practices of monitoring and analysis of waters. Thus, this study, based on CONAMA resolution n°357 of 17 March 2005, analyzed in water bodies of the Federal District the cationic contents of Na^{+}, Ca^{2+}, Mg^{2+}, NH_4^{+}, and anionic levels of Cl^{-}, NO^{2-}, NO_3^{2-}, SO_4^{2-}, PO_4^{3-}, together with the values of $\delta^{18}O$ and $\delta^{13}C$ of the dissolved inorganic carbon of the same samples for a better understanding of the water bodies of the DF in addition to the realization of possible correlations of isotopic and ionic ratios of the waters of the DF.

The objective of this work is to collect samples from points in the Federal District to carry out quantitative analysis for quality control and adequacy of the parameters established by CONAMA, also seeking to observe anthropic influences and changes.

Water samples from water bodies in the Federal District were collected in February (a period characterized by constant rainfall in the DF), and later analyzed using ion chromatography and mass spectrometry. The sample collection procedure consisted of placing the polyethylene bottle three times in the water body to be collected before collection to ensure that the collected sample represents the real characteristic of the water body. Eleven samples were collected at different points of Lake Paranoá and Sobradinho stream. In the Laboratory of Chemistry and Forensic Physics, the samples collected were analyzed for quantification of ions Cl^{-}, NO^{2-}, NO_3^{2-}, SO_4^{2-}, PO_4^{3-}, Mg^{2+}, Na^{+}, Ca^{2+}, NH_4^{+}. The determination of $\delta^{13}C$ of dissolved inorganic carbon (DIC - dissolved inorganic carbon) in water was carried out at the Geochronology Laboratory at UnB. for isotopic analysis of DIC.

We developed a methodology for quantification of cations and anions that best suited the parameters of good water quality in CONAMA Resolution N° 357. From these data, the contents found were analyzed, separated into groups and positive correlations were found between NO_3^{2-}, Cl^{-}, and Ca^{2+} and Mg^{2+} ions. Being NO_3^{2-} and Cl^{-} good indicators of pollution. With the values of $\delta^{18}O$ and $\delta^{13}C$ of dissolved inorganic carbon obtained from the same samples, climatic correlations, origin and water pollution were made, however the isotopic results are still inconclusive about these parameters, however, the negative correlation between nitrate and $\delta^{13}C$, leads us to suggest a possible biological origin for dissolved inorganic carbon, to the detriment of the weathering of carbonate rocks.

A higher nitrate value was observed in the samples collected at the sampling point near the North Sewage Treatment Station. At this point also occurs one of the most negative values of $\delta^{13}C$. It is suggested that there is a relationship between sewage discharge and more negative $\delta^{13}C$ values, of biological origin, to the detriment of values close to 0 of geological origin. However, at points 2 and 11, the $\delta^{13}C$ values are similar to point 4, but the nitrate values are not as high. It is necessary to expand the sampling area and complement the isotopic analyzes with $\delta^{13}C$ data from dissolved organic carbon, in order to better assess which factors control the isotopic signature of carbon in the waters of the Federal District.

Combined petrological, U-Pb zircon geochronology, and zircon Hf and whole-rock Nd isotopes studies in Permian granitoids as monitor of sources, Frontal Cordillera of Argentina

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The Frontal Cordillera is composed of mountain ranges identified as 'cordones', which exceed an altitude of 5,000 m.a.s.l., encompassing the provinces of La Rioja, San Juan, and Mendoza in the western of Argentina. The Cordón del Portillo (CP), located in the central part of the province of Mendoza, displays different Permian granitic rocks (1) mostly emplaced in metamorphic rocks assigned to the Guarguaráz Complex (GC), which represent a Neoproterozoic-Early Cambrian metasedimentary assemblage associated with mafic and ultramafic rocks affected by Middle Devonian metamorphism (see (2) and references therein). A Sm-Nd isochron age of 655 ± 70 Ma (2σ) was reported by (3) for the mafic rocks of the GC. Using Sm-Nd data reported by (3), we calculated εNd_t (t = 655 Ma) values, which yield positive values (average = +5.5, n = 7) indicating a Neoproterozoic juvenile source.

In the CP, a granodiorite sample (PBL-109) from the Cerro Punta Blanca pluton (CPBP) was analyzed to obtain U-Pb and Hf zircon and whole-rock Nd isotopes data. The CPBP mostly ranges from granodiorite to monzogranite in the chemical classification diagrams, are metaluminous, and define a high-K calc-alkaline *suite* (1). The representative sample PBL-109, a medium-grained mostly equigranular (1-4 mm) granodiorite, is formed by plagioclase, quartz, and alkali feldspar in order of abundance, with amphibole and biotite as mafic minerals. Accessory minerals are titanite, zircon, allanite, apatite, and opaque minerals. In the geochemical classification diagrams the sample PBL-109 is classified as granodiorite, with SiO_2 = 65.3 wt.%.

Thirteen data selected from eighteen U–Pb zircon SHRIMP analyses yield a Tera-Wasserburg Concordia (TWC) age of 282 ± 2 Ma. However, a detailed analysis based on weighted mean diagram and probability linear plot using *Isoplot* (4) strongly suggest the presence of three ages. Thus, three TWC ages of 278 ± 2 Ma (n = 7), 284 ± 2 Ma (n = 5), and 290 ± 3 Ma (n = 4) can be calculated. These ages are taken as three major crystallization event during the magmatic activity that led to the formation of the CPBP. Although the outer zones of zircon grains were mostly targeted in order to obtain crystallization ages an individual concordant inherited age of 722 ± 7 Ma was obtained.

εHf_t (t = 282 Ma) values (n = 17) mostly range from +0.55 to -2.2 (excepting three values of -3.0, -4.5, and -8.5). The inherited zircon (t = 722 Ma) yield a εHf_t value of +9.0, but when the εHf_t is recalculated to the crystallization age of 282 Ma yield a εHf_t value of +0.21 that is within the range obtained for the magmatic Permian zircons. εNd_t (t = 282 Ma) value is -2 for the sample PBL-109. Hf and Nd T_{DM} (two stages) values yield similar values ranging from 1.2 to 1.4 Ga, and 1.2 Ga, respectively.

The εHf_t values calculated from magmatic zircon of the sample PBL-109 would suggest participation of juvenile material or subcontinental mantle lithosphere in the source, but the combination of geological, U-Pb zircon geochronology and zircon Hf isotopes data suggest that a potential source for these rocks would be primitive mafic rocks hosted in the continental crust such as the GC of Neoproterozoic age. In addition, three negative εHf_t values (-3.0, -4.5, and -8.5) suggest participation of other source such as older continental lithosphere (ca. 1.3 Ga according to Hf and Nd T_{DM} values) as well as the metasedimentary sequence of the GC. εNd_t value of -2 from the sample PBL-109 is consistent with the combined participation of the primitive mafic rocks and the metasedimentary sequence of the GC in the source.

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Financing: Grants: FONCyT PICT-2016 0843, PIP0178 and PIP0564 CONICET, Consolidar 2018 SECyT-UNC, PUE 2016 N◦ 22920160100016 CONICET, and FAPESP 2018/06837-3 linked to Thematic Project (FAPESP 2015/03737-0).

Zircon U-Pb ages and Hf isotopes tracking the origin of Permian Paraná Basin ash-fall layers: are they coming from Choiyoi formation?

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In the Paleozoic, during the supercontinent Pangea, the regions furthest from the active margins experienced extensive periods of tectonic stability and large syneclyses have been formed in south Brazil, Argentina, Paraguay, and Uruguay. In Brazil, volcanic ash and volcanic glass fragments were found in several formations of the Paraná Basin, such as the Rio Bonito, Irati, Rio do Rasto, and Estrada Nova/Teresina.

We present new Hf isotope compositions of zircons previously dated by SHRIMP U-Pb ages ((1),(2)) with an interest in deepening the previous suggestions that the volcanic ash-fall layers and vitroclastic-carrying sediments from the Paraná Basin and the Choiyoi Formation volcanic rocks would have a common origin, in addition to their Permian ages. Hf isotopic measurements were made as closely as possible to the same area of the U-Pb spot in zircon grains.

Thus, representative samples from the Gondwana I Super-sequence in Paraná Basin in Brazil (states of MT, SP, PR, SC, and RS) and Uruguay from ashfall deposits and volcanic particles belonging to the Rio Bonito Formation (BR), Irati Formation (BR) / Mangrullo Formation (UY), Estrada Nova/Teresina Formation (BR), Yaguari Formation (UY), and Rio do Rasto Formations were selected for Hf analysis.

From the Choiyoi Igneous Province, the collected samples in Argentine territory belong to andesitic breccias, continental conglomerates, and dacitic-rhyolitic ignimbrites from the Yacimiento Los Reyunos Formations of the Cochicó Group (lower section of Choiyoi); pyroclastic flows and rhyolitic ignimbrites from Cerro Carrizalito and Água de Los Burros (upper-section of Choiyoi); and sandstones from the El Imperial Formation - sedimentary unit discordantly covered by the Choiyoi succession.

In total, we analyzed 183 spots, of which 129 belonged to formations from Paraná Basin, and 54 from Choiyoi. Preliminary results show that Irati Formation (274.2 ± 1.3 Ma; MSWD = 0.016) and Estrada Nova Formation (268.6 ± 6.4 Ma; MSWD = 0.96) with εHf (-7 --> +1) and Hf-T_{DM} Model Ages (1100 --> 1600 Ma) are similar with the Choiyoi samples with (264.5 ± 3.0 Ma; MSWD = 0.47), and εHf (-10 --> +5) and major Hf-T_{DM} Model Ages (1100 --> 1500 Ma). Therefore, there is an accordance between zircon U-Pb ages and Hf isotopes of both units. This information supports the hypothesis that they have the same origin with contribution from the peri-Gondwanan magmatism.

Conversely, the zircon ages of Rio Bonito Formation (297.0 ± 64 Ma; MSWD = 1.5) with εHf (-3 --> +13) and most Hf-T_{DM} Model Ages (500 --> 1500 Ma) might indicate that the origin of the zircons are older than the volcanism that originated the Permian ash-falls layers found in the other Paraná Basin units. Therefore, they are probably related to an older volcanic episode that is not recognized yet in Paraná Basin. Moreover, the El Imperial Formation with a single Permian zircon volcanogenic grain (298 Ma) and considerable Ordovician population of (453.7 ± 8.1 Ma; MSWD = 2.6) with εHf (-10 --> +15) and Hf-T_{DM} Model Ages (1000 --> 1800 Ma) probably correspond to another volcanic event prior to Choiyoi.

Consequently, our results reinforce the previous literature suggestions ((1),(2)) that the Choiyoi volcanic event is the responsible for the presence of the Permian ash-fall layers found in the Paraná Basin units. The refinement of this suggestion will be made by geochemical characteristics of the zircons from both units – Choiyoi and Paraná Basin Permian zircon grains.

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Financing: First author has a financial funding from FUSP Project 3218. Special thanks to FAPESP 2015/03737-0 which made possible the geochronological analysis and field trips.

Denudation rates of the southern Espinhaço range basement, southeastern Brazil, constrained by apatite fission-track thermochronology

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The vicinity of the southern border of the São Francisco Craton (SFC) and the Araçuaí Belt (ArB) is marked by high relief surrounded by deeply dissected plains. This portion of the Brazilian Shield, namely the Southern Espinhaço Range (SER) and Quadrilátero Ferrífero Province (QFe), is formed by Archean and Paleoproterozoic granitoid-gneiss composing the dissected areas of the basement. On top of it, Archean to Paleo-Mesoproterozoic metasedimentary sequences, mainly composed of quartzites and banded iron formations support the escarpments and ranges. To constrain the denudation rates of the exposed basement in this area, nine rock samples normally rich in apatite crystals were collected and analyzed according to the apatite fission-track thermochronology method (AFT). This technique is based on the accumulation of linear defects, called fission-tracks, formed by the spontaneous fission of ^{238}U through time. This method constrains the thermal evolution of shallow portions of the crust, between depths of five to two kilometers and temperatures between 120 and 60 ºC. In general, the AFT ages obtained range from 187 ± 18 to 91.8 ± 7.3 Ma. The inversion models show two accelerated cooling episodes: (i) From Upper Devonian/Early Permian to Middle Triassic/Lower Jurassic, and (ii) Eocene/Oligocene to present-day. To estimate a range of possible values for both the denudation rates and the amount of erosion, the values of 20, 25 and 30 ºC.km^{-1} were chosen as the geothermal gradient in the area. These values were chosen because they represent typical values for Earth's crust and because the present-day geothermal gradient in the SFC and ArB varies from 14 to 42 ºC.km^{-1}. The first cooling event is attributed to far field stresses from the Gondwanic cycle in the southern West Gondwana paleocontinent, which records denudation rates varying from 7.6 to 21.7 m.Ma^{-1} and the erosion of 1.3 to 2.5 km, values that are in agreement with other parts of West Gondwana. The second cooling episode is attributed to a compressional stress of the South American plate due to ridge-push from the spreading center in the Atlantic Ocean coeval to subduction in the Andean orogeny. This cooling event records cooling from temperatures of 65-55 ºC to present-day surface conditions, with denudation rates varying largely through the study area from 15.7 to 87.5 m.Ma^{-1}. Also, these estimates suggest erosion of 1.3 to 2.2 km, which are compatible to the sedimentary record found in the Espírito Santo and Jequitinhonha basins. In addition to the nearly 2.6 to 4.7 km eroded away, another 4.0 km of rocks were eroded from the orogenic pile before the Upper Devonian, as indicated by the metamorphic grade of basal rocks of the Espinhaço Supergroup. Therefore, this work provides not only an overview on the denudation rates and the amounts of erosion of the SER and QFe basement, but also on how the apatite fission-track method can be used to estimate these values.

Financing: Edgar do Amaral Santos: CNPq PhD Scholaship – (140775/2019-6)Andréa Ritter Jelinek: CNPq – (Project 309329/2020-5)

Preliminary results of the control sources of apatite (U-Th)/He ages obtained in the Catarinense Shield, Northern Dom Feliciano Belt

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The Dom Feliciano Belt (DFB) is an orogenic belt located to the south of the Mantiqueira Province, extending for about 1200 km, from Uruguay to southern Brazil. The DFB was formed by the convergence of several terrains and cratonic blocks during the Neoproterozoic, composing the southern portion of the Gondwana paleocontinent. After ceasing the compressive phase responsible for the consolidation of this paleocontinent, this belt became subject to weathering and erosive processes. One of the ways to understand in detail the evolution of the DFB during the Phanerozoic is using low-temperature thermochronometers, such as (U-Th)/He in apatite (AHe). This thermochronometer is based on accumulation of a particles (^{4}He) generated from the radioactive decay of U, Th and Sm and it provides the cooling age of rocks, generally restricted to low temperatures and more superficial portions of the crust. Aiming understand the control sources in the AHe ages of the Catarinense Shield, northern portion of the DFB, rock samples of granitic composition were collected. The samples were submitted to mineral separation processes to obtain apatite concentrates. Subsequently, the methodology of (U-Th)/He in apatite was used in the separated mineral aliquots as follows: (i) measurements of the length and width of the crystals were taken; (ii) the apatites were subjected to He extraction in a vacuum chamber with subsequent measurement of the concentration of this isotope in a quadrupole mass spectrometer; (iii) the apatites were dissolved to obtain the concentration of U, Th and Sm isotopes. The results obtained indicate uncorrected single crystal AHe ages that range from 38.5 ± 2.3 to 103.8 ± 6.2 Ma, with a predominance of Cenozoic ages. After F_t correction, AHe ages range from 62.5 ± 3.7 to 153 ± 9.2 Ma, predominantly Mesozoic (Cretaceous). The concentration of eU varies between 4.5 and 96 ug/g and its correlation with AHe ages is slightly positive and non-linear. Equivalent spherical radius (ESR) measurements of apatites are between 26.4 and 59.8 um and the correlation of this parameter with AHe ages is slightly negative. The correlation between AHe ages and distance from the coastline and altitude is also negative, with the oldest ages being at low altitudes and close to the coastline. These results will be combined with inverse numerical modeling in QTQt software to obtain the thermal histories recorded in these samples, which will provide a better understanding of the main controls of the AHe ages and the thermal evolution of the Santa Catarina Shield during the Phanerozoic.

Financing: Edgar do Amaral Santos: CNPq PhD scholarship - (140775/2019-6)Andréa Ritter Jelinek: CNPq - (Project 309329/2020-5).

Dispersion of apatite and zircon (U-Th)/He ages and their relationship with eU concentration, craton border proximity, elevation, and shoreline distance: A case study in eastern Brazil

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From the Neoproterozoic to the Cambrian, several cratonic fragments amalgamated into a large landmass called Gondwana continent. The mobile belts formed in this process register the opening and closure of oceans and the collision of the stable cratonic blocks, such as the Araçuaí Belt situated to the southeast of the São Francisco Craton, in Eastern Brazil. After ceasing the stresses related to the convergence of the cratons, the Gondwana paleocontinent interior became subject to weathering and erosion. The thermal history of this region indicates cooling during the Paleozoic recorded in low-temperature thermochronometers, such as zircon and apatite (U-Th)/He. These thermochronometers together record the thermal history of temperatures lower than ~190 to nearly 40 ºC, which corresponds to the upper crust ~10 km. However, these methods provide not only the thermal history itself, but also cooling ages. Therefore, this study aims to understand the main factors controlling the cooling ages obtained for both thermochronometers. For that, seven samples were analyzed, of which five were subject to both zircon (ZHe) and apatite (AHe) (U-Th)/He analyses. ZHe corrected cooling ages vary from 483.1 ± 38.6 to 93.8 ±7.5 Ma and eU concentration on zircon crystals range from 10.91 to 632.51 ug/g. On the other hand, AHe corrected cooling ages range from 129.9 ± 7.8 to 32.7 Ma and the eU concentration of apatite crystals spans from 5.6 to 62.8 ug/g. Both ZHe and AHe correlate positively with eU concentration in a non-linear trend, suggesting relatively slow, monotonic cooling and/or long residence in temperatures between 70 to 40 ºC. The Equivalent Spherical Radius (ESR) of zircon ranges from 50.61 to 103.02 um, whereas apatite crystals have values spanning from 70.94 to 166.39 um. ESR and ZHe ages present a negative correlation, suggesting unknown sources of natural dispersion. Conversely, the ESR and AHe ages correlation is sparse, suggesting little interdependence between these parameters in this study. The distance to the coastline and elevation in relation to ZHe and AHe ages are also another source of possible control. This control only seems to be legit for apatite locally, with older ages far from the shore and at higher elevations. When analyzing regional trends, however, the correlation is sparse. It is also absent any correlation between elevation and the distance to the shoreline and ZHe ages. Finally, the distance to the craton border was also analyzed, evidencing that it controls the ZHe ages, but fails to control AHe ones. These results suggest that the samples of the Araçuaí Belt and the São Francisco Craton were subject to slow, monotonic cooling, and that none of these parameters act as a single age controlling source, at least locally. Therefore, more studies are required to investigate the additional parameters that control the age dispersion in northern Araçuaí Belt and São Francisco Craton.

Financing: Edgar do Amaral Santos: Conselho Nacional de Desenvolvimento Científico e Tecnológico – CNPq, Ph.D scholarship (140775/2019-6). Andrea Ritter Jelinek: CNPq (Project 309329/2020-5).

Verde River Basin: isotopic geochemistry and traceability of the ichthyofauna amidst anthropogenic intervention

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The Verde River Basin covers several municipalities belonging to the Brazilian state of Mato Grosso do Sul. Its sources sprout at about 500 m of elevation, as does its main tributary, the São Domingos River. Dozens of smaller tributaries flow into the Verde River before it debouches into the Paraná River at an altitude of 260 m. Sedimentary rocks such as sandstones dominate the local geology; however, igneous rocks, such as basalt, are also found. The area has two well-defined: seasons dry (April – September) and rainy (October – March).

The Verde River has undergone anthropogenic changes due to cattle farming, agriculture, and, in the last decade, by dams. Currently, there are three electrical power plants along the river course (Verde 4A, Verde4, and São Domingos). Besides creating novelle habitats, these dams behave as obstacles for ichthyofauna´s migratory paths.

In this study, we compare river water dissolved Sr isotopic composition of (N= 52) with the isotopic composition of fish otolith of different fish species from the same river (N = 100). Otoliths are made of aragonite, and their Sr isotopic ratio provides information about fish geographic range in their environment. Water $^{87}Sr/^{86}Sr$ was determined by mass spectrometry after Sr separation using chromatographic columns. Otolith $^{87}Sr/^{86}Sr$ isotope ratios were determined by laser ablation mass spectrometry (LA-MC-ICPMS - Neptune XT HR-Thermo) using raster mode to track strontium levels from core to edge of the fish otolith.

The $^{87}Sr/^{86}Sr$ of dissolved Sr varied between 0.71267 and 0.72872 if considered samples from the two seasons. The less radiogenic values occur along the Paraná River main course and upstream regions of the Verde River. These low Sr isotope values are related to sites in which river water drains basaltic rock. Intermediate Sr isotope values are observed mostly along the main course of the Verde River, where there is a gradual mixing of less radiogenic water derived from upstream and more radiogenic ware derived from the Rio Verde tributaries. High $^{87}Sr/^{86}Sr$ tributaries (>0.72000), such as the Araras Creek and São Domingos River, drain sedimentary rocks of local geologic units. Both the Paraná River and the middle Verde River, upstream of the São Domingos reservoir, had $^{87}Sr/^{86}Sr$ ratios below 0.72, being the latter section where we caught most of the fish.

The results for $^{87}Sr/^{86}Sr$ obtained on the otolith edge are within the isotopic range of the water composition of the sites where the fishes were captured. It indicates that the Sr isotopic composition from core to edge across the otolith records the isotopic composition of the water in which the fish lived during its life span. The relationship between fish otolith and water is the basis for tracing the individual spatial range. Based on this correlation, we are retrieving the migratory and dispersal paths of ichthyofauna. We expect our results to contribute to a better understanding and management of migratory ichthyofauna, including better strategies to help these species on their migratory pathway.

The authors thank NECTAR – Núcleo de Empreendimentos em Ciência, Tecnologia e Artes, and FIBRACON – Consultoria, Perícias e Projetos Ambientais Ltda for the assistance and operational activities of the project.

Financing: This research was supported by the Itiquira Energética S.A., Tangará Energética S.A. and Brookfield Energia Renovável S.A. (grant no. PD-00700-0119/2019).

Whole rock Sr and Nd isotopic data from Neoproterozoic granitoids of central-northeast Uruguay

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In the northeastern portion of Uruguay occurs a set of small to medium size Neoproterozoic granitic bodies that intrudes the Paleoproterozoic basement of the Nico Pérez Terrane (NPT) and the meta-volcano-sedimentary sequences of the Dom Feliciano Belt (DFB). The ages of these granites are constrained by zircon LA-ICP-MS and SHRIMP methodologies between 620 Ma and 590 Ma. The predominant lithologies of these bodies are syenogranites, followed by monzogranites, alkali-feldspathic granites, and granodiorites. Geochemically, these bodies are classified as high-K to shoshonitic calc-alkaline type-I granitoids, with peraluminous affinity. New isotopic analyzes of Sr and Nd are presented here for eight of these granitic bodies located in the Central- Northeast of Uruguay, known as Guazunambí, Policlínica, Yerbal, Cerrezuelo, Cerro de las Cuentas, Arroyo los Molles, Puntas del Arroyo Gutiérrez and Arroyo Tapes Chico granites. Based on crystallization ages, the initial Sr-Nd isotopic compositions were calculated at an age of 600 Ma. The results show $^{87}Sr/^{86}Sr$ initial values between 0.72144 and 0.70839, εNd initial values between -20.18 and -14.82, and TDM values from 2.08Ga to 2.83 Ga. The $^{87}Sr/^{86}Sr_{600}$ and εNd_{600} calculated values are consistent with the involvement of crustal source materials, particularly the deep crust. In addition, the TDM values obtained would indicate that these bodies are the product of reworking of the Archean and Paleoproterozoic crust of the Nico Pérez Terrane.

Financing: This work was supported by the Agencia Nacional de Investigación e Innovación (project FCE_1_2017_1_136496 and S.F. grant) and from PEDECIBA-Geociencias.

Sedimentation and volcanism in an early Miocene intra-arc basin associated to humid climate in the Andes of Central Chile (33°S, Aconcagua River)

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The Andean Principal Cordillera of central Chile is composed mostly of Cenozoic volcanoclastic and volcanic rocks, which were deposited and erupted during the opening, inversion, and closure of the intra-arc extensional Abanico Basin. Despite this, between 32° and 33°S the current geological mapping continues showing that Cretaceous deposits outcrop (1). Considering the work of (2) and ours, the Mesozoic deposits outcrop only near the international border with Argentina. North of 32°30'S, Cretaceous deposits are directly west of the Pocuro Fault zone. At 33°S, where the hydrographic basin of the Aconcagua River is located, the Cenozoic deposits traverse this fault system, reaching the edge of the Oligocene-Early Miocene Extensional Abanico Basin, known as the Infiernillo Fault. We have obtained LA-ICP-MS zircon U-Pb ages of samples of volcanoclastic sandstones and tuffs, which were taken from volcanoclastic successions in the vicinity of the Aconcagua River at approximately 70°26'S. The ages indicate that sedimentation and volcanism occurred around 19-20 Ma. On the other hand, whole-rock, amphibole and biotite ^{40}Ar-^{39}Ar plateau ages of lavas and tuffs in the vicinity of the Aconcagua River also show results between 18 and 20 Ma, indicating that the largest volume of rocks in the sector correspond to volcanoclastic deposits of the Early Miocene, specifically of the Burdigalian. This period agrees with the beginning of the Aconcagua fold-and-thrust belt (3) suggesting that during this compression phase and inversion of the Abanico Basin, the greatest volcanism and sedimentation occurred in this sector. In addition, in the volcanoclastic deposits dated by LA-ICP-MS U-Pb in zircon we made the discovery of plant fossils not previously reported in this specific area. These fossil flora associations, mainly leaf and wood fragments, indicate a local humid and warmer climate. Cenozoic fossil flora has been reported for many years around Santiago (33°15'S-33°30'S), specifically in the areas of La Dehesa and El Arrayán (see (4), and references therein). Through the studies of this taphoflora, (4) suggested a change in the Miocene to a more humid and warmer climate than the one that existed in the Oligocene, which is supported by our paleontological results. For all of the above, we suggest that the increased sedimentation at the Burdigalian in central Chile at 33°S was marked by a more regional humid and warmer climate.

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New Campanian U-Pb ages and Hf isotopic composition in zircons from tuffs of the Lo Valle Formation at ~33°S

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The modern Andean orogen is the first order result of plate convergence in the South American continental margin. Its construction is considered to have started during the early Late Cretaceous after a regional scale compressional deformation event recorded in the region (Peruvian orogeny). However, in the central-southern region of Chile, an evolution under a compressional regime interrupted by extensional events is recognized ((1), (2), (3), (4), (5)). The oldest one of these events would have occurred during the Late Cretaceous-early Paleocene, and this has been identified from scarce and local studies of the coeval arc region in the Andes of Chile-Argentina between 35°-36°S ((3), (5)). This could be a much larger regional scale event developed at least between 20° and 36°S (5) and would result from particular characteristics of the configuration and/or dynamics of plate convergence ((3), (5)).

In this contribution we present the preliminary results of studies currently under processes in the Lo Valle Formation at ~33°S. This formation records the Late Cretaceous-early Paleocene arc in the region. A field campaign was carried out and samples were collected between 32°50'-33°S and 70°40'-70°53'W at the localities of Cuesta de Chacabuco and Llay Llay. Almost 40 samples were collected for petrographical, geochemical, isotopic, and geochronological studies.

The Lo Valle Formation is an 1800 m thick volcano-sedimentary succession composed predominantly of pyroclastic rocks, effusive volcanic intercalations, and subordinate continental sedimentary facies (6). Both discordantly, this unit overlies the Las Chilcas Formation (Albian-Campanian) ((6), (7)) and underlies the Abanico Formation (Oligocene) (8), which are composed of volcano-sedimentary continental deposits ((6), (7), (8)). K-Ar and ^{40}Ar-^{39}Ar geochronological determinations place the volcanism of the Lo Valle Formation in the Maastrichtian-Danian interval ((6), (7), (9)).

In the studied area, the Lo Valle Formation is composed mostly by 2 up to 10 m thick strata of explosive and comparatively scarce effusive igneous rocks. They correspond to commonly welded crystalline and vitreous ash tuffs, andesites and dacites. In addition, there is a frequent presence of interbedded olivine-rich basalts, which in previous works have been interpreted as younger Oligocene sills (8). Zircon U-Pb geochronological determinations in 4 tuffs reveal ages between 73.1 ± 0.8 Ma and 73.8 ± 0.8 Ma, indicating a Campanian age for the volcanism recorded in the studied area. Hf isotopic determinations were also performed along with the latter analyses. The studied rocks show ƐHf(i) values which range between +9.8 and +14.3, with intra sample variations of up to ~2 ƐHf units. These results reveal both (i) a markedly depleted signature for all the magmatism of this episode (coeval Depleted Mantle ƐHf value: +15 (10) and (ii) at least two main geochemical components involved in magma genesis, a Depleted Mantle one and a more evolved one. These characteristics show that the Lo Valle Formation represents an episode of juvenile arc magmatism with negligible involvement of evolved continental crust. This episode could be favored/triggered by a scenario of a thinned crust and/or extensional tectonic conditions.

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Financing: Proyecto FONDECYT 1200428 (Tectono-stratigraphic evolution of the western Neuquén basin during the Early Jurassic-Late Cretaceous, central Chile, 33°-35°S)

U-Pb zircon detrital data of the Araripe intracontinental basin, northeast Brazil – routes for proto-Atlantic marine incursions on northwest Gondwana

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Mesozoic extensional efforts of Gondwana breakup and the onset of the South Atlantic Ocean resulted on continental seawater ingressions during the late-Aptian registered in the northeastern Brazilian basins. The seawater routes follow a network of connected grabens, that can only be traced by the integration of paleocurrent, stratigraphic, paleontological, structural and provenance data. This work presents novel U-Pb detrital zircon data from sandstone strata covering the stratigraphic column of the Araripe basin. Five provenance patterns are recognized, reflecting, along with paleocurrent data, shifts in erosion evolution and paleodrainage system from the Upper Jurassic to the Cenomanian. The pre-Jurassic Mauriti Formation constitutes the Provenance Pattern 1, with potential sources located to the south of basin, identified as Proterozoic terranes of the Borborema Province. Provenance Pattern 2 includes the sedimentary formations from the Upper Jurassic to the mid-Aptian. The two main sources are the metamorphic and igneous rocks from the Setentrional Sub-province, Borborema Province, and the recycling of the Paleozoic sedimentary formations from the Parnaíba basin. Therefore, the N-NW region was a topographic high during that time, acting as a barrier between the Mesozoic strata of the Parnaíba basin (Grajau basin) to the west and the Araripe basin to the east. The input of recycled detrital zircons from the Paleozoic Parnaiba basin units decreases or disappears from the younger Provenance Pattern 3, suggesting that these might be eroded retreated to the west (near to its actual location). Despite that the mid-Aptian Pattern 3 still indicates a main source from the north, but now with an important Archean input, identified as the Granjeiro complex, uncovered by the erosion of the Paleozoic sediments. This pattern also shows a decrease on Cryogenian and Ediacaran detrital zircon grains input, indicating that its main source, the Rio Salgado Belt, was covered from the mid-Aptian. Provenance Pattern 4 includes the late-Aptian sedimentary formations, that shows the Paleoproterozoic units from the Orós-Jaguaribe terrane in the northeast region as main source. Provenance Pattern 5 includes the Araripina and Exu formations, from the mid-Albian, reflecting sources located to the east of the basin. The provenance patterns, here identified with U-Pb detrital zircon data, allied with the structural and paleocurrent data shows that the Paleozoic sediments were an important recycling source for the Araripe sandstones until the mid-Aptian. We also show that the northeastern Precambrian terranes were subsequently covered, corroborating with the hypothesis that the first sea-water incursions in the Araripe basin (Romualdo Member, Santana Formation) came from a network of NE-SW oriented depressions generated during the rift phase. This evidence suggests a seaway through the Potiguar basin, linking the Araripe basin with the proto-Equatorial Atlantic. Only in the mid-Albian, a major paleodrainage direction shift to the W-SW is registered in pattern 5, as consequence of the uplift of the onset of the Brazilian continental margin.

Financing: The authors are grateful for the support of SHELL BRASIL PETRÓLEO LTDA and the strategic importance of the ANP (AGÊNCIA NACIONAL DE PETRÓLEO) support, through the mandatory R&D regulation (technical cooperation #20.219-2).

Contribution of continental crust in arc magmas: the case of the southern end of the Ecuadorian arc

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In the Ecuadorian arc, the geochemical variability of magmas has been suggested to result from intra-crustal processes or the role of the subducting plate. In order to distinguish the process and the component that govern this variability in the southern segment of the Grijalva fracture zone of the Cordillera Oriental (Sangay, El Altar, Tungurahua volcanoes), Sr, Nd and Pb isotopic analyzes were carried out. Sr isotopes allowed us to visualize upper crustal AFC processes, while Pb isotopes are sensitive to lower crustal AFC processes. A principal component analysis was carried out, in which two components were identified as necessary to explain the Pb isotopic variability of the three volcanoes, i.e. a binary mixture. The convergence of the linear Pb correlations of the segments to the N of the Grijalva fracture zone with those to the south at the same point made it possible to define the eastern common component (ECC). Discrimination of possible ECC elements led to the conclusion that the Pb balance of arc andesites is controlled in this case by the lower crust.

Financing: Université Clermont Auvergne.

Preliminary geochemical data on the granitic plutons of the Cordillera Real of Bolivia

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The Cordillera Real of Bolivia comprises six Permian-Triassic plutons (age range of 260 to 220 Ma) represented by the Huato, Illampu, Yani, Huayna Potosí, Zongo and Taquesi and two Oligocene major plutons (27 Ma) represented by the Illimani and Quimsa Cruz. They were emplaced within Ordovician metapelites (Amutara Fm.) along the NW-SE strike of the Eastern Cordillera, within the Central Andes. The context over which the Permian-Triassic plutons were emplaced corresponds to an extensional setting of continental rifting associated to the Mitu group in northern Perú, while the Oligocene plutons were emplaced along a compressional setting that is associated to lower crust delamination. The Amutara Fm. was affected by a low grade regional metamorphism associated to the Gondwanian orogeny.

The magmatic suite is characterized by quartz diorites and tonalites as the more mafic units, however the main lithologies are granodiorites and granites. Pegmatites, aplites and a Sn-W greisen hydrothermal system are associated. Two mica granites correspond to the more evolved felsic melts, and they usually bear sub-rounded mafic enclaves of quartz-diorites and minor metapelitic xenoliths.

Some of the mafic units outcrop on the northern side of the Illampu batholith, and their U/Pb zircon ages indicate that they correspond to a pulse of 230 Ma. Granites and granodiorites of the same batholith, as well as some rocks from the Taquesi, Huayna Potosí and Zongo plutons yield U/Pb zircon ages of about 220 Ma. Therefore, an important antecrystal and xenocrystal population is recorded in the rocks of the younger pulse, implying melting and recycling of the older pulses as well as parts of the country rocks. A large antecrystal zircon inheritance was also observed for the Quimsa Cruz batholith, which yielded a U/Pb zircon age of 27 Ma.

Chemical analyses, made at the Institute of Geosciences of the University of São Paulo, together with many other from the existing literature, show that all the plutons of the Cordillera Real apparently belong to a calc-alkalic series, which is suggestive of a subduction setting. Their magmatic evolution probably occurred by means of crystal fractionation or assimilation/crystal fractionation processes, and the Huayna Potosí and Zongo granitic plutons were the more evolved. The calc-alkalic trend, along with the trace elements ratios, indicate that a complex magmatic system operated during the emplacement of the Cordillera Real Triassic plutons, whose final episode of crystallization coincides with a continental rift episode.

In the granite discrimination diagrams, the less evolved rocks fall within the within-plate field, meanwhile the more evolved ones fall within the fields of synchronous collisional or volcanic arc granites. In the variation diagrams, the major oxides with respect to SiO_2 for most of the analyzed samples, usually show negative slopes when compared to FeO_T, TiO_2, MgO, Al_2O_3 and CaO, and positive slopes when compared to K_2O and Na_2O, suggestive of crystal fractionation as the main mechanism of differentiation. LILE elements such as Rb and Ba are highly enriched and HREE are noticeably depleted in the more evolved granites. The former can be related to assimilation of metapelites and the latter to melting of pre-existent pulses.

In a general way, the geochemical character of the granitic plutons of the Cordillera Real of Bolivia is in agreement with models of upper crust evolution in terms of melt production, country rock assimilation and recycling. In addition, it brings some understanding on how melts evolved towards an ore-rich hydrothermal system.

Financing: CAPES.

U-Pb dating of detrital zircon: a case study in the Pedra de Fogo Formation, Permian of the Parnaíba Basin

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Provenance analysis using U-Pb dating of detrital zircons is a technique widely applied in studies of the evolution of sedimentary basins. A case study in the Pedra de Fogo Formation, Permian of the Parnaíba Basin, was carried out to produce novel U-Pb data in detrital zircons for this formation integrating with previous formation data from the basin. The description of two stratigraphic sections – BS 14 and BS 07 – performed by the team of the BIOCRONORTE Project provided the characterization of fluvial-lacustrine intervals in the lower part of the Pedra de Fogo Formation in the Floriano region (Piauí, Northeast of Brazil). Representative sandstone samples were collected for U-Pb dating (sample PR-19 in section BS 14 and sample PR-14 in section BS 07). The zircon concentrates were obtained using pan concentration, Frantz isodynamic magnetic separator, and heavy liquid (Diiodomethane). The U-Pb age analyses were performed at the Geochronological Research Center at the University of São Paulo on a Thermo-Fisher Neptune inductively coupled plasma mass spectrometer (ICP-MS) connected with an Excimer ArF laser ablation system (LA) of 193 nm wavelength. Corrections of mass bias were performed by the analysis of zircon standard GJ-1. The acquired data were filtered, removing analyses above 10% of discordance and those with more than 10% of common lead. For plotting, the $^{207}Pb/^{206}Pb$ age was used for grains older than 1.2 Ga and $^{206}Pb/^{238}U$ age for grains younger than 1.2 Ga. The signatures in KDE (Kernel Density Estimator) plots of the detrital zircons of the PR-19 sample indicated three peaks of predominant contributions: (i) Orosirian-Rhyacian (1800 to 2300 Ma), (ii) Tonian-Stenian (720 to 1200 Ma), and (iii) Ediacaran-Cryogenian (538 to 720 Ma). On the other hand, the analysis of the PR-14 sample signatures highlighted only two significant contributions: (i) Orosirian (1800 to 2050 Ma) and (ii) Ediacaran-Cryogenian, although Tonian ages were present. The small number of analyses in this sample may have hampered the expression of this contribution. Comparing the results with previous data from the basin, it was found that the signatures are similar to those of other units in the Parnaíba Basin. However, the presence of Ectasian-Calymmian zircons (1200 to 1600 Ma) in the PR-14 was considered an unusual signature related to the sedimentation environment and/or local variations, perhaps involving recycling. Further studies to evaluate the influence of the sedimentation paleoenvironment on the U-Pb detrital zircon signatures of the Pedra de Fogo Formation are recommended. Another relevant data was the identification of one zircon with an age of 273 Ma, which, although consisting of a single grain, motivates further studies addressing a contribution on the age of deposition for this formation, which would be very meaningful for the Parnaíba Basin evolution.

Financing: The author Nicole Lopes Padilha is grateful for the financial support of the Human Resources Program of the National Agency for Petroleum, Natural Gas and Biofuels – PRH-ANP.

Evolution of the crustal contamination in the Paleocene-Middle Eocene volcanic chain in north of Chile (23º30'-26ºS)

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A series of arcs and volcanic chains have been emplaced in the Central Andes forearc since Upper Paleozoic to the present. These magmatic chains were distributed parallel to the trench between the Coastal Cordillera and the Chilean Pre-cordillera. The Paleocene-Middle Eocene volcanic chain is in the current Central Depression and western margin of Precordillera. Lithologic and isotopic evidence suggest the magmas originated from melts derived from the mantle, which were enriched with continental crust during their rise. However, the characteristics of this contamination are partially unknown. We modeled O-Hf in zircon using the equation of (1) in the T-Igpet program to understand and quantify contamination processes. Our results suggest the initial magmatic members correspond to the depleted mantle and the volcano-sedimentary sequence of the Quebrada Mala Formation (Upper Cretaceous). On the other, the terminal assimilated members are Cordon de Lila Formation (Ordovician) and Sierra del Tigre Formation (Devonian-Carboniferous). In addition, the magma would have ascended through a ca. 35-40 km thick continental crust. The results indicate that the Upper Cretaceous rocks initial members were formed from a depleted mantle source that assimilated less than 30% of Ordovician rocks. The youngest Upper Cretaceous rocks would have formed by assimilating up to 20% of crustal input. Moreover, the rocks with the highest $\delta^{18}O‰$ values would have formed by assimilating up to 40% of Devonian-Carboniferous turbidites. The Paleocene-Middle Eocene volcanic chain analysis contributes to understand how volcanic arcs and chains evolved in orogens like the Andean.

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Rhyacian magmatic arc rocks with sanuktoid-like signature from the Juiz de Fora Complex, Minas-Bahia Orogenic System (SE- Brazil)

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Sanukitoid rocks have intermediate geochemical and isotopic characteristics between TTG suites and granites from modern magmatic arcs, and are regarded as markers of the transition from typically Archean geodynamics to those observed in modern plate tectonics. Although most of the known sanukitoid suites were formed in the Neo- and Mesoarchean, numerous works have characterized Paleoproterozoic magmatic arc granitoids with affinity with the sanuktoid series. This work presents new field, lithogeochemistry, zircon U-Pb geochronology (LA-MC-ICP-MS), and Sm-Nd and Sr isotopic data of felsic orthogranulites with sanukitoid-like signature from the Juiz de Fora Complex (JFC), one of the Paleoproterozoic tectonic components of the Minas-Bahia Orogenic System (MBOS) in the southern São Francisco Paleocontinent (SFP, southeastern Brazil). The studied rocks have intermediate SiO_2 contents, with moderate to high Ba, Sr, Mg# together with moderate $(La/Yb)_N$ and low Na_2O/K_2O ratios. They have crystallized at around 2175 Ma and were reworked to a high-grade granulite facies during the Ediacaran (at ca. 580 Ma) due to the development of the Brasiliano-Pan African orogenic system. The initial εNd values between -4.0 and +0.5, T_{DM} between 2.57 and 2.12 Ga, and the initial $^{87}Sr/^{86}Sr$ ratios between 0.6937 and 0.7137 suggest a moderately juvenile to slightly evolved source. These rocks are interpreted as the result of crystallization of magmas from a hybrid mantle source extensively contaminated by crustal material (fluids, sediments, melts) during protracted subduction associated with the MBOS development and/or previous subduction events. From the integration of the new data from this work with that from other Paleoproterozoic sanukitoid rocks in southern SFP, there are at least two main magmatic stages of arc-related sanukitoid rocks: the first and more long-lived event, between 2.20 and 2.11 Ga, is registered within the Mineiro Belt, Mantiqueira Complex and JFC; the younger event, dated at ca. 2.07 Ga, is restricted to the JFC. Such sanukitoid association, together with other distinct magmatic arc rocks (calk-alkaline granitoids, IATs, and TTGs), attests to a complex and enduring accretionary system, very similar those from modern plate tectonics accretionary settings, developed in the southeastern margin of the SFP during the Rhyacian.

Financing: CNPq- Conselho Nacional de Desenvolvimento Científico e Tecnológico and CAPES- Coordenação de aperfeiçoamento de Pessoal de Nível Superior.

Khan River and Bear Lake: Two natural titanite reference materals for high-spatial resolution U-Pb microanalysis

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With the expansion of laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) laboratories around the world, the demand for reference materials for calibration and quality control has increased significantly. As this technique is destructive by construction, a constant supply of natural, homogeneous and well-characterized reference materials is required. Another limiting factor is the dependence on matrix-matching reference material to correct elemental fractionation of some trace elements and isotope ratios induced by the laser system. The desirable prerequisites for an ideal reference material for U-Pb includes isotopic homogeneity, negligible or constant common Pb, non-metamictic crystalline structure, absence of imperfections (e.g. inclusions, fractures) and abundance for distribution to the scientific community. For instance, the available titanites characterized as reference materials for U-Pb geochronology may have variable common Pb (BLR-1), loss of radiogenic Pb (MKED1) and some are no longer widely available for distribution (Khan). In this research, we have investigated two new potential titanites reference materials (Bear Lake and Khan River) for U-Pb geochronology by means of high precision (ID-TIMS) and high-spatial resolution methods (LA-ICP-MS and SHRIMP). The titanites investigated in this research come from the same region as the original Khan and BLR-1 titanites. A thorough chemical and isotopic characterization is required to assess their potential as reference materials as they were collected at distinct localities (Khan River titanite) or were obtained from a mineral dealer (Bear Lake titanite). We made use of the chemical abrasion technique - for the first time applied to titanites - to minimize the imperfect areas of the crystal fragments (e.g. fractures, damaged portions) and resulting in a more homogeneous translucent material. This treatment contributes to the selection of the best areas to be laser ablated. BSE images show that Bear Lake titanite is homogeneous, free from zoning and that Khan River titanite has fractures and zoned portions. Bear Lake titanite shows a uniform pattern in a REE diagram and has high but relatively constant common Pb. For Khan River titanite, the REE content is variable and the common Pb concentration is low, but slightly variable. U-Pb ID-TIMS analyses yielded Pb_c-uncorrected intercept ages of 516.3 ± 1.3 Ma (2s, n = 5, MSWD = 2.4) and 1067.81 ± 0.74 Ma (2s, n = 4, MSWD = 0.35) for Khan River and Bear Lake titanites, respectively. Multiple U-Pb LA-SF/MC-ICP-MS analyses gave consistent Pb_c-uncorrected intercept ages for both, Khan River (517 ± 1/5 Ma, 2s, n = 262, MSWD = 1.5) and Bear Lake (1070 ± 1/11 Ma, 2s, n = 325, MSWD = 0.88). Since no common Pb correction was applied to the U-Pb LA-ICP-MS data, we focused on the Pb_c-uncorrected U-Pb ID-TIMS results, then both data can be compared. U-Pb SHRIMP analyses on both titanites samples returned consistent ages within uncertainty. We have shown that the reproducibility tests using Khan River and Bear Lake titanite as calibrant to correct the $^{206}Pb/^{238}U$ ratios in our round-robin results yielded an offset smaller than 1% for all the reference materials treated as unknowns. Using Khan River titanite as calibrant, we obtained ages offset ranging from 0.003% to 0.23% for all the samples analyzed as unknowns. Using Bear Lake titanite as calibrant, the ages offset varied from 0.06% to 0.46% from the accepted ages. Thus, we propose the Bear Lake and Khan River titanites as reference material for U-Pb LA-ICP-MS geochronology. We are willing to distribute these materials to the national and international scientific community upon request.

Financing: PhD scholarship from CAPES (88887.619872/2021-00). This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001.

The Vermillion Monazite: A new archean monazite reference material for U-Pb and Sm-Nd microanalysis by LA-ICP-MS

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The use of LA-ICP-MS technique has increased in several laboratories around the world and is revolutionizing earth sciences studies. Recent advances in the LA-ICP-MS U-Th-Pb geochronology allows acquisition of U-Pb data at high spatial resolution (> 10 µm), with precision and reproducibility better than 3% on individual $^{206}Pb/^{238}U$ and $^{208}Pb/^{232}Th$ ages, at relatively fast throughput and low cost compared to other microanalytical techniques, such as SHRIMP or ID-TIMS. Of the few well-characterized monazite reference material available (e.g., Itambé, Diamantina, TS-Mnz, USGS44069, Thompson Mine, Managountry, Steenkampskraal/ Namaqualand, Iveland), there is currently no Archean homogenous monazite being widely distributed for LA-ICP-MS U-Pb geochronology. In this study, we have investigated the Vermilion monazite as a potential reference material for U-Pb geochronology, using high-precision technique (ID-TIMS) and high-spatial resolution methods (LA-ICP-MS and SHRIMP), and for Sm-Nd microanalysis (LA-MC-ICP-MS). The Vermilion monazite homogeneity in major and minor/trace elements composition were investigated by electron microprobe and LA-(SF/Q)-ICP-MS, respectively. BSE images revealed that Vermilion monazite is relatively homogeneous and free from compositional zoning. It can be classified as a monazite-(Ce) (29.58 to 30.94 wt% Ce_2O_3), with uniform REE pattern, with considerably small variations between the crystals. The ID-TIMS results show U contents varying from 592 to 817 ppm, Th contents from 49954 to 68294 ppm, and Th/U from 76.12 to 88.95. Our potential monazite reference material yielded ID-TIMS weighted mean $^{207}Pb^*/^{206}Pb^*$ age of 2667.5 ± 1.2 Ma (2s, n = 7, MSWD = 5.0) with a slightly discordant concordia age. U-Pb SHRIMP data returned a $^{207}Pb^*/^{206}Pb^*$ weighted average age of 2662 ± 2/27 Ma (2s, n = 28, MSWD = 1.4). U-Pb $^{207}Pb/^{206}Pb$ weighted average LA-MC-ICP-MS and LA-Q-ICP-MS data are 2666 ± 1/27 Ma (2s, n = 58, MSWD = 0.9) and 2665 ± 5/27 Ma (2s, n = 41, MSWD = 0.97), respectively. High-spatial resolution data are in agreement with the high precision ID-TIMS. Sm-Nd LA-MC-ICP-MS results from two laboratories returned an average $^{147}Sm/^{144}Nd$ ratio of 0.0854 ± 0.0027 (3.1 %RSD, 2SD, n = 108), with relatively small variation in the individual fragments, ranging from 0.0823 ± 0.0001 (2s) to 0.0901 ± 0.0002 (2s). We obtained a homogeneous average $^{143}Nd/^{144}Nd$ ratio of 0.51068 ± 0.00004 (0.01 %RSD, 2SD, n = 108), with individual grains average varying from 0.51065 ± 0.00002 (2s) to 0.51072 ± 0.00002 (2s). The initial epilson Nd (εNd_i) varied from -0.8 ± 0.5 (2s) to 0.6 ± 0.4 (2s). To assess Vermilion monazite suitability as a primary reference material for LA-ICP-MS analyses, we will use it as the main calibrant and analyze known reference materials, treated as unknowns. We will interpret the reproducibility of our results and verify if Vermilion monazite can be used as primary reference material for U-Pb geochronology and as a secondary reference material for Sm-Nd isotopic tracing analyzes. The Archean age of Vermilion monazite will increase the possibilities of investigating Archean crustal evolution processes by combining matrix-matched U-Pb geochronology and Sm-Nd isotopic tracing. It also broadens the prospect of studying ancient metamorphic events and to trace the source of hydrothermal fluids mineralization.

Financing: PhD scholarship from CAPES (88887.619872/2021-00). This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001.

Neogene siliciclastic sedimentation on the eastern Amazonia coast: Did the Amazon river play a role?

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Throughout the middle Miocene/Pliocene several onshore basins and platforms along the Eastern Amazonia coast experienced a massive increase in siliciclastic input. This rise in sedimentation overlaps with the timing of the establishment of the transcontinental Amazon River. Until now, this event is recorded only in wells drilled in the offshore areas located hundreds of kilometers away from the river's mouth. Here we use detrital zircon U-Pb ages and Nd-Sr isotopic compositions of clay-sized sediments as a provenance tool to investigate the presence of Amazon River derived sediments in Miocene-Pleistocene terrigenous deposits in the eastern Marajó Basin (EMB) and Bragantina Platform (BP), located in the northeastern part of the state of Pará, Brazil. The sampling strategy consisted of collecting sixteen fine- to coarse-grained mudstones, sandstones, and conglomerates contemplating not only the Miocene/Pliocene strata but the whole sedimentary record in the BP and EMB, so that the potential contribution of recycling from older formations could be addressed. Zircon morphology analysis was performed using SEM-BSE images, detrital zircon U-Pb ages were obtained by LA-ICP-MS, and Sr-Nd isotopic compositions by TIMS, all at the University of Brasília. Suspended particulate matter (SPM) transported by different Amazonian rivers can be distinguished based on their Nd-Sr isotopic compositions. While rivers draining cratonic areas present negative εNd(0) values (-17 to -45), rivers draining Andean rocks have more positive εNd(0) values (-13.8 to -8.02). Compared to SPM in the modern Amazon River and core data from the Amazon Fan, the Miocene-Pleistocene onshore deposits have $^{87}Sr/^{86}Sr$ and εNd(0) isotopic compositions that dismiss the transcontinental Amazon River characteristic Andean fingerprint. Additionally, detrital zircon U-Pb ages do not present the distinctive Andean Mesozoic-Cenozoic detrital zircon age population. Instead, our results show a predominantly Pre-Cambrian isotopic signature. In the EMB, reworked Cretaceous sedimentary rocks and Neoproterozoic granites from the Gurupi Belt were the primary sources. Meanwhile, in the BP, age distribution patterns indicate that reworked sedimentary rocks from the Paleozoic Parnaíba and Cretaceous Grajaú basins were the main sources, and crystalline basement rocks from the São Luís Craton and Gurupi Belt subordinated sources. Hence our data suggest that contrary to what was found in the Amazon fan (1-BP-2-APS and1-BP-3-APS) or at IODP 955 site (Ceará Rise), Miocene detrital sediments in onshore compartments of Eastern Amazonia never received sediments from the Andean Amazon River during the Miocene. Such findings might also indicate that at the time of the deposition of the Miocene siliciclastic sediments in onshore compartments, the north Brazilian current was already active preventing the Andean Amazon detritus to reach the Bragantina platform. Additionally, our data also highlight those distinct tectonic settings show different depositional histories along the Eastern Amazonian coast, probably controlled by the combination of sea-level fall and tectonic reactivations during the Neogene.

Financing: Coordination for the Improvement of Higher Education Personnel – Brazil (CAPES) - Finance Code 001.

Arc-related and high-grade dry metamorphic conditions of Búzios Orogeny: A case study of orthogranulites from Ribeira Belt, Ilha Grande (RJ), Brazil

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In situ U/Pb and Lu/Hf analyzes performed by laser ablation multi-collector inductively coupled plasma mass spectrometry (LA-MC-ICP-MS) on zircons and cathodoluminescence (CL) images were performed to isotopically characterize the granulitic metamorphism of the Ribeira Belt in Ilha Grande (Rio de Janeiro State, SE Brazil). Zircon grains in charnockitic rocks have a heterogeneous internal texture or cores preserved with overgrowth and Th/U ratios generally <0.1. However, it was identified a group of zircons that present the typical zoning of magmatic origin and high Th/U ratios generally >0.4. The preserved grains core provides U/Pb ages between 540-530 Ma and $^{177}Hf/^{176}Hf$ values between 0.2323 and 0.2324 and $^{177}Lu/^{176}Hf$ values between 0.2322 and 0.2321. Most metamorphic zircons grew in a dry environment, as indicated by their high $^{176}Lu/^{177}Hf$ ratios resulting in new-formed metamorphic domains with U/Th values (between 2.5 and 0.5) similar to magmatic domains, suggesting their formation by solid-state recrystallization without a presence of aqueous fluid. This event was defined by the metamorphic U/Pb age of 510-496 Ma, in zircon grains, consistent with the metamorphic age of the Búzios Orogeny. The results indicate that the protolith of the charnockites are type-I granitic rocks crystallized between 550-510 Ma. These rocks are the product of oceanic crust subduction and crustal duplication (Buzios orogeny) during the collision of the São Francisco and Congo cratons during the amalgamation of the Gondwana supercontinent.

Neon Isotopic Anomaly and He, Ar, and Xe isotopic compositions of Basaltic Glasses from South Chile Ridge Segment 1

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The Chile Ridge is being subducted beneath the South American Plate and forming a trench-ridge-trench Chile Triple Junction (CTJ) (e.g. Herron et al., 1981, Geological Society of America Memoir 154, 683-702). The Chile Ridge is separated into the North Chile Ridge (NCR) and the South Chile Ridge (SCR) by the Valdivia Fracture Zone. Niedermann and Bach (1998) first reported that $^{21}Ne/^{22}Ne$ ratios in MORB glasses from NCR are higher than those for normal Mid-Ocean Ridge Basalts (N-MORB) at a given $^{20}Ne/^{21}Ne$ ratio. This suggests mantle-endmember Ne in NCR samples is more enriched in nucleogenic ^{21}Ne (product of nuclear reactions associated with the decay of U and Th) than the N-MORB source. They interpreted that the anomaly resulted from an increase in $^{21}Ne/^{22}Ne$ ratio of the remnant solid phase that was once partially melted and degassed at the Pacific-Antarctic Ridge (PAR) and then remelted during NCR formation and mixed with N-MORB source. Strum et al. (1999, Journal of Geophysical Research, 104, B3, 5097-5114) reported He, Sr, Nd, and Pb isotopic compositions for MORBs collected in segments 1 to 4, but other noble gas isotopic compositions have not been reported. In this study, we show that major and trace element composition and noble gas isotopes from SCR segment 1, and investigate the causes of Ne isotopic anomalies.

The Ne isotopic composition of SCR segment 1 MORB glass shows nucleogenic ^{21}Ne than that of N-MORBs, some of which are even stronger than those of NCR. On the other hand, the $^{3}He/^{4}He$ ratio was within the N-MORB composition range of 8 ± 1 R_A (atmospheric value $1.40 \times 10^{-6} = 1$ R_A, Ozima and Podosek, 1983), and was slightly higher than that in NCR. The $^{3}He/^{4}He$ ratio of the continental crust has 0.02 R_A, so if there was a mixing of continental crust into the mantle source, the He isotope ratios would be lower, but no such trend was observed in the He isotope ratios. The $^{40}Ar/^{36}Ar$ ratios of SCR samples were systematically lower than NCR samples. The major element compositions showed N-MORB characteristics, and the trace elements also showed N-MORB-like compositions except for some lithophile elements. The Nb/U ratios ranged from 27.1 to 38.5, suggesting a small influence of crustal mixing. On the other hand, U and Th, which are responsible for the nuclear reaction producing ^{21}Ne, are more enriched by 2.1 and 2.6 times those in N-MORB. In summary, the Ne isotopic anomaly in MORB of SCR segment 1 can be explained by the re-melting of a mantle source of PAR with a higher $(U+Th)/^{22}Ne$ ratio due to degassing, as the model proposed by Niedermann and Bach (1998) for NCR MORB glass.

The observation that the $^{3}He/^{4}He$ isotopic ratio of MORB glass in SCR segment 1 is not significantly different from N-MORB composition may be due to equilibration with N-MORB source, the asthenospheric mantle, due to the large diffusion coefficient of He. As for the larger contribution of the nucleogenic ^{21}Ne in SCR segment 1 than that for NCR, assuming the migration of PAR source mantle asthenosphere along with the oceanic lithosphere, the asthenosphere beneath SCR would have a larger migration distance from PAR than that beneath NCR. SCR is about two times far from PAR than SCR, which may result in a greater accumulation of nucleogenic ^{21}Ne beneath SCR than NCR due to the longer time effects. On the other hand, the $^{40}Ar/^{36}Ar$ ratio of SCR segment 1 MORB glass obtained in this study did not show any significant radiogenic features as observed in NCR. Therefore, the lower $^{40}Ar/^{36}Ar$ ratios of SCR samples may be due to the selective loss of mantle-derived Ar relative to He and Ne due to solubility-dependent gas losses, resulting in a greater contribution of atmospheric contamination.

Magmagenesis of the Quaternary arc volcanic rocks from the Southern Volcanic Zone of the Andes: Constraint from characteristics of the bulk chemistry including boron content

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The Southern Volcanic Zone (SVZ) of Andes is a subduction zone where the Nazca Plate with multiple well-defined fracture zones subducts into the Chilean trench, causing an arc volcanism due to slab-derived fluids. (1) suggested that the subducted fracture zones on the slab generate a fluid "excess", which activates the arc volcanism in the region. (2) revealed that the trace element compositions of volcanic rocks in the SVZ, including boron, indicate the along-arc variation and they found that the contribution of slab-derived fluids is maximum at the Villarrica (Vill) volcano. However, there are still many volcanoes in the SVZ where multiple fracture zones are subducted that have not still been reported with detailed chemical compositions. In this study, we characterized boron content from 16 volcanoes surrounding to the Vill volcano in the SVZ and discuss the magmatic evolution.

The results in this study show that the B/Nb ratio in the along-arc variation becomes high for volcanoes directly above the subducted fracture zone (e.g., Vill volcano), as pointed out in previous studies, while it is also high for some volcanoes without the fracture zone. The B/Nb ratio in the across-arc variation tended to be higher on the volcanic front domain and lower on the back arc domain, and the degree of partial melting showed the similar trend to those of the B/Nb ratio. This suggests that the partial melting rate of the mantle wedge increases with increasing amount of fluid. In addition, many of the back-arc volcanic rocks show characteristics of garnet phases among the residual phase of the source material, and furthermore, the high Th/Nd ratio in contrast to the low B/La ratio suggest the involvement of partial melt of a subducted sediment component. However, it is unlikely that a garnet coexists at temperatures and pressures where partial melting of the peridotite occurs in normal mantle wedges, moreover, that melting of subducted sediments occurs in the back-arc volcanic region. (3) pointed out the similar features in the back-arc volcanoes adjacent to the Vill volcano and suggested that the preceding arc-basaltic magma accreted and solidified at the bottom of the lithospheric mantle to form a garnet pyroxenite layer, which was remelted and mixed by the following arc-basaltic magma.

(4) suggested that a slab window was formed by the collapse of the Farallon Plate and the increased subduction rate of the Nazca Plate during the Oligocene to early Miocene on the fore-arc volcanic zone, which temporarily enhanced the circulation and uplift of the asthenosphere. Based on our result, in the period, the mantle wedge may have been hotter than at present, and the supply of sediment melt resulting from slab melting may have been more pronounced. Therefore, we propose the following processes of magmatic evolution for the volcanic rocks in the SVZ; 1) The slab window was formed by the collapse of the Farallon plate during the Oligocene to early Miocene. An andesitic magma, which was strongly influenced by the sediment melt, was generated, accreted, and solidified in the lowermost part of the lithospheric mantle, and formed the garnet pyroxenite layer, 2) After the late Miocene, the arc system shifted to a steady-state subduction, and the involvement of altered oceanic crust-derived fluids increased in the arc volcanism. The tendency is predominant in volcanic fronts with high production of the arc basaltic magma, while in the back-arc region diminishes, with low production of the arc basaltic magma. This suggests that mixing rate of the magma formed by partial melting of the garnet pyroxenite layer with characteristics of sediment melt increases toward the back-arc region, and consequently the magma with characteristics of the garnet-bearing residual phase was predominant in back-arc region of the SVZ.

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New field data and U-Pb detrital zircon ages of turbiditic successions in the northern area of the Jerónimo Channel, Magallanes Region

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New lithostratigraphic data collected during fieldwork campaigns along the Magallanes - Fagnano Fault System in the northern area of the Jerónimo Channel, indicate the presence of rock outcrops associated with fine-grained turbiditic successions presumably deposited under marine conditions. According to the observations made in the field, the outcrops of turbiditic successions show several features of post-burial processes, evidenced by folding, development of secondary foliation, and quartz vein systems that outcrop locally cutting the successions. New detrital zircon ages obtained from sandy levels within the turbiditic successions indicate a Lower Cretaceous maximum depositional age, which can be correlated with turbiditic successions of the Mesozoic Rocas Verdes Basin. According to the above, new questions arise regarding the development and tectonic evolution of the Rocas Verdes basin at these latitudes, such as: What do the secondary structural and mineralogical features in rocks tell us about processes of tectonic burial and deformation? Are the deformation and burial styles comparable with coeval geological units in the region? Is it possible to attribute the development of secondary structures, such as dioritic dikes and quartz vein systems, to a post-Lower Cretaceous magmatic-hydrothermal event? In this contribution, we present preliminary results that aim to answer these questions.

Financing: This contribution was funded by Fondecyt grant 1211906.

U-Pb provenance ages and Hf isotopes of Tatuí Formation – Paraná Basin: Paranapanema Craton cover

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Permo-Carboniferous to Cretaceous lithostratigraphic units outcrop in the Pitanga Structural Dome, east of the Paraná Basin (PB), State of São Paulo (SP) - Brazil.

Studies of the provenance of detrital zircons of the Permian Gondwana I Supersequence are still scarce in the state of São Paulo and limit broader correlations and interpretations. This work presents the first U-Pb and Hf isotopic results of detrital zircons obtained by the LA-ICP-MS technique for the Tatuí Formation, SP, described as correlated to the Rio Bonito Formation that is distributed along the entire eastern border of the PB from the Rio Grande do Sul to Paraná states.

The Tatuí Formation is represented by siltstones and fine-grained sandstones and, in its upper part, fossiliferous conglomeratic sandstone with a thickness close to 50 cm called Ibicatú Layer. This upper layer, in turn, has an abrupt contact with the siltstones of the Taquaral Member of the Irati Formation.

The younger ages obtained in the zircon crystals of the fine-grained sandstones of the Tatuí Formation are between ca. 269 and 262 Ma with εHf values between -1 and -5 and Hf-T_{DM} Model Ages (1000 to 1500 Ma). Most zircon crystals aged between 289 and 261 Ma showed εHf values between -4 and +2, and more rarely values of -7 and +5. The zircon age spectrum shows three well-defined peaks at 500 Ma, 283 Ma, and 1060 Ma. Lower Mesoproterozoic, Paleoproterozoic, and Neoarchean rocks are subordinate contributions with extremely variable εHf values, between +8 and -10.

The youngest zircon crystals of the Ibicatú Layer, although stratigraphically above, presented slightly older ages between 276 and 271 Ma and εHf of -1 and -7 and Hf-T_{DM} Model Ages (1200 to 1600 Ma). Zircon crystals aged between 293 and 270 Ma showed εHf values predominantly between -1 and 0, but also values of -5. The zircon age spectra are likely similar to the fine-grained sandstones and show three well-defined peaks at 520 Ma, 278 Ma, and 995 Ma. Mesoproterozoic, Paleoproterozoic, Neoarchean, and one contribution of Paleo to Mesoarchean source show εHf quite variable between +7 and -12.

The ages ranging from 289 and 269 Ma may suggest a possible volcanogenic origin for these zircon crystals. These ages, along with εHf values, are compatible with those observed in the volcanic rocks of the Choiyoi Magmatic Province.

Although preliminary, these ages are incompatible with the current stratigraphic positioning of the Tatuí Formation, being compatible with the ages obtained in volcanogenic zircons of the Passa Dois Group Formations stratigraphically above.

Conversely, it is imperative to confirm this hypothesis by conducting a more detailed investigation in the Tatuí Formation.

Financing: Special thanks to “The Rio de La Plata Craton and the Western Gondwana Assembly”-Thematic Project (FAPESP 2015/03737-0) which made possible the isotopic analysis.

Differentiating post-magmatic cooling and erosional exhumation in the thermochronological record of the northern Chilean Forearc (22.5° and 24.5° S)

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Exhumation of the upper crust is a consequence of tectonic deformation and associated mountain building. In cases in which the tectonic deformation results in kilometric-scale uplift, thermochronology can potentially provide ages of cooling that can be interpreted as a response to erosional exhumation. The forearc of the Central Andes of northern Chile hosts a widespread record of Mesozoic and Cenozoic arc magmatism and sediment accumulation in adjacent basins. The early stage of Andean orogenesis in the forearc led to the closure and inversion of former extensional basins through contractional reactivation of Mesozoic normal faults since the Late Cretaceous-Paleocene. This compression is also recorded by changes in the sedimentary systems and post-tectonic magmatism. Ongoing convergence during Eocene–Oligocene resulted in vertical-axis rotations and thrusting, and its record is preserved in syn-tectonic units. These contractional events have been also related to cooling ages from low-temperature thermochronology. The Neogene tectonic setting of the forearc is debated between an extensional and compressional regime. Overprinting of multiple compressive episodes affecting the continental margin hinders the recognition of their individual contribution to crustal thickening over time.

A positive correlation between the spatial distribution of Cretaceous to Cenozoic intrusive and hypabyssal rocks with available U-Pb crystallization ages between ~110 and 30 Ma, and low-temperature thermochronological ages precludes ruling out that cooling resulted from post-magmatic refrigeration instead of from exhumation. This alternative has been underestimated in a continental margin with long-live magmatism as the Andes margin.

In this scenario, discriminating the cooling of the forearc upper crust between a signature of deformation versus post-magmatic cooling by estimating the depth of emplacement of intrusive rocks contributes to better constraining the Late Cretaceous to Cenozoic pulses of orogenesis and their potential effect on changes in the crustal thickness.

Fieldwork was carried out in a transect between the Coastal Cordillera and the Salar de Punta Negra basin and in the surroundings of Calama (~22.5-24.5° S). In the field was recognized preserved normal and thrust structures involving Meso-Cenozoic units and the Neogene sedimentary cover affected by brittle deformation.

Available and new thermochronological ages illustrate that the younger ages are spatially correlated with the Domeyko fault system. The youngest ages of the highest temperature systems (zircon fission-track and zircon (U-Th)/He) are Eocene (~ 57-47 Ma, a cluster of ~30 Ma could be correlated with hydrothermal alteration), suggesting that the deepest exhumation was controlled by structures of the Precordillera. In contrast, the ages of the lowest temperature thermochronometers (apatite fission track and apatite (U-Th)/He) became younger to the east. This contribution aims to determine the thermal evolution of the upper crust through the use of structural modeling, low-temperature thermochronology, and paleo-crustal thickness estimations from geochemical proxies and paleobarometry markers of the emplacement of Late Cretaceous to Cenozoic plutonic rocks. Our multi-method approach will enable the recognition of exhumation modulated by tectonics and will provide constraints of crustal thickening in a pre and syn-orogenic phase. Thermokinematic modeling incorporating all datasets will allow us to quantify the magnitude of shortening over time.

Sr and Nd isotopic data from deep-drill-core samples of basement rocks from the southernmost Paraná Basin (Uruguay)

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Sr and Nd isotopic analysis were performed on six samples from deep drill-cores of the basement rocks of the Norte Basin (depth ca. 1500 m), the southern extreme portion of the Paraná Basin in Uruguay. This basin, located in the central-eastern region of South America, is a large area which extends approximately 1.5 x106 km^2 through part of Brazil, Paraguay, Argentina, and Uruguay. It is of intracratonic type, being supported by a cratonic basement since its inception. The Paraná Basin holds a volcano-sedimentary infill with ages from Devonian to Late Cretaceous. The model about the nature of the Paraná basement in its southernmost portion in Uruguay includes the Paleoproterozoic Piedra Alta Terrane (PAT) and the Archean to Neoproterozoic Nico Pérez Terrane (NPT), both separated by the Sarandí del Yi shear zone in their outcropping areas in the south of the country.

Recent petrological studies about rocks from drill-cores allowed to recognize these rocks as high K-calc-alkaline monzonites, quartz monzonites and granites (with biotite ± hornblende) with metaluminous to peraluminous nature, spanning from 2100 to 570 Ma. Considering these information, initial $^{87}Sr/^{86}Sr$, initial εNd and TDM ages were calculated for each sample. The values obtained in the PAT samples show $^{87}Sr/^{86}Sr_{(2000)}$ from 0.70192 to 0.71458, $\varepsilon Nd_{(2000)}$ from -12.25 to +0.76, and TDM ages from 2.22 Ga to 3.5 Ga. In the NPT samples $^{87}Sr/^{86}Sr_{(600)}$ values range from 0.70815 to 0.75757, $\varepsilon Nd_{(600)}$ from -26.31 to -19.68, and TDM ages from 3.12 Ga to 1.99 Ga. According to these results, the PAT samples suggest less crustal participation and a juvenile origin for one of the samples (Quebracho Granite) based on its TDM and positive εNd. On the contrary, the NPT shows important involvement of the crust with Archean and Paleoproterozoic model ages for the Neoproterozoic granitic rocks.

Financing: This work was supported by the Agencia Nacional de Investigación e Innovación (grant FCE_1_2017_1_136496) and from PEDECIBA-Geociencias.

U-Pb shrimp detrital zircon ages of the eastern series of the metamorphic basement of south central Chile, at the hanging wall of the Lanalhue fault zone (38°S)

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Late Paleozoic accretionary complexes crop out along the coast of south-central Chile (c. 34-41°S). They are composed of two units with contrasting styles of deformation and metamorphism; the Eastern Series (ES), formed by frontal accretion under low-grade metamorphism, and the Western Series, formed by basal accretion under high P/T metamorphic gradients. The Lumaco and Capitán Pastene formations (c. 38°S) are local denominations for parts of the Eastern Series and crop out <15 km north of the Lanalhue Fault Zone (1). The Capitán Pastene Formation comprises deformed slates and pelitic schists, while the Lumaco Formation consists of poorly deformed slates and fine-grained metasandstones (2). The age of the protolith of the Lumaco Formation has been considered as Silurian based on the occurrence of trace fossils described in metasandstone beds. A garnet-bearing pelitic schist of the Capitán Pastene Formation (sample FO2107) and a fine-grained metasandstone of the Lumaco Formation (sample FO2109) were collected and 70 zircon grains from each were dated by U-Pb SHRIMP for provenance analysis. The zircons from sample FO2107 are mainly elongate euhedral grains with pyramidal terminations together with subrounded grains. Importantly, some zircon grains have low U rims and embayments. Sample FO2109 contains prismatic zircons with central cavities and length parallel zoning; low U rims are less common than in FO2107. Both samples show similar provenance patterns with major age peaks at c. 340-345 Ma, subordinate age peaks at c. 330 and 355 Ma, and a less prominent Devonian component of c. 360-380 Ma. A similar, c. 330 Ma, maximum age of deposition for Lumaco and Capitán Pastene formations discards the previous interpretation of a Silurian age for the protolith. The near absence of older cratonic zircon dates and the abundance of euhedral igneous zircon grains implies derivation from relatively local sources. Notably, igneous units with 340-355 Ma crystallization ages in northern Patagonia are unknown. The ES is intruded by the Pennsylvanian Coastal Batholith generating a HT-LP metamorphic overprint, and near the study area c. 310 Ma U-Pb SHRIMP crystallization ages are reported (3). The ages obtained in the low U rims (sample FO2107) are scattered, but some grains yielded concordant Mississippian ages (~325-340 Ma) and are comparable to previously reported metamorphic ages in the basement of north-western Patagonia (4). It is suggested that the studied formations represent different portions of the same paleo-basin that was later deformed and metamorphosed to different extents during the late Carboniferous to Permian Gondwanide tectonic cycle.

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Financing: This research was funded by Consejo Nacional de Investigación Científica y Tecnológica (presently ANID) through Project Fondecyt N°1180457.

Tracing the silicification mechanisms of fossil woods in Central Panama: Evidences from stable isotopes

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Within the Barro Colorado Natural Monument (BCNM) in the Panama Canal Zone, are the Barro Colorado Islands (BCI) and the Gigante Peninsula (GP), that house one of the most interesting tropical forests for multidisciplinary scientific research. Recent investigations in BCI and GP have allowed the discovery of hundreds of fragments of silicified fossil woods in localities associated with distributed drainages and embedded in weathered volcanoclastic units. Their ages and fossilization histories have been considered similar due to semblances in the type and age of the surrounding materials. However, dating at GP provided two different ages, thus making confusion on whether the silicification process and event of the woods from both sites were the same. The purpose of this work is to clarify the silicification history and age of these woods and to establish if there is a relationship between them in order to improve the paleoecological and paleoclimatic knowledge of the neotropical forest. Important biogeographical questions related to the timing and magnitude of the intercontinental exchange of tree species prior to the definitive closure of the Isthmus of Panama can be clarified after these results.

In order to trace and clarify the process, history and age of silicification of GP wood fossils and their possible relationship with BCI fossils, isotopic geochemistry has been mainly used in this work, for oxygen stable isotopes ($\delta^{18}O$) analysis in the silicified material. These data have been accompanied with (i) analysis of the geochemical composition of the total rock of Si, Fe, Ca, K and Sr to determine the silicification environment and the possible source of the fluid with high Si content with which the woods interacted to be silicified; (ii) carbon stable isotopes ($\delta^{13}C$) in the material apparently less affected by silicification to try to control if the isotopic ratios are still similar to those of the original forest; (iii) petrographic analysis to better understand how the silicification process occurs and the mineralogical content of the material that fills the wood; (iv) K/Ar geochronological analysis directly from the fossil samples to try to constrain the age of fossilization.

The $\delta^{18}O$ isotopic ratios obtained in BCI show an average value of 24.8‰ and in GP the average is 22.3‰ indicating the same silicification environment. Yet the precipitation temperature in BCI would have been between 45°C and 60°C while in GP it would be around 65°C to 70°C. The ICP-MS and $\delta^{13}C$ results suggest geochemical affinity between the wood fossils and their surrounding rocks that allows associating the silicification of BCI to calcoalkaline volcanic activity and adakitic volcanism in GP. Finally, the age of the material silicifying the BCI woods is around 20 times older than the GP fossils. Therefore, the present results indicate that the fossilization events that silicified the woods from both sites occurred independently.

Financing: Financial and logistical support from the Smithsonian Tropical Research Institute made possible the development of this research project.

The Yarituses Suite, Eastern Bolivia: Implications for the Mesoproterozoic evolution of the Paraguá Block

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The Paraguá Block (PB) in Eastern Bolivia (EBB) and Southwest Brazil has been tectonically stable during the Meso- to Neoproterozoic Sunsas Orogeny (1.25-1.00 Ga). This block represents an important terrane during the crustal growth along the western margin of South America in Paleo- to Mesoproterozoic times. Its relationship with the SW Amazonian Craton and the Rio Apa Block (RAB) has been a matter of intense debate for some 30 years. The basement of this block (1) comprises orthogneisses and paragneisses of the Lomas Maneches Complex (ca. 1.96 Ga) and Chiquitania Complex (CC) (ca. 1.75-1.69 Ga) and by schist of San Ignácio Group (ca. 1.69 - 1.58 Ga). Granites and orthogneiss of ca. 1.68-1.61 Ga age represent a magmatic event of calc-alkaline signature, positive ε_{Nd} and T_{DM} of ca. 1.90-1.70 Ga was grouped together as the Yarituses Suite (YS) (2). The San Miguel Gneiss (SMG) and Rosario Gneiss (RG) crop out at the SW border and at the S edge of the PB bordering against the RAB, respectively. U-Pb on zircon analysis allows us to define protolith ages of 1681 ± 13 and 1678 ± 21 Ma, respectively. Geochemical data indicate that the protoliths of both bodies, monzogranite and granite, were metaluminous, calc-alkaline to alkali-calcic, and I-type. They were associated with the evolution of volcanic arcs in a subduction environment. In this sense, the protolith of the SMG is characterized by a positive $\varepsilon_{Nd}(t)$ value of +1.93 and T_{DM} 1.81 Ga, and the RG protolith gave a nearly positive $\varepsilon_{Nd}(t)$ value of +0.92 and T_{DM} of 1.89 Ga. The Hf data for these protoliths indicate parental magmas with essentially positive $\varepsilon_{Hf}(t)$ values between +0.3 and +8.9 and Hf T_{DM} between 2.32 and 1.82 Ga. Thus, the RG and SMG can be considered as part of the Yarituses Suite, as well as the Sujalito Granite (1.68 Ga; (3)) and the Turvo Orthogneiss (1.65 Ga, (4)) that previously associated with the CC. Our data allow us to suggest that the YS represents a magmatic event at ca. 1.68 Ga of regional scale, and that this event involved crustal reworking of the units that compose the basement of the PB.

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Rare Earth Elements implication on paleo-depositional environment of Salitre Formation (Neoproterozoic), Irecê sub-basin, São Francisco craton, Brazil

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Rare Earth Elements (REE) and other trace elements, as well as carbon ($\delta^{13}C$) and oxygen ($\delta^{18}O$) isotopic ratios, from marine precipitates record the digital signature seawater composition in paleo-oceans. Isotopic composition of seawater can be modified by as evaporation rate changes, mixing with other waters, contamination by continental detrital material and late diagenesis. REE have low solubility, similarity in the ionic radius values and the predominance of trivalent state, low residence time in sea water (around 102 to 103 years old) that can be useful to evaluate the originally of the precipitation. To define the reliability of $\delta^{13}C$ (16 samples), depositional environment proxies and pre, sin and post-depositional processes of Salitre Formation (Irecê sub-basin, São Francisco Craton), petrographic and geochemical analyzes were performed. A total of 21 limestone and dolomite samples from Nova América Unit were collected in four outcrops located at Lapa Doce farm, south of Irecê sub-basin Northeast of Brazil. Major and minor elements of 21 samples were determined using X-Ray Fluorescence (Lithochemistry and Mineral Analysis of the Center for Studies in Petrology and Geochemistry – UFRGS). Rare earth elements (19 samples) were determined with mass spectrometer with inductively coupled plasma (ICP-MS, SGS GEOSOL laboratory). Prior to rare earth elements analysis of 12 samples, a dissolution of about 80% of whole carbonate was applied with 5% v/v acetic acid (Laboratory of Isotopic Geology of Federal University of Rio Grande do Sul) intending to avoid non-carbonate phases. Limestones and dolomites are characterized as laminates with spastic cement, neomorphized mudstones, rudstones and stratiform stromatolites. Carbonates are predominantly characterized by spastic calcite (40-75%), spastic dolomite (5-10%), quartz (0-10%) and peloids (0- 5%). Geometry of layers varies, from tabular to lenticular layers, with the presence of concordant and discordant calcite and spastic dolomite profiles. Limestones are predominantly micritic, widely recrystallized, individualized by dissolution surfaces (styloliths) associated with dolomitization and microcrystalline quartz silicification next to veins. Sr concentrations of 77.71 to 1187.20 ppm (average 500 ppm) and Mn (77 to 309.8 ppm) are low and have a negative correlation, indicating an influence of this element during diagenesis, decreasing Sr concentrations. Concentrations of Pb, Zn and Zr (27.6 to 556.7 ppm) are high in some samples and indicate contamination by siliciclastic detritic minerals. SiO_2 content is higher in facies with greater occurrence of styloliths, recrystallization and more intense silicification. Linear pattern or slight medium REE enrichment of rare earth elements indicates more proximal precipitation conditions, that cannot correspond the isotopic composition of the global ocean. Anomalies of Ce (1.10 ± 0.16) and Gd (0.54 ± 0.28) indicate a predominant anoxic origin of precipitation. Negative Ce anomalies of some samples are related to input of freshwater during precipitation and subaerial exposure, considering that they show, high concentrations of REE, a flat pattern and tepee structures. Anomalies of positive Eu/Eu^*_{PAAS} (4.19 ± 6.78) indicate performance of hydrothermal processes and are related to recrystallization of limestones and dolomites. Eu anomalies did not show positive correlations with MgO concentrations, suggesting a diagenetic origin for dolomite. Y/Ho ratios (23.9 ± 6.84), Nd/Yb^*_{PAAS} ratios (0.64 ± 0.31) and average REE enrichment indicate a shallow marine environment with freshwater influence during precipitation for all samples. Secondary carbonate phases capable of altering original ΣREE such as glauconite, feldspars, hematite, phosphates, evaporites and pyrite were not verified in petrographic thin sections. Variations in ΣREE (5.68 ppb to 696.18 ppb), Nd/Yb^*_{PAAS} and Ce/Ce^*_{PAAS} show a tendency to shallowing towards silicified direction.

Financing: Federal University of Rio Grande do Sul and Petrobrás.

Testing the MARA craton hypothesis: Isotope geology at the Cerro Uyarani Metamorphic Complex, Bolivia

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The understanding of Precambrian crustal growth towards the assembly of the South American continent has been focused intensely on the evolution of the Amazon craton. The western part of the South American continental crust is mainly composed of volcanic rocks and younger basins related to the Andean Orogeny. However, at least 10 inliers, grouped as the Arequipa terrane, have been identified in southern Peru, western Bolivia, and northern Chile. On the basis of U-Pb in zircon geochronology, Nd T_{DM} ages, $^{87}Sr/^{86}Sr$ ratios, whole-rock chemical compositions, and geological contexts, the existence of a craton, the so-called MARA craton, has been proposed based on an inferred Paleoproterozoic basement of the Maz terrane (Sierra de Pie de Palo and Sierra de Maz). This craton would comprise the Maz, Arequipa, and Rio Apa terranes. This hypothesis postulates that the MARA craton accreted onto the Amazon craton during the San Ignacio orogeny (~1.37-1.34 Ga). Among these inliers, the Cerro Uyarani Metamorphic Complex (CUMC) is the only Precambrian basement that is exposed in western Bolivia. It is one of the best-preserved inliers in the Andean region. The CUMC also has a privileged paleogeographic position between the Amazon craton and the Arequipa terrane, which allows us to test the MARA craton hypothesis with further U-Pb in zircon geochronology. The study of zircon textures and the U-Pb in-situ data by LA-ICP-MS, as well as first the Hf isotope data for samples from three domains in the CUMC (felsic granulites of DI and DII; banded granulites - DIII; and amphibolites - DI), reveal a complex Paleo- to Mesoproterozoic tectono-magmatic evolution of this basement. The oldest event involved crustal reworking at ~1.81-1.74 Ga in a magmatic arc setting. This basement was again reworked during the Mesoproterozoic: firstly during a migmatization event at 1.19-1.17 Ga, and later at ~1.1-1.0 Ga in a high-grade metamorphic event associated with the generation of granulites. For Paleoproterozoic zircon of the CUMC (εHf_T of +6.3 to -0.2), this old basement is similar to the Arequipa-Antofalla basement, the Rio Apa terrane, and the Ventuari-Tapajós and Rio Negro-Juruena provinces and Jauru terrane of SW Amazon craton, all of which show mainly positive εHf values for zircon. Zircon from the Maz terrane of 1.5-0.9 Ga age recorded mainly positive εHf_T values (+18.5 to +0.1), besides negative few ones (-6.9 to -0.2). Paleoproterozoic zircon ages of 2.0-1.7 Ga were also reported for the Maz terrane but there are few Hf data (εHf values of -4.6 to +9.8) to compare. The youngest event registered for the CUMC (~1.2-1.0 Ga) is related to zircon with negative εHf_T values (-15.1 to -2.6). Our data allow us to propose that the CUMC was at the first part of the southernmost portion of the Arequipa terrane from at least ~1.74 Ga. The missing of 1.6-1.3 Ga ages for the CUMC of an important event for the Amazon craton and the Paraguá terrane, we believe that the CUMC basement became attached to the Paraguá terrane and Amazon craton only at 1.19-1.17 Ga. This collision generated migmatites. Then, with beginning of Laurentia´s passing through the Arequipa terrane front (while the CUMC was at the Arequipa terrane border), the conditions of metamorphism in the CUMC basement were raised to granulite facies at ~1.10-1.00 Ga. The Paleo- to Mesoproterozoic history of the CUMC is, thus, similar to that of the Arequipa and Rio Apa terranes, SW Amazon craton, and other Grenville-age inliers but distinct from the metasedimentary basement of the Sierra de Maz and Pie de Palo. This metasedimentary basement, until now, has a widely unresolved, complex history hypothetically linked with Mesoproterozoic and Ordovician reactivations episodes. Thus, the existence of the so-called MARA craton, allegedly composed of the Maz terrane, Arequipa terrane, including the CUMC, and the Rio Apa terrane, must be re-evaluated.

Financing: Financial support was provided by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brazil (CAPES) – under Finance Code 001, CNPq fellowship (309878/2019-5) and FAP-DF.

Boron and lithium isotopes as tracers of fluid-rock interaction and magmatic contribution in thermal fluids of the Southern Volcanic Zone

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In the Southern Volcanic Zone of Chile (SVZ, 33-46ºS) the interaction between regional fault systems and volcanic centers creates the conditions to form high enthalpy geothermal systems. The objective of this work is to understand the control that tectono-volcanic associations have on hydrogeochemical processes (e.g., water mixing and water-rock interaction) recorded on B and Li isotopic evolution. We selected two hydrothermal systems in contrasting tectono-volcanic domains: (1) Alpehue, located in a NE-elongated stratovolcano, likely related to NE-striking basement faults, which are favorably orientated for shear and extension, and (2) Puyehue-Cordón Caulle, located in a NW-trending volcano-tectonic domain, which is built over faults that promote the development of crustal magma reservoirs. We used a combination of geochemical and isotopic methods, including major and trace-element concentration, and stable isotopes of lithium ($\delta^{7}Li$) and boron ($\delta^{11}B$) in a set of samples from thermal emissions, meteoric waters and volcanic rocks. We analyze the potential sources of dissolved boron and lithium, and the hydrogeochemical processes that control their behavior in the systems. At Alpehue, the geothermal fluids exhibit homogeneous isotopic compositions of lithium and boron ($\delta^{7}Li \approx +0.5‰$, $\delta^{11}B \approx -3.3‰$) that closely approximate to those in volcanic rocks ($\delta^{7}Li = +1.39‰$, $\delta^{11}B = -2.2‰$), suggesting that the geothermal fluids could be acquiring these cations from the host rock during water-rock interaction at high temperatures. The chemical and isotopic composition data at Puyehue-Cordón Caulle indicate that the signal varies inside the large-scale volcanic system: at the steam-heated zone, composed by high temperature features (fumaroles and mud pools) and affected by argillic alteration, waters have a boron isotopic signal similar to that of the altered rocks in the area ($\delta^{11}B \approx +15‰$), while in lithium there is a much lighter isotopic composition ($\delta^{7}Li \approx -2.0‰$) that is close to neither that from rocks in the area nor that from the meteoric water. Contrastingly, at the periphery of the system, where surface features are bicarbonate mid-temperature springs ($T \sim 50°C$), geothermal fluids have an isotopic signal similar to those from volcanic rocks ($\delta^{7}Li \approx +5.9‰$; $\delta^{11}B \approx -2.2‰$) but with very low concentrations due to mixing with cold meteoric waters, suggesting that the isotopic signal in these fluids records equilibrium with deeper and neutral geothermal reservoir. The results are consistent with a model where the geothermal water acquires the isotopic signal from the host rocks of the systems, and from magmatic vapors related to each volcano. While in Alpehue the waters are close to equilibrium with the rocks in the geothermal reservoir, in Puyehue-Cordón Caulle there are probably two reservoirs with different isotopic signals; in the steam-heated area, acid-sulfate fluids dissolve the altered volcanic rocks and acquire their boron isotopic composition ($\delta^{11}B \approx +15‰$), while lithium comes mainly from magmatic vapors heating the aquifer ($\delta^{7}Li \approx -2.0‰$). In the peripheral springs of the system, the dissolved lithium and boron in the thermal water come from the geothermal reservoir and are found in low concentrations due to mixing of the springs with Li-B-free meteoric waters. The multi-isotopic analysis allowed us to determine that the structural and magmatic context in which the geothermal systems of the SVZ are located control the chemical composition of the geothermal water, conditioning factors such as the degree of water-rock interaction and the contribution of magmatic fluids.

Financing: FONDECYT-1201219 "The optimal geological conditions that form high entalphy, metal-rich hydrothermal systems in the Andes: Thermodynamic and mechanical numerical approach."

Origin of magmatic and geothermal fluids: a noble gas isotopic study by fluid inclusions from Tolhuaca volcano, Chilean Andes

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Several volcanic systems along the South American Volcanic Zone (SAVZ) are susceptible to erupt having evidence of volcanic activity by degassing and active hydrothermal systems. Improving monitoring strategies to understand the eruptive and degassing behaviors is a key challenge for petrologists and volcanologists to face geohazards. In this study we use the noble gas isotopic signature of fluid inclusions (FI) because such isotopes represent a telegraph on the origin of magmatic fluids, and therefore can complement traditional techniques for sampling and monitoring volcanic gases. The FI chemical signature trapped in minerals in volcanic rocks helps interpret fluctuations in the surface gas signature in response to changes in volcanic activity and interaction with surface hydrothermal fluids in the crust. We choose the Tolhuaca volcano because has Holocene records of explosive eruptions, with less fumarole activity to date, which draws attention to the contribution to geothermal energy. This volcano is also close to populated areas in the vicinity of the Chile-Argentina border (Melipeuco, Curacautin, Los Angeles, Temuco), making it relevant for the study of geohazards. In Tolhuaca, minor volcanic centers located on the NW flank were investigated (Cordón Fisural, Cono Canción), then on its SW flank (Cono Colli, Caracol).

Analysis of the ratios of isotopic noble gases (helium, neon, argon) in FI from mafic minerals was used to determine the isotopic signature of the most primitive fluids per unit of volcanic rocks. These rocks are restricted to basaltic andesites and andesitic basalts compositions according to the major element contents from our bulk rock analyses. Helium isotopes (^{3}He and ^{4}He) and ^{20}Ne were measured separately by two different split flight tube mass spectrometers (Helix SFT-Thermo). The analytical uncertainty of the isotopic ratio of He is generally <11%. Argon isotopes (^{36}Ar, ^{38}Ar and ^{40}Ar) were analyzed using a multi-collector mass spectrometer (GVI Argus), with analytical uncertainty generally <1.5%. Mainly, using $^{3}He/^{4}He$ ratios with air corrections (Rc/Ra), it is possible to verify if each eruptive sequence is fed by the same parent magmatic fluid ($^{3}He/^{4}He$ = 8 ± 1 for the parental mantle-MORB signature). For Cordón Fisural, Cono Canción, and Cono Caracol, these respectively have the following Rc/Ra ratios; 6.28-8.16,6.4, 6.56.

After a data quality check and a comparison with previous measurements of hydrothermal vent sites in the SAVZ, we constrained a Rc/Ra magmatic signature of 8.16 Ra for Tolhuaca, within the MORB range (8±1Ra), which represents fluids connected to the mantle origin in a volcanic arc. Our results on the $^{3}He/^{4}He$ differences, show variations in degassing during Holocene magmatic ascent, although this might also indicate an addition of radiogenic ^{4}He due to the variable crust thickness and host rock lithology. For the later, our isotopic data from FIs and petrologic characterization contributes to a better understanding of the petrogenetic influence on magmatic fluid chemistry that were produced during several volcanic events at Tolhuaca. It also confirms the magmatic origin of the fluids for which we presume are transferred and mixed in the water from geothermal reservoirs located below Tolhuaca, at least since Holocene.

Financing: Project 11190846 Fondecyt Iniciación to Philippe Robidoux. ANID-FONDAP project "Andean Geothermal Center of Excellence" (CEGA 15090013 – 15200001 and ACE210005).

Sr Isotope analysis of Apatite using the SHRIMP at IG-USP

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In situ Sr isotopic analysis of apatite mineral were analyzed by SHRIMP at Geoscience Institute - São Paulo University-Brazil to have an apatite substandard. For comparison, two crystals were analyzed: one of hydrothermal origin (AP-BR) and another from Belo Horizonte (AP-BH). Apatite AP-BR is blue-green and has a 3cm x 2cm tabular shape. AP-BH has a caramel color and is a hexagonal prism with size 2x3cm. Both samples are relatively homogeneous and have very few inclusions.

SHRIMP analytical conditions were: primary beam = 3ηA, spot size = 30μm. A post-ESA slit was used to give resolution greater than 4500: this excludes double charge interferences from rare earth elements on Sr isotopes and also separates the isobaric complex $^{40}Ca^{31}P^{16}O$ from ^{87}Sr. Ca dimers, such as $^{40}Ca^{44}Ca$ (m=84), $^{42}Ca^{42}Ca$ (m=84), $^{40}Ca^{46}Ca$ (m=86) $^{42}Ca^{44}Ca$ (m=86), etc., were corrected by monitoring $^{40}Ca^{40}Ca$ and $^{40}Ca^{42}Ca$ and ^{87}Rb interference on ^{87}Sr was corrected by measuring ^{85}Rb. Presence of $^{40}Ca^{40}Ca$ and $^{42}Ca^{40}Ca$ indicates that they will have Ca molecular interferences in the Sr and Rb isotopes. $^{87}Sr/^{86}Sr$ ratios were normalized to $^{86}Sr/^{88}Sr$=0.1194.

The mean $^{87}Sr/^{86}Sr$ ratio from 10 analyses of AP-BR was 0.72824 ± 0.00073 (2s) and 8 analyses of AP-BH gave an average value of 0.70926 ± 0.00055 (2s). These values are very close to those obtained by TIMS analysis using a TRITON at IG-USP, which gave $^{87}Sr/^{86}Sr$ ratios of 0.728216 ± 0.000016 (2s) for AP-BR and 0.709244 ± 0.000007 (2s) for AP-BH. The analytical errors of the SHRIMP results are higher than TIMS because measurements are made in peak jump mode as opposed to multi-collection. The Sr concentrations found for these apatites using the NIST610 standard were: AP-BR = 474 ± 24 ppm and AP-BH = 492 ± 55 ppm (2 sigma errors). Rb was detected but contents were practically negligible.

Highlights: The $^{87}Sr/^{86}Sr$ of AP-BR is high (0.72824) with a Rb content less than 1ppm and uranium content around 10ppm yielding SHRIMP $^{206}Pb/^{238}U$ age of ~1.0Ga and the analysed mineral is homogeneous throughout its entire area (10000x10000μm). For the AP-BH sample, the $^{87}Sr/^{86}Sr$ ratio (0.709244) is very close to sea water composition, also with very low Rb and U contents (<0.5ppm) and the $^{206}Pb/^{238}U$ SHRIMP age is estimated around 0.5 Ga to 0.2 Ga. The homogeneity of both apatite crystals suggests that they could be used as a potential standards in the future. Interferences on Sr isotopes measurements in apatite are correctable with mass resolution (MR) around 4500 - 5000, but for silicate minerals need MR > 10.000. Si molecular combinations with other elements such as Fe can cause a lot of problems at Sr isotopes (for example,$^{28}Si^{56}Fe$= 84,$^{32}Si^{54}Fe$= 86, etc).

Financing: CNPq - Conselho Nacional de Desenvolvimento Científico e Pesquisa - Bolsa de PQ.

Understanding tectonic and upper plate controls on plutonic and dyke-emplacement in the southern Colombian Andes

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The Northern Andes is a cordilleran orogen formed by multiple phases of deformation that occurred between the Cretaceous and the Pliocene. The pre-compressional evolution of this orogen includes the Permian and the Jurassic phases of subduction with associated arc magmatism. Cretaceous to Cenozoic deformation phases have been interpreted as responsible for extensive erosion, uplift, block rotation, and dextral strike-slip displacements, which have hindered precise reconstructions of pre-Andean tectono-magmatic settings. Although Permian to Jurassic reconstructions have been done based on large regional geochemical and geochronological data sets from plutonic rocks, the structural and tectono-magmatic settings are still an open research question.

Cenozoic exhumation has exposed deep structural levels of the Permian to Jurassic magmatic arcs, including the unroofing of large plutonic bodies and the associated dyke swarms in south-central Colombia. These exposures present a major opportunity to understand the structural disposition of these rocks during the magma emplacement and the role that basement inherited structures have on the tectonic history of this region.

As a part of a current project funded by Minciencias which aims to understand the tectono-structural evolution of the crystalline basement in southern Colombia, we have performed a multi-technique structural analysis that includes a regional lineament analysis; field structural measurements of magmatic foliations and fractures; U-Pb zircon geochronology; and AMS analysis. The study area comprises two temporally distinct plutonic rocks: (1) the Permian La Plata Granite composed of a leucocratic massive to strongly foliated hornblende-biotite monzogranite with medium to coarse-grained and inequigranular texture, and (2) the Jurassic Páez Massif which consist of a predominant mesocratic slightly foliated hornblende quartz monzodiorite of medium-grained and equi- to inequigranular texture. These rocks are cross-cutting by several melanocratic pyroxene-biotite dolerite and hornblende-pyroxene monzonite dykes.

Regional-scale lineament analysis using a digital elevation model combined with fieldwork reveals two predominant directions of structural lineaments in the study area: (i) one in the NE-SW orientation that is subparallel to magmatic foliations observed in both the plutonic units and sub-parallel to regional Andean faults, and (ii) the other in the NW-SE which is concordant to fractures and the dominant orientation of the dykes.

New zircon U-Pb LA-ICP-MS results of four samples from the studied rocks confirm their Permian and Jurassic ages: ~270 Ma for the La Plata monzogranite, ~186 Ma for the Paéz quartz monzodiorite and ~182 Ma for a dolerite dyke intruding the latter pluton. These ages overlap former zircon crystallization age intervals for the plutonic units of 277-268 Ma and 193-180 Ma obtained by the same technique.

AMS measurements from the plutonic rocks reveal mainly oblate magnetic fabrics with NE-striking, consistent with the magmatic foliations and the adjacent Andean faults while the sub-vertical dykes with mostly striking NW-SE, indicate an oblique component relative to the main plutonic host rock fabrics.

Our preliminary results indicate the existence of strong structural controls during the emplacement of the Permian and Jurassic plutons and the latter intrusion of the dykes on these rocks. Magmatic fabrics suggest that strike-slip tectonics play a major role during magma emplacement. Additionally, several structures subparallel to the Permian and Jurassic magnetic and magmatic fabrics were reactivated during the Cenozoic deformation phases, evidencing a first-order control of the upper plate inhomogeneities on the construction of the Andes.

Financing: Project funding by the Colombian agents MinCiencias (Ministerio de Ciencias) and ANH (Agencia Nacional de Hidrocarburos). Process 877-2020. No. Project: 111887780671.

First zircon provenance analysis of suevite matrix from the Araguainha impact structure, Brazil

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The Araguainha impact structure (AIS) offers a stratigraphic window into the sedimentary sequences and the basement of the Paraná Basin in central Brazil. The structure is 40 km in diameter and was formed at ~254 Ma, close to the time of the Permian-Triassic boundary. The AIS central uplift is ~12 km wide. The core comprises porphyritic granite intruded into metasedimentary sequences assigned to the Cuiabá Group linked with the evolution of the Neoproterozoic Paraguay Belt. This basement is surrounded by a belt of polymict impact breccias (PIB), intercalated with impact melt rocks (IMR), and strata from the lowermost sequences of the Paraná Basin: Rio Ivaí Group (Ordovician-Silurian) and Furnas and Ponta Grossa formations (Devonian). PIB is well exposed in the AIS central uplift. It has been shown to be composed of a particulate matrix containing a heterogeneous population of lithic and mineral clasts, and cogenetic melt particles, and, thus, represents a so-called suevite. Field study has indicated that the PIB contains large clasts from the basement, mainly phyllite – some with evidence of contact metamorphism against the alkali granite – as well as metasandstone and metapelite. Quartz pebbles, conglomerates, sandstones, and pelites are derived from Rio Ivaí, Furnas, and Ponta Grossa sources and are also abundant as clasts. In order to determine the maximum grade of shock metamorphism registered by components of the suevite, and track the main units that provided the clast material and correlate them with regional stratigraphy, zircon age provenance studies are being conducted on selected suevite samples. Two samples from the northern and from the southern part of the central uplift, respectively P-3 (16°48'9.83"S/53°00'2.93"W) and SF-04 (16°49'55.47"S/52°59'43.47"W). Zircon grains are transparent and range in size to 200 µm. Most of them are rounded to subrounded, but some show elongated and prismatic habits. Erosive features were observed by BSE study on exterior surfaces. Internally, magmatic zonation, metamorphic overgrowths, and/or inherited cores were recognized by CL analysis. Granular texture and planar shock features of zircon grains are relatively rare (9% from P-03 and 2% from SF-04). These features, together with planar fractures and planar deformation features in quartz grains observed by optical microscopic analysis, indicate maximum shock pressures of the PIB clastic components of ~30 GPa. The presence of impact-melt particles does testify to significantly higher shock pressures (>45 GPa). 88 concordant U-Pb isotope data were obtained at the Geochronology Laboratory of the University of Brasilia with a LA-MC-ICP-MS Thermo Finnigan instrument coupled with a New Wave 213 µm laser. The results, together with published data for the basement and the lower stratigraphy of the Paraná Basin, were analyzed by multidimensional scaling (MDS) and kernel density estimation (KDE). Both suevite samples show a bimodal age population with the main peak at ~640 Ma and a second peak at 2000-2500 Ma. The MDS and KDE plots indicate that the provenance for the two suevite samples is similar to the zircon age populations for the lower units of the Paraná Basin, specifically for the Furnas Formation. It differs significantly of samples from Cuiabá Group. Based on these first provenance results, it appears that our field observations that initially favored a strong contribution of clastic material from the Cuiabá Group, need to be considered with caution. These new results are in agreement with the abundant quartzo-feldspathic, felsic sandy character of the suevite matrix. Clearly, our provenance studies need to be extended statistically. These results will be very useful in determining how deep the transient cavity at AIS was excavated, and how deep the projectile may have penetrated into the target. Moreover, the results will contribute modeling of the cratering processes related to the formation of the Araguainha impact structure.

Financing: CAPES, FAPDF, CNPq (406256/2018-7, 309878/2019-5, 305761/2019-6), Barringer Family Fund for Meteorite Impact Research.

New fragment of Siderian continental crust in the Rio Grande do Norte Terrane, Borborema Province, NE - Brazil

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The range of U-Pb zircon age that occurs between ~ 2.45 e 2.22 Ga, transition from Archean to Paleoproterozoic, represents for some the longest break in crust addition of the entire Proterozoic: both with regard to the magmatic record, as well as the abundance of detrital zircon grains. This period became known as the siderian quiet interval and, for a long time, was interpreted as being the product of a kind of tectonic shutdown; in which, a prolonged acquiescence of tectonic plates would be the product of a generalized lithospheric stagnation. The idea of a total tectonic disconnection came to be widely questioned as new siderian fragments began to be discovered and better studied, mainly in an isotopic form. In this scenario, the Borborema Province, Northeast Brazil, formed by the convergence of the São Luis-Oeste Africano and São Francisco Congo cratons during the assembly of Western Gondwana, *c.* 600 Ma, may represent an important piece in the puzzle of the world paleoproterozoic models. The northeast portion of Borborema, called the Rio Grande do Norte terrain (TRGN), consists of a series of basement inliers, calc-alkaline graniteoids often described with ages predominantly between 2.1 to 2.2 Ga, surrounded by Neoproterozoic fold belts. However, in this work, we present new systematic Sm-Nd isotope and U-Pb geochronological data that effectively demonstrate that the basement of the region is also composed of siderian rocks, *c.* 100 to 200 Ma older than the calc-alkaline granitoids often described in the area. The Santa Luzia volcano-sedimentary sequence is composed of tholeiitic amphibolites (andesites and basalts), with calc-silicate gneisses, banded iron formations (BIFs) and hornblendite bodies. Absolute ages for rocks in this sequence range from 2.5 to 2.3 Ga.; while the T_{DM} model ages are between 2.9 and 2.3 Ga and negative to positive εNd(t) values, which characterize cyclical periods of juvenile crustal growth and reworking in this region. The integration of these data demonstrates that the operation of tectonic plates remained uninterrupted throughout the transition from Archean to Paleoproterozoic in the studied region.

Financing: Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPQ) Universidade Brasília (UnB).

Stable water isotope evidence from Aparejo catchment, central Chile: insights of a collapsed glacier's dynamics

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The catastrophic detachment of Aparejo Glacier, central Chile, which took place on March 1st 1980, resulted in the removal of an ice volume of 7.2 Mm^3, 85% of the total volume of the glacier. The event obliterated most of the glacier and caused geomorphological changes down valley. 35 years after the event, new evidence shows the existence of a small glacier preserved within the same basin in the Aparejo Valley, with an estimated volume equivalent to 15% of the original glacier prior its collapse. To clarify the process that led to the Aparejo Glacier current state, a water mix model was established through the analysis of 26 samples of stable water isotopes of glacial ice, including two samples from neighboring Glacier 51 (which didn't collapse in the 1980 event), snow cover of Aparejo Glacier, frozen water from a stream in front of the latter and a stream water down valley, all within Aparejo catchment. Analyses were performed at the Isotope Analysis Laboratory, Andrés Bello University, Viña del Mar, Chile. In order to establish the $^{18}O/^{16}O$ and H/D ratios of the aliquots, samples were filtered using 0.2 µm cellulose filters and analyzed by OA-ICOS methodology using a LGR TLWIA-45EP isotope analyzer. Results were normalized to the V-SMOW–SLAP scale, according to the δ scale. The most depleted values of δD and $\delta^{18}O$ were observed in samples from Glacier 51, whereas the less depleted values were found on water samples collected downstream. No relationship of water isotope composition and altitude was observed. All collected samples plotted near the GMWL. Three clusters of samples were recognizable from more depleted to more enriched values: those from Glacier 51, the ones from the stream and those obtained at the Aparejo Glacier. The stream water's isotopic signature could be the result of the mix between both glaciers meltwater. The fact that the stable isotopic signature of Aparejo ice closely resembles that of the sampled snow above the glacier suggests that its temporal scale and air temperature condition at the deposition time were similar. Contrastingly, a clear difference is found for Glacier 51's ice close to its front, showing more depleted values. Thus, suggesting the presence of older ice. We can conclude based on the stable water isotope composition that Aparejo ice is younger than the one of Glacier 51, supporting the idea that Aparejo Glacier's dynamics allowed it to a restoration process, leading to the full occupation of its former basin.

Financing: This work was funded by Geoestudios Asesores S.A. with the support of the Isotopic Analysis Laboratory (LAI), Universidad Andrés Bello, Viña del Mar, Chile.

SPECIAL SESSION

The Rio de la Plata Craton and its importance for the amalgamation of West Gondwana

Whole-rock Nd-Sr and zircon Hf-O systematics on the inner units of the Eastern Paraguay Belt: Insights on the sedimentary provenance and orogenic-controlled sedimentation

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The Neoproterozoic Brasília and Paraguay orogenic belts are part of the Tocantins Province, a diachronic orogenic system developed during the Brasiliano-Pan African events as part of the Western Gondwana building process. The Brasília Orogen resulted from long-lasting subduction-collision events between São Francisco, Amazonian, and Paranapanema paleoplates. It comprises the volcano-sedimentary Bom Jardim de Goiás (BJG) sequence that makes contact with the Paraguay Belt. The Paraguay Belt is represented by metasedimentary units related to glacial-carbonate-like passive continental margin deposits, followed by the external and internal Glaciomarine (GU) and Foreland (FU) units, with granitic intrusions and volcano-sedimentary of the Nova Xavantina Sequence (NX), all at nonconformity above the Amazonas and Rio Apa cratons.

The BJG metasedimentary rocks have a detrital zircon age pattern restrict to the Paleoproterozoic, with an orthogneiss sample indicating a magmatic event around 0.68-0.67 Ga ($U\text{-}Pb_{Zrc}$). Zircons from both lithotypes point to more evolved crustal sources ($\delta^{18}O$=6-11‰; negative εHf_t). Tuffs of the NX have contribution of Paleoprotezoic, Mesoproterozoic and Neoproterozoic detritus, with the youngest age group setting the volcanic activity at 0.71 Ga. Hf-O data suggest a mantle-derived source for the Neoproterozoic and Mesoproterozoic zircons ($\delta^{18}O$=4-6‰; positive εHf_t). Metarenites of the same sequence confirms the maximum depositional age at around 0.69 Ga. The detrital zircons of the GU has mixed to more evolved isotopic signatures (high $\delta^{18}O$; negative εHf_t), with prevalence of Mesoproterozoic over Paleoproterozoic and Neoproterozoic detritus and maximum depositional age around 0.98-0.86 Ga. The FU has main contribution of Neoproterozoic detritus, with subordinate Mesoproterozoic and Paleoproterozoic detrital zircons and maximum depositional age around 0.59-0.53 Ga. Metasedimentary rocks suggest contribution varying from depleted mantle-derived to more evolved supracrustal sources ($\delta^{18}O$=3-8‰; negative to slightly negative εHf_t), with an orthogneiss presenting a wide range of εHf_t values (-15 to 3) with consistent low $\delta^{18}O$ values ($\delta^{18}O$=3-6‰).

Sr-Nd isotopic data of the BJG sequence suggests active margin and fore-arc environments of deposition (metavolcanic rocks: $\varepsilon Nd_{0.75\ Ga}$= -4.7 to 4.3; NdT_{DM}=1.8-1.0 Ga; tuffs: $\varepsilon Nd_{0.75\ Ga}$= 3.3 to 5.6; NdT_{DM}=1.1-0.9 Ga; $^{87}Sr/^{86}Sr$<0.71), with prominent mafic components for the volcanic rocks (Th/Sc<0.1) and more evolved features for the tuffs (Th/Sc around 1.0). NX sequence data suggests a back-arc environment of deposition, with mafic and upper crust components ($\varepsilon Nd_{0.75\ Ga}$= -12.5 to -10.2; NdT_{DM}=2.3-2.1 Ga; $^{87}Sr/^{86}Sr_{volcanic\ rocks}$<0.71; $^{87}Sr/^{86}Sr_{tuff}$ around 0.72). The GU presents a more scattered pattern, pointing to a passive margin environment (εNd_t= -9.3 to -4.0; NdT_{DM}=2.1-1.6 Ga), while the inner FU has a well-marked trend consistent with deposition in an active margin environment (εNd_t= -4.0 to 7.8; NdT_{DM}=1.8-1.4 Ga; $^{87}Sr/^{86}Sr$=0.71-0.73).

The reported data suggest that the Brasília Orogen possibly controlled the volcanic activity and sedimentation of the NX sequence, with the rising of the Goiás Magmatic Arc. The volcanism likely resulted from the Paranapanema paleoplate thinning crust in a back-arc setting. The inherited and detrital zircon U-Pb data evinces the presence of a Rhyacian basement. As the rift in the back-arc became prominent, the GU deposition took place in the Amazonian and Rio Apa edges. It registers a main Mesoproterozoic source-area, which is found mainly in the Amazonian Craton, with the influence of Paleoproterozoic sources, possibly derivate from the Rio Apa Block. The inner FU, with maximum depositional age of 0.56 Ga, represents the syn-tectonic erosion of the uplifted Goiás Magmatic Arc and internal granites from Paraguay-Pampean Belt that advanced towards the Amazonian Craton during the passive margin inversion.

Financing: FAPESP nº 2017/18174-6

Analysis of the isotopic behaviour of $\delta^{13}C$ and $\delta^{18}O$ of the San Miguel skarn, in the Paleoproterozoic basement of the Tandilia System, Río de la Plata Craton

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Stable isotope studies of $\delta^{13}C$ and $\delta^{18}O$ have become a powerful tool for the identification of fluid- and carbon sources and also for the characterization of fluid-rock interactions in metasomatic processes (1). Metasomatism in skarn formation is a typical example of such interaction.

The San Miguel skarn (SMs), Paleoproterozoic basement of the Tandilia Belt, Río de la Plata Craton, has a LA-ICP-MS U-Pb titanita age of 2206 Ma (2). Despite presenting metamorphism in amphibolite facies, 642 to 654 C°, the SMs marble records the positive $\delta^{13}C$ anomaly of the "Lomagundi-Jatuli Event" (LJE) (2).

New data on $\delta^{13}C_{(V\text{-}PDB)}$ and $\delta^{18}O_{(SMOW)}$ from marble Cc, and $\delta^{18}O_{(SMOW)}$ from siliceous intrusion minerals (Qtz and Pl) along with those from marble, exo and endoskarn, previously obtained (2), allowed an isotopic characterization of the metasomatic processes occurred in the SMs to be completed.

Marble and exoskarn Cc crystals show a $\delta^{13}C_{(V\text{-}PDB)}$ and $\delta^{18}O_{(SMOW)}$ variation range of +3.08‰ to +7.01‰ and +12.49 to +17.12‰, respectively. The lowest values correspond to the endo-exoskarn contact zone while the highest ones to the upper part of the marble sequence and to the metasomatic front furthest sectors. The exoskarn has the most enriched $\delta^{18}O_{(SMOW)}$ contents (Ves +10.2‰ and Wo and Di +9‰) while the endoskarn registered the most depleted ones (Grs +8‰ and Di +9‰). Besides, Pl and Qtz from the siliceous source have $\delta^{18}O_{(SMOW)}$ values of +9.9‰ and +10.1‰, respectively.

The variation of $\delta^{13}C$ involved isotopic fractionation during metasomatic and metamorphic processes and the rising in ^{13}C values during the beginning of the LJE (2).

Replacement of the $\delta^{18}O$-enriched carbonate host rock by skarn silicates is accompanied by a ^{18}O depletion in the skarn to values that reach an exchange equilibrium with the adjacent siliceous intrusion. So, the variation range of $\delta^{18}O$ of the SMs minerals was generated by an isothermal flow with hydrodynamic dispersion (1). Moreover, (3) showed that the $\delta^{18}O$ values of early-stage skarn silicates are equal or enriched compared to those of the adjacent intrusion. Thus, the $\delta^{18}O$ of Pl and Qtz values are similar to those of Wo, Ves and Di, which are the early minerals crystalized in the exoskarn (4), matching with the +9.35‰ $\delta^{18}O$ estimated by empirical methods for the fluid source of SMs. The lowest $\delta^{18}O$ values of the Grs could indicate a second stage of aqueous fluid ingress, also considering the pseudomorphic replacement of this mineral by Zo.

Finally, the $\delta^{13}C$ and $\delta^{18}O$ isotopic composition of skarn minerals constitutes an effective tool to determine the advance direction of the metasomatic front, especially in geological environments where deformation and metamorphism could have obliterated field evidence of this process.

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Financing: This study was supported by the CONICET, the CICpBA, and the Universidad Nacional de La Plata.

Field Trip: One-Day Cross-Section to the Andes East of Santiago

Guided by Dr. Reynaldo Charrier, Sociedad Geológica de Chile

July 7, 2022

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