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EDITORIAL

From Proterozoic tectonics to Quaternary climate variability: Earth system science studies in Latin America

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Collaborative research projects between German and Latin-American scientists in the Earth sciences have a long tradition. With the aim to disseminate joint research results and to foster collaboration, the Latin-American Colloquium was established in 1972. Over the years, the Colloquium has advanced as an important international venue to showcase collaborative projects supported chiefly by the German Science Foundation, the German Academic Exchange Service, the Alexander von Humboldt Foundation and Germany's Federal Ministry of Science and Technology. In light of the pivotal role of the geosciences to tackle numerous environmental and associated societal challenges, the 25th Latin-American Colloquium, held in Hamburg from September 18–21, 2019, embraced an Earth System Science format addressing individual components and interactions of the Earth System.

The holistic scientific approach of understanding causes and effects within System Earth, including the feedback mechanisms between geological processes, environmental change and human activity, reverts to Alexander von Humboldt and is the focus of the Earth sciences of Universität Hamburg. It was, therefore, not less than a fitting opportunity to also celebrate at the Colloquium von Humboldt's 250th birthday and the 100th anniversary of Universität Hamburg. Following von Humboldt's intellectual spirit, the Latin-American Colloquium promoted interdisciplinary thinking and showcased the results of new research alliances in the fields of marine geology, geophysics, structural geology, paleontology, mineralogy, sedimentology, exploration geology, impact geology, as well as paleoclimate and paleo-environmental studies. The participation of the largest German–Latin-American collaborative research initiatives, notably the Integrated Plate Boundary Observatory Chile (IPOC), the International Research Training Group StRATEGy on Andean foreland processes and the Priority Programmes 527 and 1006 of the German Science Foundation (DFG), International Ocean Discovery Programme (IODP), and the International Continental Drilling Programme (ICDP), respectively, added significantly to the conference profile.

The Special Issue of International Journal of Earth Sciences features a selection of scientific contributions presented at the 25th Latin-American Colloquium. According to the Earth System Science format of the Colloquium, the contributions embrace a large temporal and topical spectrum of geological processes and their effects on the individual components of the Earth System. More specifically, the processes address intraplate and plate boundary dynamics related to the architecture of Gondwana and the Cenozoic Andes as well as paleo-environmental, exploration and impact geological studies. The scientific highlights of the contributions, listed consecutively below, are delineated as follows:

In their most detailed reconstruction of the P-T-D-t path of 2.1 Ga metagranite from the Paleoproterozoic Tandilia Belt of the Río del la Plata Craton, Angeletti et al. document slow exhumation of rocks from a depth of 22 km. Metagranite cooled first isobarically at the end of the collisional Camboriu orogeny before being uplifted to shallow crustal level at about 1.9 Ga, while being mylonitized as a consequence of horizontal shorting. The study highlights significant differences in the style of Mesoproterozoic exhumation of the Tandilia Belt with regard to modern collisional orogens.

Vazquez Lucero et al. and Gomez Dacal et al. address large-scale intracontinental uplift of the lithosphere and

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its consequences for topography, based on 3-D gravity and thermal modelling, respectively. Vazquez Lucero et al. conclude that the formation of large intracontinental basins and ranges of the southernmost part of the Río de la Plata Craton are strongly influenced by structural and lithological heterogeneities during uplift. The authors also redefine the southern boundary of the Río de la Plata Craton. Rather than structural heterogeneity, Gomez Dacal et al. advocate a lithosphere-scale thermal anomaly, caused by heating of the mantle during the Paleogene, for the existence of the North Patagonian Massif, a continental plateau with an average elevation of 1200 m above sea level. Their study raises issues as to the causes for the apparent longevity of giant thermal and associated topographic anomalies within continents.

The studies by Rodriguez Piceda et al. and Barrionuevo et al., both based on multiple geophysical and geological data sets, focus on the structure of the continental lithosphere of the eastern Andean foreland and its influence on the deformation style of the Southern Central Andes. Rodriguez Piceda et al. emphasize the influence of pre-Andean lithological variations on the long-term tectono-magmatic evolution, short-term deformation patterns, coupling of the upper and the lower plate, and on the dip of the subducting slab. Geodynamic modelling by Barrionuevo et al. highlights the importance of the lithosphere-asthenosphere boundary as a first-order structural control on the polarity of evolving crustal-scale thrusts. Moreover, the composition of upper and lower crust, i.e., mafic versus felsic, also influences crustal-scale structural geometries and deformation patterns. The resulting models are characterized chiefly by first-order, east-verging thrusts, which challenge hypotheses of bivergent thrust systems to account for deformation and uplift of the Southern Central Andes.

In keeping with tectonics of the Southern Andes, Göllner et al. explore the mechanism of kinematic partitioning of deformation caused by oblique plate convergence. New lineament and compiled thermochronology data call into question the traditional concept of kinematic partitioning in the Southern Andes, in which strike-slip is focussed on the Liquiñe-Ofqui Fault Zone. Revision of the concept points to transverse shortening and margin-parallel displacement of crust as a consequence of orogen-scale transpression, superseded by the development of the Liquiñe-Ofqui Fault Zone at a very late stage in the evolution of the orogen.

Petrinovic et al. conclude the contributions on Andean tectonics by providing the community with a long overdue review on the geodynamic factors controlling collapse caldera formation in the Andes. The authors recognise systematic differences between collapse calderas from the Central Andes and those from the Southern Andes. Slab anchoring in the lower mantle, maturity of the subduction zone, crustal thickness, regional deformation regime, pre-caldera structures, magma flux, and the type of heat flow anomalies are identified as important factors controlling the evolution of collapse calderas.

Ramírez-Fernández et al., Tazzo-Rangel et al. and Demartis et al. address petrologic, geochronological, geochemical and structural aspects of Gondwana margin tectonics. Ramírez-Fernández et al. start off this topic by illuminating the pre-Mesozoic geological history of the NW-margin of Gondwana exposed in NE-Mexico. Based on the correlation with other Carboniferous–Early Permian magmatic complexes in Mexico and Central America, the authors suggest that the Aserradero Rhyolite, a lithological unit they studied in detail, formed as part of a pre-collisional peri-Gondwanan volcanic arc. This arc includes the Oaxaquia terrane, the Acatlán Complex, the Maya Block and crystalline basement rocks of the Western Gulf of Mexico. In their study on a distinct Early Mesozoic tectono-thermal event of the Mérida Andes, Venezuela, Tazzo-Rangel et al. continue with the reconstruction of a clockwise P-T path. The authors interpret thermobarometric data in terms of post-orogenic gravitational collapse following oblique collision of Gondwana and Laurentia. They relate this event to high-grade metamorphism in other peri-Gondwanan crustal fragments, such as the Maya Block in México-Central America and the Sierra Nevada de Santa Marta Massif in Colombia. Finally, Demartis et al. report on synkinematic leucogranite and pegmatite bodies from the Sierras de Córdoba, Argentina, i.e., the western margin of Gondwana. The authors provide structural and geochemical evidence for deformation-assisted fluid migration from host rocks into a large shear zone triggering water-fluxed melting. The proposed feedback between deformation, anatexis, magma evolution and mass transfer in the shear zone promises to have far-reaching consequences for our understanding of melt segregation in the lower crust.

Paleo-environmental studies on sedimentary basins located in Central Mexico, the southern Andes and the central Andes are tackled respectively by Martínez-Abarca et al., Hernando et al., and Hinzer et al. Based on high-resolution facies analysis of drill core material from Lake Chalco, Mexico, recovered by the ICDP "MexiDrill Project", Martínez-Abarca et al. propose a four-stage evolutionary model for the lake, which the authors dated at 400 ± 46 ka. The study highlights the transition from alluvial sedimentation to a deep eutrophic lake, influenced by a volcanic event, and the climatic conditions prevailing during lake formation. Similarly, Hernando et al. investigate the sedimentary infill underlying a thick ignimbrite layer covering the floor of the Caviahue depression in the Southern Andean Volcanic zone, Argentina. The origin of this well-defined depression has been discussed most controversially for a long time. Using digital outcrop models, the authors recognize a variety of deltaic and alluvial deposits and discuss evidence for

a purely tectonic origin of the depression as well as for a collapse caldera origin. Hinzer et al. conclude the paleoenvironmental topics with a study on artesian groundwater flow and resulting mud volcano formation from the central Andean Valle de Iglesia, Argentina. The authors present evidence for a genetic relationship between mud volcano and fault activity and identify arsenic concentrations in the analysed spring waters that are higher than the current limit set by the World Health Organisation.

Due to ongoing exploration efforts by the hydrocarbon industry, geological information on prolific oil fields of deep-water offshore basins, such as the Santos and Campos off the coast of Brasil, is limited. The more appreciated are the contributions by Basso et al. and Chinelatto et al. in this regard. Multi-scale petrophysical and petrographic image analyses as well as computer tomography (CT)-scan data by Basso et al. characterize facies and porosity of Cretaceous pre-salt lacustrine carbonate reservoirs. The data are expected to improve hydrocarbon prediction and recovery of these underexplored reservoirs. Similarly, the study by Chinelatto et al. reports on the porosity and permeability of coquina reservoirs with regard to biofabric characteristics and is based on gas injection measurements and high-resolution CT imaging. The authors conclude that the best reservoirs are those formed in high-energy environments and characterized by high dissolution. They also demonstrate that pore network modelling and the use of hydraulic flow units are effective tools to identify and characterize reservoirs.

The Special Issue closes with a contribution by Schulte et al. on the 66 Ma Chicxulub impact crater, Mexico, based on drill core samples of IODP/ICDP expedition 365. The drill core provides a rare opportunity to study the effects of hypervelocity impact of large meteorites into marine depositional environments. Schulte et al. report on the interaction of superheated impact melt with seawater, returning into the crater approximately one hour after the impact. Contact between the two physically most distinct liquids resulted in mingling of two melt phases followed rapidly by their solidification and brecciation.

The guest editors of this Special Issue thank all reviewers for their assessments, which were, without exception, prompt, detailed and constructive. In particular, the editors thank the Editor-In-Chief, Wolf-Christian Dullo, for granting us the opportunity to assemble the selected contributions of the 25th Latin-American Colloquium in a Special Issue of the International Journal of Earth Sciences. We sincerely hope that the community finds the Special Issue beneficial and that it will provoke further interest in conducting geological research in Latin America.

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