

SOTA7: STATE OF THE [CONTINENTAL] ARC



In September 2018, 32 participants from 25 institutions took part in the highest-altitude, State of the Arc (SOTA) meeting yet: SOTA7. Participants spent a week in San Pedro in the Chilean Atacama Desert, situated on top of the world's thickest arc crust. A mixture of keynote, regular, and "pop-up" talks and posters explored the realms of geochemistry, geophysics, experimental petrology, and numerical models to address topics in arc magmatism, such as volcano "personality", the movement of volatiles, compositional evolution, how to match geophysical studies with petrology, and how eruptions are triggered.

There were extensive discussions on the role of the crust. How do magmas interact with the crust, how do magmas transit through the crust, how do magmas modify and are modified by the crust? Whereas in other arcs the mantle inputs are continually being described and constrained in ever-increasing detail, elucidating processes in the mantle remain a challenge in continental arcs such as the Andes. Here, poor constraints exist for how magma is input into the crust and how magma differentiation is controlled by fractionation versus recycling. New approaches that utilize improved temporal records through detailed age dating and volume estimates from high-resolution digital elevation models that integrate heat and mass balance calculations over an entire arcs segment may refine the relative roles. However, until we have more accurate estimates for plutonic–volcanic ratios within individual arcs, in addition to across-arc settings, ambiguous models will persist for crustal growth and recycling.

The discussion converged on the general view that the more we advance our understanding of magmatism at convergent margins, the more difficult it becomes to define end-members. At first glance this could seem rather obvious and discouraging, but, in our opinion, this signals the progressive maturity of geology. Hence, as it has been the case for science in general, the way forward is the integration of multiple approaches to generate consistent and cross-validated datasets on which to build models for magmatism at convergent margins. The single most important base for this development is the collection of the largest possible amount of high-quality data, a pathway that has been delineated by the career effort of the three "Senators of Andean magmatism" who shared with us their knowledge during the SOTA7 meeting: Gerhard Wörner, Suzanne Kay, and Shan de Silva.

A special role at the SOTA7 meeting was given to economic geology, motivated by the exceptional importance of Chilean ore deposits to the world's economies and by the vast amount of data that these extinct systems have provided to our understanding of magma assembly in the crust. The Andes offer a unique opportunity to relate crustal magmatism with tectonic controls, this being most apparent during the generation of porphyry deposits that frequently show a correlation with intersecting large-scale faults. Furthermore, the role of tectonics manifests itself in the longevity of the convergent margin and the progressive eastward stepping of the volcanic arc. The related process of subduction erosion can modify the underlying arc mantle, creating an excellent link to tectonic and geochemical studies.

Highlights of the week were the spectacular fieldtrips, showcasing the area's unrivalled scenery and geology. Participants experienced the giddiness of 4,800 m altitudes when on the daytrip to the Altiplano, which was led by Shan de Silva (Oregon State University, USA), Dale

Burns (Stanford University, California, USA) and assisted by Axel Schmitt (Heidelberg University, Germany). There, participants saw volcanic deposits from the waxing and waning of the La Pacana Volcano supereruption. Later in the week, Felipe Aguilera (Universidad Católica del Norte, Chile) took participants to Lascar Volcano, the most active volcano in the Central Volcanic Zone in western South America, to observe several generations of eruption deposits.

Post-conference fieldtrips gave participants the opportunity to ascend the Lascar stratovolcano and to journey further north into the Andes through a marvelous geological section of the active convergent margin from the Coastal Cordillera to the volcanoes of the Altiplano. The outstanding nature of the exposure and the scale of geological structures, immediately clarified to the participants the reasons why the Central Andes are such an exceptional natural laboratory to study the interaction between magmatism, mountain building processes, and climate. The journey started from the base where participants observed molasse-type sediments that were deposited during a magmatic lull associated with a period of flat-slab subduction. The increased coupling associated with the flat-slab lead to uplift, erosion and the deposition of massive amounts of sediments. This period was followed by the deposition of several large ignimbrites that now constitute the base on which the modern arc volcanoes are built. These processes took place in association with dramatic climatic modifications that led first to aridification and then to hyper-aridification. The remaining portion of the fieldtrip focused on Taapaca and Parinacota Volcanoes.

During the fieldtrip, it became evident that a full understanding of magmatism at convergent margins cannot be achieved with a one-sided approach but must include a broader geological perspective and include not only the impact of geological processes on surface dynamics but also a consideration of the feedbacks of climate on geology. Such a realization was sparked from the discussions with Prof. Gerhard Wörner and his ability to discuss large-scale processes starting from field observations and not-too-busy geochemical diagrams. This capacity requires deeply rooted understanding of geology and should serve as an example for future generation of geologists.

Lastly, the contributions from early career scientists were invaluable. An "early career scientist" day allowed everyone to become part of the family and gave these scientists an opportunity to showcase their research. A lively poster session furthered the involvement of the more junior scientists in the discussion, and such activities added positively to their overall experience. Thus, a new crop of excited "SOTaphiles" is becoming part of the community and will ensure that future SOTA conferences will continue to explore the "state of the arc". Such future SOTAs will have their own flavor as the organizers and locations change and the focus may shift from detailed discussion about the mantle wedge, which for example dominated the discussion of the Santorini SOTA, to the role of the crust as was extensively discussed in this Central Andes SOTA.

Further information on the San Pedro SOTA conference, including its detailed program and the field guides of the excursions for download, can be found at <https://www.sota7.org/>.

Philipp Ruprecht, Luca Caricchi and Lucy McGee