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Geochemical evidence for shear heating, slab melting, and slab melt channelization in the South Andean subduction zone

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The thermal structures of subducting plates should dictate when and where key devolatilization and melting reactions occur and have an important impact on elemental fluxes across subduction zones. Although analytical and numerical calculations provide valuable constraints on slab and mantle thermal structures, the relative importance of some key parameters, such as shear heating on the slab surface, remain debated. Geochemical proxies based on arc magma geochemistry provide another important constraint on slab thermal structures. However, these depend on several underlying assumptions regarding the pathways that slab materials take through the mantle and the processes that affect these materials along the way.

In this presentation, I will highlight geochemical evidence that arc-front stratovolcanoes and nearby minor eruptive centers in the South Andean Volcanic Zone (SAVZ) and Eastern Mexico largely sample two-component mixtures between ‘ambient’ mantle and a surprisingly homogenous slab melt. The slab component is best understood as a mixture of melts extracted from the slab across a large range of depths. These slab melts are then channelized into the mantle beneath large volcanoes.

This hypothesis is further tested using a new chemo-thermo-mechanical model that tracks the slab fluxes of key compounds/elements such as K_2O, H_2O, Cl, Sr, B, and N. The model was constructed using the tools provided by [1], with parameters and geometry relevant to the SAVZ. Modeled dehydration and melting reactions in the slab are based directly on a large body of published experiments. The model indicates that reasonable variations in shear heating can significantly impact the depth and extent of slab melting. The model can successfully account for the composition of SAVZ lavas and melt inclusions, but only if shear heating is substantial. In the absence of shear heating, various elemental and isotopic ratios differ considerably from observations. The integrated chemo-thermo-mechanical approach thus provides a promising new avenue for the study of subduction processes.

[1] van Keken, P. E., Wada, I., Sime, N., & Abers, G. A. (2019). Thermal structure of the forearc in subduction zones: A comparison of methodologies. *Geochemistry, Geophysics, Geosystems*, *20*(7), 3268-3288.