Probing the relationship between slab-surface processes and arc-magma chemistry

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Across-arc patterns in magma chemistry provide key insights into the processes taking place at the subducting slab surface, and are an essential component of improving our understanding of arc-magma generation. This project will use samples of primitive volcanic rocks from a range of arcs to explore differences in primary melt chemistry both within and between arcs. Microanalytical techniques will be used in conjunction with melting and thermal models to assess whether systematic variations in slab input occur between arcs, and to explore what this implies about the overall controls on the location of arc volcanism.

Description: Recent work on primitive volcanic rocks hints at systematic across-arc patterns in the volatile and trace-element contents of primary arc magmas, with some consistency in these chemical patterns between thermally-diverse subduction zones. Such consistency suggests that the position and width of arcs is modulated by the release of material from the slab-surface, with water-rich primary magmas at the arc front giving way to magmas more enriched in certain trace-elements slightly behind the arc front. This change may reflect a particular stage of devolatilisation/melting at the downgoing slab interface, which exerts a key control on melting in the mantle wedge and ultimately determines where magmas reach the surface. The suggestion that this pattern is replicated in different arcs implies that these slab-surface processes are key to arc magma generation. Microanalytical techniques allow us to make the measurements required to investigate these deep processes in more detail.

This project will build on existing samples from southern Chile and compare these with across-arc samples from other, thermally different arcs (e.g. Alaska, Kamchatka, C. America), including fieldwork in C./S. America. Comprehensive analysis of whole rock geochemistry, mineral compositional and melt inclusion data (including electron microprobe and ion probe analyses) will seek to compile datasets of variation in trace element and primary volatile content across the range of samples. This will be coupled with melting models and existing thermal models of arc systems to ascertain primary melt compositions and relate these to chemistry of the slab-derived liquid entering the mantle wedge. Further developments may investigate fluid transport through the wedge or melting processes at the slab interface.

Training: This project will provide comprehensive training in methods of analysing and interpreting igneous processes, including petrographic methods, whole rock geochemistry and a range of microanalytical methods (electon probe; ion probe). It will also provide training in modelling approaches for the assessment of melting and petrogenetic processes.

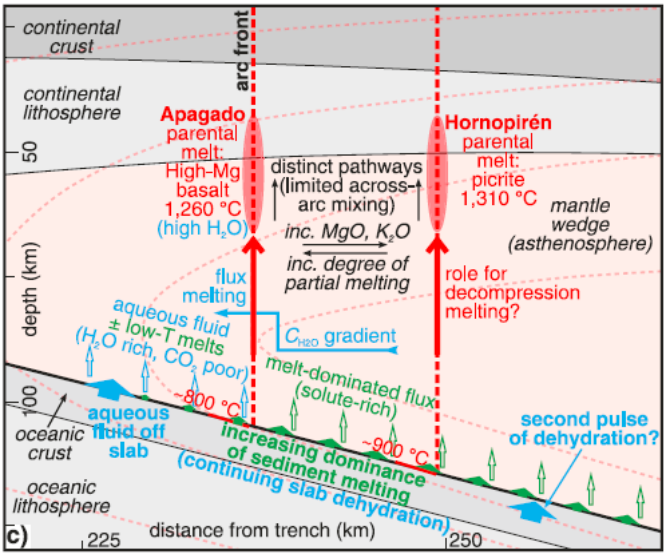

Figure 1: Melt generation across the S. Chile subduction zone.

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