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Transfer and evolution of arc magma within lower crustal conduits

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Understanding the formation of magmatic arcs requires not only understanding the formation of primitive arc melts, but also their evolution during migration from the mantle source to the arc. Indeed, the chemical characteristics of arc-melts are acquired during a complex process involving the slab input, the mantle wedge, and transfer (fractionation-assimilation) of the melt at the base of and in the crust.
The Sapat complex (Pakistan) exposes a lower crust section of the Kohistan Paleo-Island Arc. The section is composed of predominantly fine-grained meta-plutonics hosting kilometer-scale pyroxenite-wehrlite-dunite bodies which show intrusive contacts. Structures and lithological relationships indicate that the pyroxenitic bodies formed through thermal erosion of the host plutonics. We show that these bodies represent magma conduits and feeder pipes ("differentiation highways") of arc-magmas of the growing Kohistan arc. Various petrological compositions characterize the different ultramafic bodies. The largest is composed of hornblende-bearing wherlite, clinopyroxenite, and dunite. These lithologies provide evidence for melts intruding and reacting with their own, earlier cumulates that are magmatically eroded or cut. Another ultramafic body is composed of homogeneous hornblende-bearing websterite with, in places, sub-vertical layers. Within this body, plagioclase- and amphibole-rich, sub-vertical zones denote impregnation by a later reactive percolating melt.
The petrological differences in the various feeder pipes may reflect differences in melt composition, temperature and H2O-concentration during crystallization, as e.g. suggested by the presence of garnet and fluid exsolutions. Texturally controlled mineral analyses coupled with structural interpretations lead to the conclusion that the arc magmas evolved and acquired at least part of their chemical signature in these conduits. Such magmatic bodies are analogues to deep-seated "magmatic chambers" and elucidate the mode of magma transfer and evolution from the top of the mantle to the final emplacement or extrusion level.