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Non-slab melt origin for adakites from Mindanao, Philippines

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Several suites of Plio-Pleistocene andesitic and dacitic stocks occur in the Surigao peninsula in north-eastern Mindanao. These are the first phase of magmatism resulting from initiation of subduction of the Philippine Sea Plate at the Philippine Trench. Whole rock geochemistry suggests that the majority can be classed as adakites (e.g. elevated Sr/Y and low Y and Yb).

In some suites there is a relationship between Sr/Y and the modal abundance of plagioclase and crystal size distribution of plagioclase provides evidence for complex, multiple populations of phenocrysts. Furthermore, there is inter- and intra-crystal variation in $^{87}Sr/^{86}Sr$; the cores of plagioclase crystals in one rock displaying a similar range of $^{87}Sr/^{86}Sr$ to whole rocks from the entire peninsula. This provides strong evidence for open system behaviour of Sr.

Within individual suites trace element ratios correlate with SiO_2 suggesting mixing of basic and evolved melts and the adakitic signal is associated with the latter. The geochemistry of the stocks varies systematically across the peninsula, with enrichment of more incompatible elements at greater distance from the trench. These variations mirror across-arc changes in the chemistry of Neogene basement volcanics providing a possible link between the two. Furthermore, the $^{187}Os/^{188}Os$ of rocks from throughout the peninsula are low, suggesting a relatively juvenile source for the magmas which is inconsistent with melting of 50Ma Philippine Sea Plate.

The geochemical and textural evidence indicates that most Plio-Pleistocene magmas behaved as open systems in the arc lithosphere. Whole rock and crystal geochemistry is not consistent with melting of the subducted Philippine Sea Plate. The data suggest that the adakitic signature has a source in the arc lithosphere that has been incorporated into more basic magma generated by fluid fluxing of the mantle wedge above the current subduction zone. This adakitic source is probably remelting of basaltic material from a previous arc or the present day subduction zone.

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Experimental constraints on pelite melting in subduction zones: A new approach using HP metapelites

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Pelitic sediments transport nearly all of the large-ion lithophile elements and continental isotope signatures entering a subduction zone, and these elements are released into the overlying mantle wedge creating the characteristic signatures of subduction magma. Whether the transfer occurs through aqueous fluids, silicate melt, or a supercritical silica-rich phase is still debated, but the discrepancies in previous sediment melting conditions have left doubts about whether all forms of element transfer are even possible in a subduction zone. To simulate a more realistic metamorphic environment, we have located the solidus and characterized the melt compositions for a high-pressure metapelite that has undergone subduction.

Other sediment melting experiments have used highly metastable starting materials and have necessarily assumed closed system behavior. However, a growing body of evidence from UHP and HP terrains suggests that prograde metamorphism during subduction involves localized and regionalized metasomatism. The most appropriate starting material for subduction zone melting, therefore, would be a pre-anatectic metapelite that has undergone the chemical and mineral changes associated with prograde metamorphism. Our starting material is a minimally retrogressed sample of the Gåsetjørn gt-st-ky pelite from the ophiolite sequence in the Solund Basin, Western Gneiss Region of Norway. The metasediments were subducted to 50km and locked in peak metamorphic conditions of 1.5 GPa and 600 °C [1]. As observed in other HP and UHP ophiolites, our pelites were depleted in alkalis and calcium by metasomatism.

Our results show that the solidus is located between 625 and 650 °C at 2 GPa, which is lower than any previously reported solidus for pelitic compositions. Thus, our results support sediment melting as a possible mechanism for arc magma enrichment.

References

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