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Petrology of "Mt. Shasta" high-magnesian andesite (HMA): A product of multi-stage crustal assembly

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Abstract

Occurrences of high-Mg andesite (HMA) in modern volcanic arcs raise the possibility that significant volumes of continental crust could be directly derived from Earth's mantle. Such rocks are commonly associated with subduction of young, warm oceanic lithosphere or occur in areas heated by mantle convection. A relatively rare occurrence near Mt. Shasta in the Cascades volcanic arc has been considered to represent one such primary mantle-derived magma type, from which more evolved andesitic and dacitic magmas are derived. Recognition that the Shasta area HMA is actually a hybrid mixed magma, calls into question this notion as well as the criteria upon which it is based. We report new chemical and mineralogical data for samples of the Shasta HMA that bear on the components and processes involved in its formation. Several generations of pyroxenes and olivines are present along with different generations of oxide minerals and melt inclusions. The most magnesian olivines (Fo_{93}) exhibit disequilibria textures, exotic melt inclusions, and reaction rims of Fo_{87} composition; these crystals along with spongy, ~Mg# 87 orthopyroxene crystals are interpreted to be xenocrystic and do not signify a primitive mantle derivation. The groundmass is andesitic with moderate MgO content, and melt inclusions of similar compositions are hosted by equilibrium olivine (~Fo_{87}). The bulk magma (whole rock) is more magnesian, but primarily due to incorporation of mafic minerals and ultramafic xenolith debris. We propose that the exotic crystal and lithic debris in these rocks is derived from (1) dacitic magmas of possible crustal derivation, (2) prograded ultramafic rocks in the underlying crust, and (3) random lithic debris and crystals derived from conduit wall rocks and earlier intruded magmas within the feeder plexus beneath Shasta. The HMA is inferred to represent a mixture between evolved dacitic and primitive basaltic magmas as well as incorporation of xenolithic crystal cargo. There is no compelling evidence that HMA is present in large volumes, and it is not considered to be an important parental liquid to more evolved magmas at Shasta.

Keywords: High-Mg andesite, Mt. Shasta, Cascades arc, mineral zoning and populations; New Advances in Subduction Zone Magma Genesis