The origin of andesites by hybridization in thin and thick crustal settings

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Andesites are a common precursor to large-volume rhyolitic ash eruptions in many volcanic fields that produce voluminous explosive silicic volcanic eruptions, but are notably absent from some fields. An example of the latter is the Silurian coastal Maine volcanic field, which hosts several plutonic complexes that produced bimodal volcanic successions up to 3 km thick, dominated by rhyolitic ignimbrites. The only andesitic ignimbrites identified in this setting formed as a result of mechanical mixing of basaltic and rhyolitic ash just before or during eruption. We refer to these andesitic ignimbrites that form in the very shallow near-surface eruption setting by mechanical hybridization of rhyolitic ash and basaltic enclaves as 'physical andesites'. We suggest that one of the distinctions between the subduction-related settings in which voluminous andesites form and those in which these physical andesites form is crustal thickness. The Silurian crust of coastal Maine was a thin, back-arc crust dominated by mafic batholiths supporting felsic magma chambers near the surface. Volcanic fields that are built on thick crust dominated by felsic batholiths produce andesites that result from the interaction of basaltic melt with partially melted felsic crust in magma chambers at various crustal levels. The trachyandesitic middle Tertiary Atascosa Lookout lava flow of southern Arizona is the product of magma interaction across a range of levels in a thick crust. Crystals in the lava flow originated in at least three distinct magmas and their hybrids. U-Pb ages of zircon crystals analyzed in situ in contrasting settings in a single thin section of the lava flow range from 22.8 +/- 0.4 my to 25.2+/- 0.5 my, recording a minimum of 1.5 my of history of the magmatic complex. Crystallization pressures based on hornblende barometry range from 5 to 7 kbar, and on clinopyroxene barometry range from 3.5 to 7 kbar in crystals of contrasting texture, indicating that crystals in the flow originated at different levels of the crust. In contrast, the volcanic centers of coastal Maine are examples of large-scale eruptions generated by magma chambers built on thin crust with little or no andesite production. In both cases, however, the resulting andesites are products of hybridization of crystals of both mafic and felsic ancestry.