Unraveling the diversity in eruption styles at arc volcanoes

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The magmatic systems that feed arc volcanoes are undeniably complex. Beginning in the slab and mantle wedge regions, volatile-charged arc magmas traverse a long, tortuous journey to the surface. The processes that create the magmas we study from surface deposits are variably understood depending on our ability to resolve different depth ranges in the crust using geophysical and petrological tools. For example, we know much more petrologically about the shallow crust than the deep crust, which is more difficult to access using experiments or thermobarometric models. There are four categories of processes that could influence eruption style from arc volcanoes: 1) Tectonic controls – many studies point to geodynamical controls resulting from subduction that influence the overall geochemical character of arc volcanoes, yet fewer studies address upper-plate tectonic influences on magmatism. 2) Geochemical controls – how do crustal geochemical processes geochemically shape the magmas staged in the shallow crust prior to eruption? Crystal-choked andesite-dacite magmas versus phenocryst-poor basalt to basaltic andesites have very different viscosities, volatile contents, and compositions before ascent begins. 3) Extreme changes in P-T-X and viscosity happen during final ascent from storage in the crust primarily due to volatile exsolution. Coupled with the physical state of the conduit, these changes influence eruption style even within a single episode fed by one magma composition. 4) Shallow depth to surface phreatomagmatic processes can cause highly explosive, sustained ash producing eruptions from typically mafic volcanoes not only in Alaska (Okmok) but also in Iceland and elsewhere. Isolation of one category that is the most influential in producing the differing eruption styles observed at all volcanoes is perhaps not a tractable research problem. Rather, it is most likely the case that multiple factors combine in some way to produce a typical eruption style at a given volcano located within a specific sector of the arc. This talk will review past accomplishments and outstanding questions that remain in our quest for understanding arc magmatic systems and what controls eruption style, with a focus on the Aleutian-Alaskan subduction zone.