Collaborative Research: From the Slab to the Surface: Origin, Storage, Ascent, and Eruption of Volatile-Bearing Magmas (NSF 1456939 & 1456814)

Diana Roman, Erik Hauri, Terry Plank

On any given day, approximately 15-30 volcanoes worldwide are either in eruption or show strong signs of unrest (e.g., anomalously high rates of seismic activity, ground deformation, or gas emissions). Volcanic activity, including high-altitude eruptions of ash or emission of large volumes of gas, poses a significant hazard to people and property in the United States and worldwide. This is particularly true in Alaska, with over 10,000 passengers a day flying over 35 historically active volcanoes on North America/Asia flight routes. Although significant progress has been made in recent decades in understanding the physical processes occurring in the upper portions of the Earth's crust that lead directly to volcanic activity and associated unrest, there is a fundamental lack of understanding of how these shallow crustal processes link to and are controlled by the large-scale crustal tectonics and deep mantle melting that are ultimately responsible for arc volcanism. Specifically, although it is well understood that the amount of water and other volatiles dissolved in a magma plays a key role in its generation, ascent, and eruption, it is unclear why some arc volcanoes erupt 'wetter' magmas than others. Identifying large scale controls on magma volatile contents is thus critical for accurate forecasting of the frequency, volume, and explosivity of volcanic eruptions.

Beginning in August 2015, we will conduct an integrated geochemical-geophysical study of the Unimak-Cleveland corridor of the Aleutian volcanic arc, which encompasses six volcanoes that have erupted in the past 25 years with a wide range of magmatic water contents. This relatively small corridor also exhibits a range of deep and upper-crustal seismicity, apparent magma storage depths, and depths to the subducting tectonic plate. Our goal is to link two normally disconnected big-picture problems: 1) the deep origin of magmas and volatiles, and 2) the formation and eruption of crustal magma reservoirs, which we propose to do by establishing the depth(s) of crustal magma reservoirs and pre-eruptive volatile contents throughout the corridor. The integrated study components include analysis of volcano- seismic events and magmatic volatile analysis. Existing seismic data catalogs contain ~ 14,000 events, and some samples of volcanic eruption products are already in hand. The existence of two actively erupting volcanoes in the corridor further motivates collection of simultaneous seismic, gas (in collaboration with the USGS Alaska Volcano Observatory) and tephra samples during eruption, that reflect active evolution of the magmatic system.

Cleveland Volcano