Deciphering crust vs. mantle inputs and timescales of magma genesis at Mount Adams using ^{238}U-^{230}Th disequilibria and Os isotopes

B.R. JICHA[1], C.M. JOHNSON[1], W. HILDRETH[2], B.L. BEARD[1], G.L.HART[3], S.B. SHIREY[4] AND B.S. SINGER[1]

[1]Department of Geology & Geophysics, Univ. of Wisconsin-Madison (*correspondence: bjicha@geology.wisc.edu)
[2]U.S. Geological Survey, Menlo Park, CA 94025
[3]School of Earth and Environmental Sciences, Washington State University, Pullman, WA
[4]Department of Terrestrial Magnetism, Carnegie Institution of Washington, Washington DC

Identifying the physical processes involved in the origin of mafic arc magmas and their subsequent evolution to more silicic compositions is critical for understanding the eruptive histories of volcanoes located above subduction zones and ultimately the growth of continental crust. A suite of 23 basaltic to dacitic lavas erupted over the last 342 ka from the Mount Adams volcanic field has been analyzed for U-Th isotope compositions to evaluate the roles of mantle vs. crustal components during magma genesis. All of the lavas have ($^{230}Th/^{238}U$) > 1 and span a large range in ($^{230}Th/^{232}Th$) ratios, and most basalts have higher ($^{230}Th/^{232}Th$) ratios than the andesites and dacites. Several lavas contain antecrysts (crystals of pre-existing material) yet internal U-Th mineral isochrons from six of seven lavas are indistinguishable from their eruption ages. This indicates a relatively brief period of crystal residence in the magma for most of the phenocrysts (ol, cpx, mt, plag) prior to eruption. One isochron gave a crystallization age that is ~20-25 ka older than its eruptive age, and is interpreted to reflect mixing of older and juvenile crystals. Much of the eruptive volume since 350 ka consists of lavas that have small to moderate ^{230}Th excesses (2-16%), which are likely inherited from melting of a garnet-bearing intraplate ("OIB-like") mantle source. Following melt generation and subsequent migration through the upper mantle, most Adams magmas interacted with young, mafic lower crust as indicated by $^{187}Os/^{188}Os$ ratios that are substantially more radiogenic than the mantle. Moreover, Os-Th isotope variations suggest that unusually large ^{230}Th excesses (25-48%) and high $^{187}Os/^{188}Os$ ratios in some peripheral lavas are the result of assimilation of small degree partial melts of pre-Quaternary basement that had residual garnet or Al-rich clinopyroxene. The time elapsed since crustal assimilation to eruption must have been short enough (few tens of ka or less) to preserve the ^{230}Th excesses.

Development of micro-porosity in granite and shale: Characterizing mineral weathering fronts by neutron scattering studies

LIXIN JIN[1]*, GERNOT ROTHER[2], DAVID R. COLE[2] AND SUSAN L. BRANTLEY[1]

[1]Center for Environmental Kinetics Analysis, Earth and Environmental Systems Institute, Penn State University, State College, PA16802, USA (*correspondence: luj10@psu.edu)
[2]Chemical Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN37831, USA

Physical disaggregation is crucial in the critical zone, allowing exposure of reactive surface area for chemical dissolution reactions to occur. This is especially important at the bedrock/saprolite interface, where soil formation is initiated. Here, we present neutron scattering (NS) data from soil profiles of two different rock types (granite from Puerto Rico and grey shale from Pennsylvania, USA), to characterize development of internal micro-porosity and micro-structure.

Preliminary results showed that NS intensities of soils are generally similar within each soil profile but much higher than those of bedrocks, especially in the large pore size range (µm). This observation agreed with the concept that pores are initially produced at the bedrock/saprolite boundary. Neutron scattering probes the pore geometry and alignment. In our studies, granites exhibit azimuthally symmetric scattering spectra, which is expected for random two-phase systems (pore-mineral matrix). In contrast, scattering patterns obtained from shales are anisotropic, suggesting that cylindrical pores were developed preferentially along a certain orientation, probably along the water flowpath. A power law scattering was observed for all the samples with slopes of -3 to -4 over large Q-regions, suggesting that surface fractality/roughness is independent of scale in the nanometer region. Porosity and surface area were extracted from analysis of the invariant.

In summary, neutron scattering was applied to characterize the process of physical disaggregation of bedrock. In combination with chemical, mineralogical, and physical characterization of bedrock and soils, conceptual models can be developed to understand development of porosity, reaction kinetics at the bedrock/saprolite interface, and formation of soils.