A 7400-sample geochemical-geospatial database for Oregon Cascade Range volcanic rocks

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We have compiled a whole-rock geochemical database containing 7400 analyses of Cenozoic volcanic rocks from the Cascade Range of Oregon. The database comprises 5700 analyses from publications, theses, and dissertations, and 1700 of our own previously unpublished analyses. The majority of the 7400-sample suite has been analyzed for 27 major and trace elements. Each sample is assigned to one of eleven age groups – five from period 0-2 Ma and six more for period 2-45 Ma; these groupings correspond to the map units on the Oregon Cascade geologic map (USGS I-map 2569). Over 70 percent of the entries have corresponding geospatial coordinates, including many that were generated exclusively for this database by extensive consultation with the data-source authors.

Some broad geographic correlations are obvious and consistent with Cascade Range-wide geologic maps. For example, Quaternary andesite and dacite are predominant at the stratocones, and Quaternary mafic lava--basalt and basaltic andesite--forms the extensive background along the arc in Oregon. But many geochemical findings from this geospatial database reveal significant regional variation reflective of tectonomagmatic trends. Some big-picture items:

(1) Low-K tholeiite is found along the entire arc in Oregon since 8 Ma. In northern Oregon these basalts become younger northward along the arc. In southern Oregon they span the age range 0-8 Ma with no apparent age progression.

(2) K-rich basalt is widely but sporadically distributed along the arc, and a wide range in basalt composition is found at any latitudinal position.

(3) The composition of 0-8-Ma mafic lava changes systematically along the arc, in a manner compatible with decreased partial melting northward—such as lower Ca/Al ratio and higher concentrations of Na and incompatible elements.

Helium isotope systematics in geothermal fluids of the Cascade volcanic arc

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Helium isotopes are excellent tracers of magmatic processes, but also processes at the geothermal-hydrological interface, and are therefore uniquely suited to study magmatic and geothermal interactions in the Cascade volcanic arc. Results are presented here of an on-going study to characterize the $^3He/^4He$ systematics of geothermal fluids of the Cascade volcanic arc.

The $^3He/^4He$ ratios of geothermal features at or near the summit of most Cascade volcanic centers fall within the range of 6.8 – 8.6 Ra (Ra is the $^3He/^4He$ ratio in air) typical for subduction zones. Mt. Shasta (5.5 Ra) and Mt. St. Helens (5.7 Ra) are noted exceptions. Moving away from the volcanic crest, $^3He/^4He$ ratios in fluids from thermal and chemically anomalous non-thermal features systematically decrease. This observation is consistent with the thermal fluids that feed the hot springs far (> 25 km) to the west (and east) of the volcanic crest deriving their heat and helium from a magmatic source centered on the volcanic crest.

The new $^3He/^4He$ data combine with existing literature and unpublished data to cover a period of more than 20 (in some cases even 30) years of sporadic sampling. Comparison with the older data shows that many features appear to have remained relatively stable over that period of time. However, several features, most notably summit features at Mt. Hood, Mt. Shasta, and Newberry Caldera, show significant variation in their $^3He/^4He$ systematics on a decadal time scale. For these particular cases, changes in the shallow geothermal system can be excluded as the cause for the observed variations. So the most likely cause is changes in the shallow magmatic plumbing system of the volcanoes.

These observations illustrate the value of building up a helium isotope (and other fluid chemistry) history for these volcanic centers. Since changes in fluid chemistry are usually closely associated with changes in the activity level of the volcano, such a database will lead to a better understanding about the causes of events like periods of bulging, subsidence or earthquake swarms that are still poorly understood.