2011

Geochemistry of the Mt. Persis Volcanics and Evidence for Thickening of Cascade Crust Over Time

Monica Hanson
mhanson@pugetsound.edu

Follow this and additional works at: http://soundideas.pugetsound.edu/summer_research

Recommended Citation
Hanson, Monica, "Geochemistry of the Mt. Persis Volcanics and Evidence for Thickening of Cascade Crust Over Time" (2011).
Summer Research. Paper 105.
http://soundideas.pugetsound.edu/summer_research/105

This Article is brought to you for free and open access by Sound Ideas. It has been accepted for inclusion in Summer Research by an authorized administrator of Sound Ideas. For more information, please contact soundideas@pugetsound.edu.
Geochemistry of the Mt. Persis Volcanics and Evidence for Thickening of Cascade Crust Over Time

By Monica Hanson and Jeff Tepper, Research Advisor

Abstract

The Cascade Range is a classic example of a continental magmatic arc, a belt of igneous activity resulting from subduction of the oceanic Juan de Fuca plate beneath the western margin of the North American plate. The Cascade arc, which started forming about 38 million years ago (Ma), is unique in that extensive uplift and erosion have exposed plutonic and volcanic rocks of similar age. We compare geochemical analyses from the Index batholith and the nearby Mt. Persis Volcanics to see how plutonic and volcanic rocks are related. Our data indicate both formed by similar processes but do not have the same parent magma (thus are not genetically related). This study also uses geochemical data gathered from the Mt. Persis area with data from other studies to allow investigation of temporal changes in the nature of the crust beneath the Cascade arc. We calculated crustal thickness, based on rock chemistry, to rock units of various ages in the Cascades to see if thickness changed over time. An apparent thinning of the Cascade crust around 25 Ma makes way for more questions that may be addressed through geochemical analysis.

Mt. Persis

- The Mt. Persis volcanics consist of plagioclase and hornblende-rich andesite flows and breccias, dated to roughly 38 Ma.
- A pluton of the Index batholith, which is 34 Ma, is surrounded by near-source Mt. Persis volcanic rocks and suggests that the volcano may have originated from the same magma chamber as the batholith, as shown in Figure 1.
- One of the aims of this study is to determine whether the plutonic and volcanic rocks near Mt. Persis are genetically related to each other.
- Another goal is to figure out how the Cascade arc rocks vary in composition along the length of the arc and through time.

Methods

- Collect fresh rocks (that have not been heavily weathered or chemically altered) on Mt. Persis and nearby areas.
- Cut samples with a rock saw and pulverize them using a shatterbox.
- Weigh out 0.1 gram of each sample and 0.5 gram of a LiBO2 flux, and fuse the powders in a furnace set at 1000° C.
- Run ICP-ES and ICP-MS (inductively coupled plasma emission and mass spectrometry) to obtain major and trace element chemical information.
- Collect geochemical data from other volcanic and plutonic units within the Cascade Arc for spatial and temporal comparison.

Geochemical Analyses

- Geochemical data for the Mt. Persis volcanics and the Index batholith were analyzed to compare their magmatic history and genetic relationship.
- We collected this data from Mt. Persis and compiled data from previous studies for comparison (Ponzini, 2003; Dragovich et al., 2009, 2010, 2011).
- The general linear trend in Figures 2 and 3 show that the magmatic processes by which the Index batholith and the Mt. Persis volcanics formed were very similar.
- However, Figure 3 shows a lower average silica content for the Mt. Persis volcanics, which suggests that this pluton of the Index batholith is not the source for the surrounding Mt. Persis volcanics (Figure 1).
- Dense, mafic minerals in a magma chamber tend to cool into batholiths while the more buoyant, silica-rich material rises and becomes the volcanic counterpart.
- The lower silica levels in the Mt. Persis volcanics are an indicator of the source of the batholith may have been different.
- Figure 4 shows a similar linear trend, but the Mt. Persis rocks have less CaO/Na2O content than the Index batholith, further suggesting these units have different parent magmas and are not directly related.

Crustal Thickness Through Time

- Plank and Langmuir (1988) observed that magmas in arcs with thicker crust have higher Na2O/CaO.
- They attribute this to less melting under these arcs (Figure 5).
- Thicker crust = more mantle melting
- Smaller wedge = less melting during decompression
- Less melting = higher Na

Acknowledgements

Special thanks to the University of Puget Sound Summer Research Grant, for funding my time in the field and the lab, and to Jack Dragovich for his Mt. Persis data.

Conclusions

- Our geochemical analyses suggest by their linearity that the Index batholith and Mt. Persis volcanics were formed by broadly similar processes.
- However, the variable chemical content of these units indicates that these rock units formed from different parent magmas.
- Our crustal thickness regression lines are reasonable because they agree with current geophysical knowledge.
- There is an unexplained crustal thinning event around 25 Ma.
- Future studies may entail sorting these geologic units spatially in order to look at chemical variation indicative of subduction parameters.
- Examples of parameters that have changed over the last 38 Ma, and that may have affected magma chemistry, include rate of subduction and the thickness of the overlying crust.