Analysis of sector-zoned clinopyroxene from Kaua‘i, Hawai‘i

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Igneous rocks that erupt from volcanoes or form under the Earth's surface provide an excellent opportunity to study the melt and crystallization processes that occur in the uppermost layers of Earth's crust. Minerals, the building blocks of igneous rocks, record information through their chemical compositions and crystalline textures that we can use to interpret these processes. Clinopyroxene is one prominent mineral in Hawaii's igneous rocks in the interpretation.

Notably, some clinopyroxene minerals from Kaua‘i's Lihue Basin are sector-zoned, in which crystal faces vary in their distinct chemical composition. These 'triangle' or 'hourglass' sectors are observable by their color differences under polarized-light microscopy (Fig. 1), backscattered electron imaging (Fig. 2, left), and elemental compositional crystal mapping (Fig. 2, right). The presence of sector zones in the clinopyroxenes is significant, because it provides evidence that these minerals grew under non-equilibrium conditions when the rock was crystallizing.

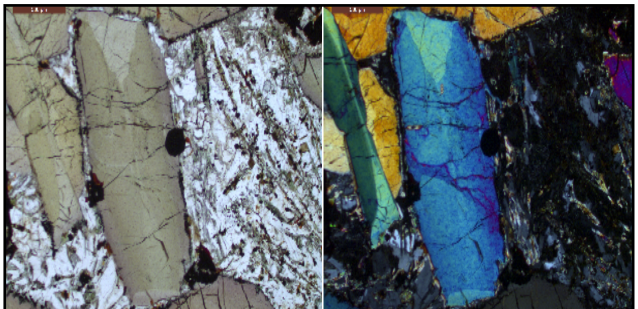

Figure 1: Clinopyroxene under plane-polarized light (left) and cross-polarized light (right). Note color variations of sectors.

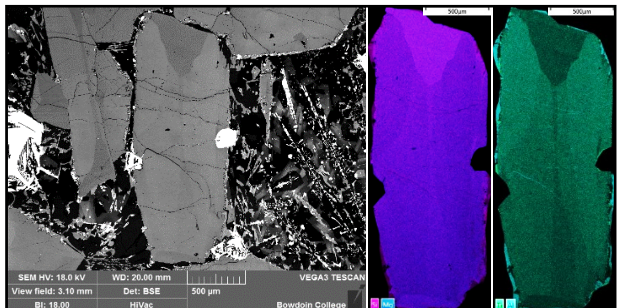

Figure 2: Clinopyroxene backscattered electron (BSE) image (left) Si + Mg compositional maps (middle), and Al + Ti map (right). Brighter intensity corresponds with higher elemental enrichment.

I analyzed and documented chemical and textural variations from more than eighty clinopyroxene crystals from a suite of intrusive igneous rocks on Kaua'i, Hawai'i. Using Bowdoin's Scanning Electron Microscope (SEM), I collected backscattered electron (BSE) images (Fig. 2, left) to reveal the sector zones, collected electron-backscatter diffraction (EBSD) maps to determine the crystallographic orientations for the sectors, and collected energy dispersive spectrometry (EDS) maps (Fig. 2, right) to determine compositional differences between sectors. Using the combined data, I determined that the {111} crystal sectors tended to be enriched in Si + Mg, the {100} sectors in Al + Ti, and other sectors showed intermediate elemental enrichment (Fig. 3).

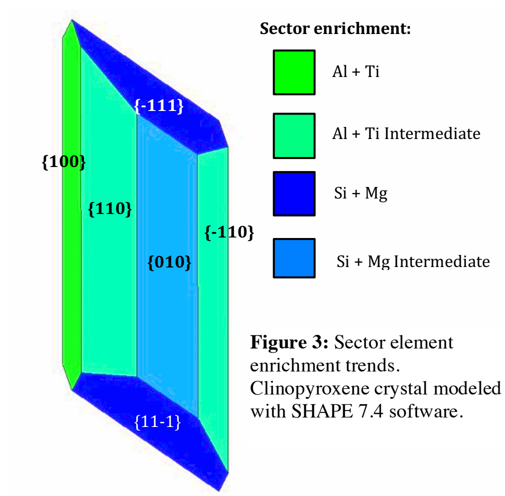

Figure 3: Sector element enrichment trends. Clinopyroxene crystal modeled with SHAPE 7.4 software.

This summer research focused on analyzing element enrichment trends relative to crystallographic orientations for sector-zoned clinopyroxene. My next steps are to compare these data to previously published experimental and analytical studies of mineral sector zones to work towards interpreting the mineral growth histories and conditions. I look forward to continuing this as an Honors project during the 2019-2020 academic year.

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