Unravelling monogenetic volcanism in the Oregon Cascades

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We have studied tephra and scoria deposits from several volcanic cones amongst the numerous basaltic and basaltic-andesite eruptions across the Central Oregon Cascades. This type of volcanism is under studied in the region. Gaining an understanding of the eruption timescales associated with this type of volcanism is important in the event of future eruptions, due to their spatial and temporal distribution. We used Fe-Mg diffusion modeling techniques in olivine together with crystal textures to calculate eruption timescales and to consider the presence (or not) of a transport and storage network in the subsurface and how this may or may not differ between the various cones. Our early work has focused on two volcanic centers within 9 km of each other - Four in One Cone, a ~2000 year old fissure eruption made up of six small cones and Belknap Crater, a ~3000 year old small shield volcano.

The latest tephra from Belknap contains at least two olivine populations – a more dominant population with core compositions of Fo81-80 and a second, smaller olivine population with core compositions of Fo84. Both olivine populations contain normally zoned olivine that give maximum Fe-Mg diffusion timescales of weeks or several months. This indicates the olivine resided for some time in the sub-surface diffusively re-equilibrating before eruption, suggesting shallow storage beneath Belknap Crater.

At Four in One Cone we studied material from the entire eruptive sequence, to study pre-eruptive processes at a higher resolution. The earliest tephra layer contains weakly zoned (both normal and reverse) or unzoned olivine, with core compositions of Fo83-82. Later tephra layers contain olivine with mostly the same or similar forsterite cores (Fo84-81) with the exception of one reversely zoned olivine with a core composition of Fo73. Olivine within the later tephra layers exhibit stronger zoning patterns with rim compositions down to Fo71 for normally zoned crystals. Together with the weaker zoning, olivine within the initial tephra layer are mostly euhedral, however olivine from the later tephra layers exhibit dendritic overgrowths. The indicates the more evolved, dendritic rims grew under conditions favourable for rapid crystal growth, potentially associated with degassing processes. Maximum diffusion timescales range from days to months suggesting these magmas did not travel straight to the surface unimpeded. ■

Four-in-One Cone, of the holocene monogenetic centers in Central Oregon studied for this project.