# Interactions between magmatic degassing and regional tectonic revealed through stable carbon isotopes, Long Valley Caldera, California

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Long Valley Caldera is a large volcanic complex located on the western margin of the Basin and Range province. Its rich history of volcanic activity and its location on the eastern escarpment of the Sierra Nevada make it an ideal place to study volcano-tectonic interactions. Recent seismic swarms associated with resurgence as well as an extensive hydrothermal network of fumaroles, hot springs and tree-kill zones suggest the magmatic system is active and may potentially erupt in the future. In this project we present a comprehensive characterization of soil gases aimed at improving our understanding of relationships between the magmatic system and regional tectonics. This study marks the first field-based deployment of a portable cavity ring-down spectrometer used to obtain $\delta^{13}C$ values in near real-time fashion. The speed and precision of this method open doors for a new generation of stable isotopic studies. A total of 223 soil gas samples were collected as point measurements, transects and grids, and they fall into three sets based on their characteristic $CO_2$ (%) and $\delta^{13}C$ (permil) signatures: background soil flux (–15 to –20 permil), vegetated soil flux (–20 to –25 permil) and magmatic soil flux (–2 to –7 permil). The first group of magmatic sites clusters along the southern boundary of the resurgent dome where regional throughgoing faults intersect the domal structure (average: –5.7 permil). The second group extends to the Hot Creek geothermal area located 2.5 km to the southeast of the resurgent dome in a zone dominated by the WNW-ESE restraining band of regional faulting that propagates through the caldera (–5.26 permil). The third group is associated with Mammoth Mountain volcanism and its surrounding tree kill zones (–4.57 permil). The fourth group is related to volcanism north of the Mono-Inyo domes (–6.88 permil). Based on this preliminary grouping, degassing at Mammoth Mountain, the resurgent dome and Hot Creek, and Mono Lake appears to be controlled by three distinct sources of $CO_2$. The high water vapor content and presence of numerous hot springs within the caldera implies significant groundwater interaction with the hydrothermal system. Furthermore, the high temperature, heavy $\delta^{13}C$ gas requires a magmatic heat source, or a very efficient network of fluid flow pathways that circulate water and gas between the heat source and the surface along faults. Such structures are likely provided by the caldera-related and resurgence-related faults as well as by regional structures. Field observations show that degassing sites occur in close proximity to major faults, and the dimensions of these sites commonly reflects the morphology of the faults. We propose that both caldera-related and tectonic fault structures play an important role in the occurrence of magmatic gas signatures at Long Valley Caldera.