

Eruptive source of volcanic ash in Jurassic Morrison Formation suggested by Pb isotopic composition of sanidine

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The Late Jurassic Morrison Formation (famous for its diverse dinosaur fossils and as a source of uranium ore), underlies a large area of the western interior of the United States. It was deposited in a variety of terrestrial and lacustrine environments east of a magmatic arc along the western boundary of North America. As a result, much of the formation (particularly the Brushy Basin Member on the Colorado Plateau) consists of pyroclastic fall deposits erupted from volcanoes to the west of its outcrop belt. As such, the Morrison Formation provides an important record of Mesozoic magmatic activity along the western North American plate boundary. However, the exact locations of the pyroclastic eruptions are debated, and thus are not able to constrain tectono-magmatic models during the Mesozoic. In an effort to constrain the eruptive sources of pyroclastic deposits, we have analyzed Pb isotope ratios of sanidine separated from three samples of the Morrison Formation. To check for homogeneity and reproducibility, several subsamples of different weights were analyzed. In an individual sample, almost all of the ratios overlap at the 2-sigma error level—even for samples as small as 10 mg (10s of grains). When all three Pb isotope ratios are considered, each sample is uniform, but distinct from the other samples. This is consistent with a lack of xenocrysts or detrital contaminants in the ash. The Pb isotope compositions of two of the beds plot in Zartman's (1974) lead isotope province 2 and one lies very close to the boundary between provinces 1 and 2. There are only a few plutons in these provinces (in southern Arizona-New Mexico and in southern California) that are currently known to have Late Jurassic ages. Consequently, future research should focus on magmatic centers in these provinces as potential eruptive sources for pyroclastic beds in the Morrison Formation, and tectono-magmatic models for the Late Jurassic need to include a period of significant magmatic activity in southern California and western Arizona during the Mesozoic.

Trace element and oxygen isotope zonations in growth sectors of natural quartz crystals

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It is generally accepted that there is a structural control on trace element incorporation into crystals. By analogy, isotopic fractionation between fluid and a growing crystal surface may also occur. With the aim of examining the processes that govern mineral-fluid oxygen isotope fractionation at low to medium temperatures (150 to 350°C) in natural systems, variations in trace element and oxygen isotope compositions across and along different growth zones and sectors are being investigated in natural quartz crystals formed in veins during retrograde regional Alpine metamorphism.

$\delta^{18}\text{O}$ values measured for different parts of single crystals (center and rims; bottom and top parts) during a preliminary study were found to differ by close to 3‰ (values between 3.6 and 6.2‰). Similarly, Onasch and Vennemann (1995) have measured differences in $\delta^{18}\text{O}$ values of up to 2‰ in different sectors of the same growth zone in sector-zoned quartz crystals, opening up the possibility of fluid-mineral disequilibrium partitioning of oxygen isotopes.

Growth and sector zoning in the Alpine quartz crystals studied are highlighted using cathodoluminescence. Several profiles, selected on the basis of their cathodoluminescent appearance, had significant variations in Al, Fe, and Mg, detected using an electron microprobe. Most notable are changes in Al content that reach 100's ppm, with maxima of about 500 ppm in distinct growth zones. LA-ICPMS analyses indicated locally high concentrations of K, Ca, Ge, Li, Ti, Zr in some crystals but these anomalies could not be correlated to distinct growth zones. Additional analyses of oxygen isotope and trace element (Li, Ge, K,...) variations are planned using an ion microprobe as well as UV-Laser based *in-situ* measurements, in order to augment the data base and ultimately obtain information on growth mechanisms and their possible controls on elemental and isotopic fractionation processes for natural crystals.

Reference

Onasch C.M. and Vennemann T.W., (1995), *Geology*, 23, 1103-1106.