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SIMS oxygen isotope analyses of white mica from the Larderello geothermal field reveal a complex magmatic – hydrothermal petrogenesis

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The Larderello geothermal field (LGF) in southern Tuscany is underlain by a series of shallow intrusions of isotopically and geochemically distinct two-mica granites belonging to the Miocene-Pleistocene Tuscan Magmatic Province (1). Muscovite is ubiquitous in the granites, the contact metamorphic aureole and the deep pre-Alpine metasedimentary units that constitute the lower reservoir of the LGF. Texturally and chemically distinct generations of muscovite record stages of magmatic crystallization, thermometamorphic/hydrothermal replacement and fluid/rock interaction (2,3).

Existing O isotope data of whole rock and mineral separates indicates that granite and contact metamorphic rocks have been gradually depleted in ^{18}O (δ^{18}O from 5-12‰ [4]).$Althoughsomesecondaryminerals, suchasmuscovite, provedhighlyretentiveandretainedtheirpre-alteration\delta^{18}$O signature (8-10%¸), biotite in the alteration zone can have δ^{18}O values as low as 1.5‰ (3).

In-situ Secondary Ion Mass Spectrometry (SIMS) O isotope analysis of white mica is used to resolve the fluid/mineral interaction on microscale in the dynamic environment of the LGF. Data of white mica from granite, contact metamorphic micaschist and phyllite show a large and variable spectrum of δ^{18}O values ranging from 14‰ to as low as 2‰The highest δ^{18}O data (≤14%¸) are found in chemically homogeneous white mica from a phyllite sample, which are close to values from unaltered micaschist from the Northern Appeninnes (4). White mica from a contact metamorphic micaschist shows the largest spread of δ^{18}O values, from 12‰ in homogeneous domains in larger grains to 2‰ in a more heterogeneous small grain. A granite and a high-temperature magmatic/hydrothermal vein contain white mica with a magmatic δ^{18}O of ~9‰ and higher values of ~13‰ respectively. In both samples, white mica show a pronounced *intra-grain* δ^{18}O variability of up to 5‰ either as core-rim zoning, or as ^{18}O-depletion in Fe-Mg-enriched domains (~2.5 wt.% higher in Fe-Mg) that surround inclusions of chlorite.

The highest measured δ^{18}O values from white mica in metasediments are either related to a pre-intrusive, syntectonic metamorphic overprint, or were caused by recrystallization from a more recent ^{18}O-rich fluid, as proposed for other secondary minerals (2). Large homogeneous domains in the igneous white mica retained their magmatic δ^{18}O values, whereas the selective ^{18}O-depletion in the Fe-Mg-enriched, recrystallized domains results from hydrothermal alteration by meteoric water that also affected some metasedimentary white mica (2,4). The new SIMS δ^{18}O data of white mica, therefore, reveal, for the first time, their multifaceted petrogenesis on a microscale, and may prove a valuable tool in further describing the fluid dynamics of complex magmatic-hydrothermal-metamorphic systems.

REFERENCES

1-Dini, A., Gianelli G., Puxeddu M., Ruggieri G., 2005: Lithos 81, 1 – 31.

2-Petrucci, E., Gianelli, G., Puxeddu, M., Iacumin, P., 1994: Geothermics 23, 327–337.

3-Cavarretta, G., Puxeddu, M., 2001: N.Jb.Miner.Abh. 177, 77–112.

4-Gianelli, G., Ruggieri, G., 2002: Geothermics 31, 443– 474.