RUTILE THERMOMETRY: STATE OF THE ART AND OUTLOOK

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In a recent study we demonstrated that the Zr content in rutile is strongly temperature dependent if it is buffered by quartz and zircon. (ZACK et al., 2004). We analysed rutile-quartz-zircon assemblages of 31 metamorphic rocks spanning a temperature range from 430 to 1100 °C. Electron microprobe measurements of Zr concentrations in rutile vary from 30 to 8400 ppm, being highly dependent on metamorphic grade. No pressure dependence is observed. An uncertainty of absolute T of ± 50 °C is inherited from T estimates of the natural samples used.

To promote wide application of rutile thermometry, we selected relatively homogeneous rutiles (Zr variation less than 10% within a given sample) that span a range of Zr contents (100, 260 and 770 ppm) for distribution as secondary mineral standards. These rutiles were measured by isotope dilution MC-ICP-MS (ZACK et al., in prep), to create accurate calibration values for instrumental facilities (e.g. EMP, SIMS, LA-ICP-MS) for Zr in rutile determinations. The calibration of the Heidelberg SIMS facility through these three rutiles as well as titanites, MPI-DING glasses and NIST-SRM 610 glass show no matrix effect for Zr determination outside 15 % (2 sigma), thus SIMS analysis of Zr in rutile is straightforward.

Temperature information of ordinary high variance eclogites often can be retrieved only by Grt-Cpx Fe-Mg geothermometers. However, such calculations have large uncertainties (± 50 - 250 °C) because Fe^{3+} in omphacites can not be reliably obtained unless Mössbauer analysis are available (e.g. PROYER et al., 2004). Rutiles are an attractive alternative for geothermometry of such eclogites. Although absolute temperatures can be currently calculated only within ± 50 °C with rutile thermometry, relative temperature differences can be distinguished within ± 10 °C, as examplified by Trescolmen eclogites where two eclogites and one HP metapelite give identical Zr concentrations within counting statistical errors (ca. ± 2 %). As a next step we are currently investigating a wide range of low-variance eclogites where temperatures can be relatively well constrained, e.g. containing index minerals such as lawsonite, zoisite, glaucophane and/or allowing thermobarometry by the critical assemblage Grt-Omp-Ky-Phe-SiO_2 (RAVNA & TERRY, 2004). This will demonstrate if well-equilibrated rutiles are a common feature in eclogites and how closely rutiles show a general increase of Zr from low-T to high-T eclogites.

References

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