New constraints on Pb diffusion and closure temperature in rutile from *in situ* U-Pb dating by LA-ICP-MS

E. KOOIJMAN*, K. MEZGER AND J. BERNDT

Institut für Mineralogie, Westfälische Wilhelms-Universität, Correnssstraße 24, D-48149 Münster, Germany (*correspondence: e.kooijman@uni-muenster.de)

Rutile (TiO_2) is a common accessory phase in metamorphic rocks of different compositions and it is stable over a wide range of *P*-*T* conditions. Rutile can contain up to 100 ppm U allowing U-Pb dating with an excellent precision. Rutile ages have been shown to provide information about the cooling history of a metamorphic terrane, although there is a discrepancy of closure temperature estimates between nature (ca. 400°C [1]) and experiment (ca. 600°C [2]). To provide further constraints on Pb diffusion and the closure temperature in rutile we analyzed U and Pb isotopes in rutiles from granulite facies metapelitic rocks of the Archean Pikwitonei granulite domain (Manitoba, Canada). The thermal history of these rocks involved slow cooling from high temperature conditions, which is ideal for estimating closure temperatures, since age uncertainties due to analytical precision are small relative to the duration of cooling.

To resolve age heterogeneity within single rutile grains LA-ICP-MS was applied. This technique is very suitable for rutile dating, because it allows analysis of multiple small spots on single grains as well as *in situ* measurements in thin sections preserving textural information. Rutile contains almost no Th and therefore insignificant thorogenic ^{208}Pb allowing approximations of common Pb contents based on ^{208}Pb, which are more precise than those based on the less abundant ^{204}Pb isotope [3]. Selected grains were analyzed using a Thermo-Finnigan Element2 ICP-MS coupled to an Excimer laser system. Transects of 35 µm spots were measured across rutiles with a grain size ranging from 100 to 350 µm. The rutile cores have ages of ca. 2450 Ma and show core-to-rim younging towards 2280 Ma. These results agree with the range of U-Pb ages obtained by ID-TIMS on bulk samples [1]. The ages follow diffusion profiles indicating that zoning is the result of Pb volume diffusion. Our data and estimated diffusion parameters combined with parameters determined by Cherniak [2] are consistent with a closure temperature for Pb diffusion in rutile of 570-630°C.

[1] Mezger *et al*. (1989) *Earth Planet. Sci. Lett.* **96**, 106-118.
[2] Cherniak (2000) *Contrib. Mineral. Petrol.* **139**, 198-207.
[3] Zack *et al*. (2008) *GCA* **72**, A1069.

The effects of ultrahigh temperature metamorphism on the U-Pb systematics in zircon

E. KOOIJMAN[1]*, D. UPADHYAY[1], K. MEZGER[1], M.M. RAITH[2] AND J. BERNDT[1]

[1]Institut für Mineralogie, Westfälische Wilhelms-Universität, Correnssstraße 24, 48149 Münster, Germany (*correspondence: e.kooijman@uni-muenster.de)
[2]Steinmann Institut, Universität Bonn, Poppelsdorfer Schloß, 53115 Bonn, Germany

The U-Pb ages of zircons from igneous and metamorphic rocks often show discordance, which is commonly attributed to radiogenic Pb-loss. The causes of Pb-loss need to be understood for a reliable interpretation of the ages. To assess the behavior of the U-Pb system during ultrahigh temperature (UHT) metamorphism, we analyzed zircons from quartzites that form xenoliths in—or occur in the contact aureole of—the Kadavur anorthosite complex, SE India.

Cathodoluminescence (CL) imaging shows that the zircons consist of rounded cores with sub- to euhedral rims, some of them separated by a mantle. Interfaces between the zones are usually sharp. The cores show weak CL and are either structureless or have a faint oscillatory, sector or patchy zonation. The rims are oscillatory zoned, whereas the highly luminescent mantles show no internal structure. All rims and mantles have similar CL characteristics indicating that they may record the same growth events.

U-Pb spot dating of individual CL zones was done using laser ablation ICP-MS. The cores provide a cluster of both concordant and discordant ages in the range of 3.4 to 1.9 Ga that are interpreted to be of detrital origin. Spot ages from zircon mantles and rims define two concordant populations with weighted means of 914±22 Ma (2σ) and 815±11 Ma, respectively. The youngest age is interpreted as dating the time of anorthosite intrusion and hence the contact metamorphism whereas the 914 Ma ages record a regional granulite facies metamorphism. The preservation of old and concordant ages in a large number of cores provides strong evidence that the UHT (>1150°C) conditions did not cause Pb-loss in zircons, thereby implying that Pb-diffusion in pristine or slightly metamict zircons cannot be the cause for the discordance of U-Pb ages in metamorphosed zircons. U-Pb discordance in zircons therefore requires the zircons to be metamict, which facilitates the loss of Pb either by diffusion or recrystallization. Cores with young and discordant ages in some zircon grains were therefore probably metamict and lost Pb during contact metamorphism.