Ionprobe zircon dating at NENIMF

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Radiogenic dating of zircon by secondary-ion mass spectrometry (SIMS) based on the U-Th-Pb system was recently implemented at NENIMF. A high-mass resolution instrument, the Cameca® 1280 installed at WHOI, was used successfully to reproduce published age data on proposed zircon reference materials *Temora-2* and *91500* (Wiedenbeck *et al.*, 1995; Black *et al.*, 2004). Concordant ages were produced on both reference zircons with pooled concordia ages that are well within error of the published values (Fig. 1). The uncertainties on the pooled ages were $\leq 0.72\,\%$ (2σ). The analytical method follows well-established protocols employed in other SIMS labs (e.g., Edinburgh, UCLA, Stockholm) and was now established at NENIMF. A number of magmatic and metamorphic zircon grains from a Precambrian Antarctic rock sequence was precisely dated using this method. Age uncertainties for individual analyses were between 1.4 and 2.6 %, which compares well with other SIMS labs (Nemchin *et al.*, 2013).

We are, therefore, able to add U-Pb dating to the portfolio of analytical techniques available at NENIMF. Demand for in-situ zircon dating is high in the scientific community and we can now provide our users with this technique.

We also coupled the age information with Ti concentration measurements in the zircons and applied Ti-in-zircon thermometry (Watson *et al.*, 2006) to unravel the rocks' temperature-time history.

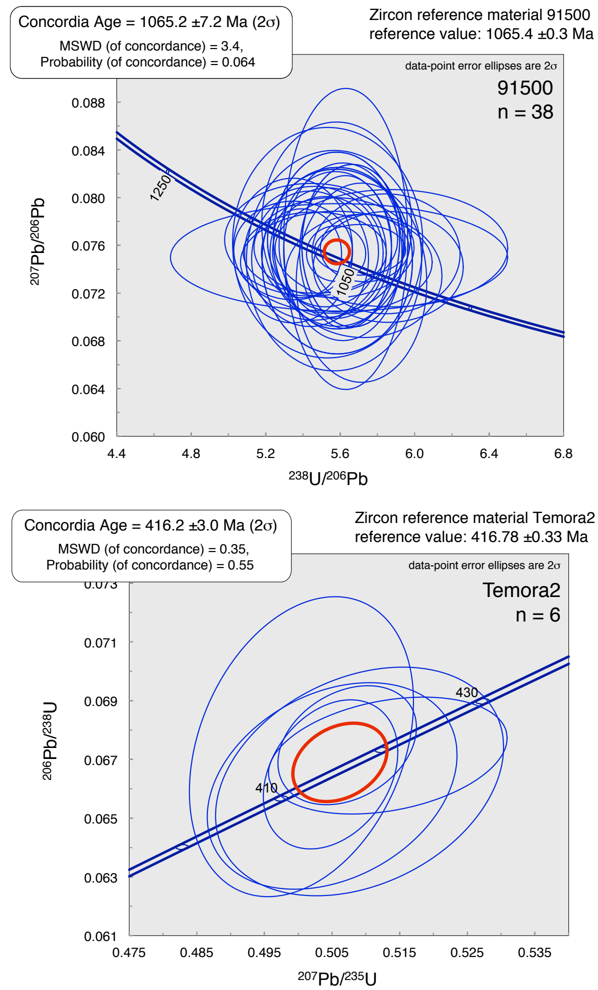

Fig. 1 Concordia diagrams showing the results of analyses on reference zircons for a two-weeks session (January 2013; no common-Pb correction applied). **(a)** 91500 **(b)** Temora-2.

Analytical details

Uranium-Pb dating of zircons was carried out at NENIMF using the Cameca® IMS1280 ion microprobe. Analytical procedures were similar to those described by Schuhmacher *et al.* (1994). 16 analytical cycles were acquired with the magnet cycling from the masses of Zr_2O^+ to $UO_2{}^+$. A $4-6\,$nA, 12.5 kV mass filtered $^{16}O_2{}^-$ primary beam was focused to a $\sim 30\,\mu$m (long axis) elliptical spot. Oxygen flooding on the surface of the sample was used to increase the Pb ion yield.

U/Pb ratios were calibrated against measurements of the 91500 proposed reference zircon, which has a $^{206}Pb/^{238}U = 0.17917$ and a $^{207}Pb/^{206}Pb$ age of $1065.4 \pm 0.3\,$Ma (Wiedenbeck *et al.*, 1995). Unknowns were bracketed by analyses of 91500 and Temora-2. Measurements over single sessions gave

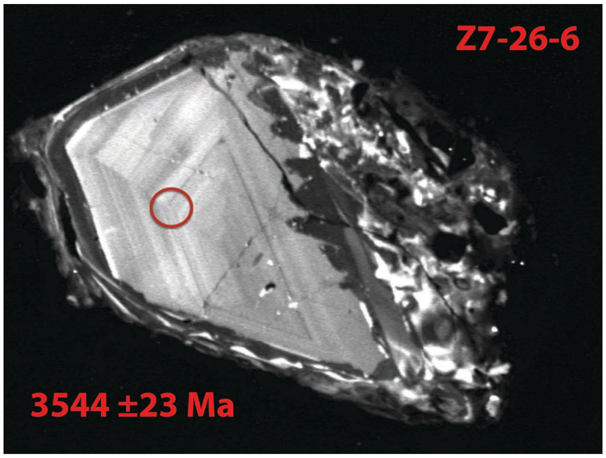

Fig. 2 Cathodo-luminescence (CL) image of a polished zircon grain from Dronning Maud Land (DML, Antarctica) showing a bright, oscillatory-zoned core with an Eoarchean $^{207}Pb/^{206}Pb$ age of 3544 ± 23 Ma (1σ), analyzed at NENIMF (length of grain ~ 400 µm). The red circle marks the position and size of the analysis spot.

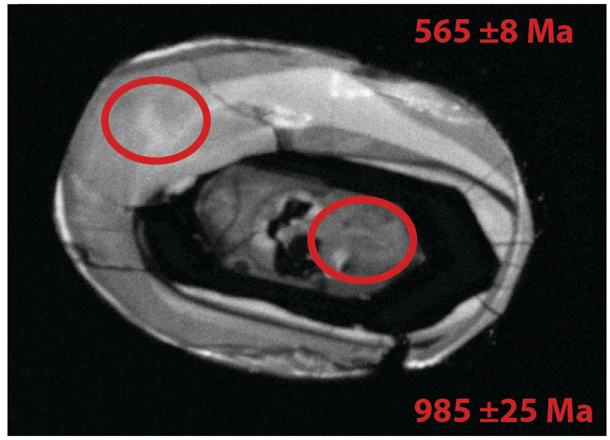

Fig. 3 CL image of a polished zircon grain from a mafic high-pressure granulite from DML showing a euhedral core region enclosed in a bright rim zone. The core revealed a concordia age of 985 ± 25 Ma (2σ), which is interpreted as the magmatic protolith age, while the rim showed an age of 565 ± 8 Ma, which is the age of high-grade metamorphism. Analyzes were performed at NENIMF (length of grain ~ 130 µm). The red circles mark the positions and size of the analysis spot.

a standard deviation for the $^{207}Pb/^{206}Pb$ ratio of 91500 of ~ 0.7 % (95 % confidence limit).

Analyses of a secondary reference zircon (Temora-2) yielded a mean $^{206}Pb/^{238}U-^{207}Pb/^{235}U$ concordia age of 416.2 ± 3.0 Ma (Fig. 1). Contributions of common Pb were monitored by measuring ^{204}Pb. Common Pb correction can be made through ^{204}Pb counts or through $^{208}Pb/Th$ (Williams, 1998). A correction for instrumental mass fractionation of 2 ‰/amu was made for the Pb isotopes. Uncertainty on this correction is included in the calculation of errors on the U/Pb and Pb/Pb ratios. Corrections for minor changes in beam density or energy were made based on the comparison of U/Pb to UO_2/UO ratios. Data were processed offline using a MatLab-based in-house data reduction routine. Plots and age calculations were made using the ISOPLOT program (Ludwig, 2003).

References

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