## **1 EPMA methodology**

 Electron Microprobe Analysis (EMPA) of mineral chemistry was carried out on a JEOL electron microprobe (JXA-8600) at the Department of Geography and Geology, University of Salzburg, using a wavelength dispersive system. We used an acceleration voltage of 15 kV and a sample current of 40 nA. Natural and synthetic mineral standards were used to calibrate the microprobe and raw data was reduced using standard ZAF correction. The detection limits (2σ) for the elements Si and Al are 0.06 wt% and 0.04 wt%, respectively, for Na, K, Mg, Mn, and Fe are 0.025 wt%.

## **2 LA-ICP-MS U–Pb zircon dating**

 U-Pb dating of zircon was conducted by LA-ICP-MS at the State Key Laboratory of Geological Processes and Mineral Resources, China University of Geosciences, Wuhan, China. Laser sampling was performed using a GeolasPro laser ablation system that consists of a COMPexPro 102 ArF excimer laser (wavelength of 193 nm and maximum energy of 200 mJ) and a MicroLas optical system. An Agilent 7700e ICP-MS instrument was used to acquire ion-signal intensities. Helium was applied as a carrier gas. Argon was used as the make-up gas and mixed with the carrier gas via a T-connector before entering the ICP. A “wire” signal smoothing device is included in this laser ablation system. The spot size and frequency of the laser were set to 33µm and 5Hz, respectively, in this study. Zircon 91500 and glass NIST610 were used as external standards for U-Pb dating and trace element calibration, respectively. Each analysis incorporated a background acquisition of approximately 20–30 s followed by 50 s of data acquisition from the sample. An Excel-based software ICPMSDataCal was used to perform off-line selection and integration of background and analyzed signals, time-drift correction and quantitative calibration for trace element analysis and U-Pb dating (Liu et al., 2010). Concordia diagrams and weighted mean calculations were made using Isoplot/Ex\_ver3 (Ludwig, 2003).

## **3 40Ar-39Ar dating**

40Ar/39Ar geochronology was performed at the ARGONAUT Laboratory at the Geology Division of the University of Salzburg. The mineral grain separates were obtained by crushing hand-sized samples and sieving them through 200 to 355 µm fractions. Mineral concentrates were packed in aluminium foil and loaded in quartz glass tubes. To calculate the J-values, flux monitors were placed between each of 4–5 unknown samples, resulting in a distance of ca. 5 mm between adjacent flux monitors. The sealed quartz glass tubes were irradiated at the 9.5-MW LVR-15 reactor at the Nuclear Research Institute Řež plc, Czech Republic, in the rotational channel Js40 in active core D2. Correction factors for interfering isotopes at the Řež plc reactor were calculated from 45 analyses of co-irradiated Ca-glass samples and 70 analyses of pure K-glass samples and are 36Ar/37Ar(Ca) = 0.000245, 39Ar/37Ar(Ca) = 0.000932 and 40Ar/39Ar(K) = 0.0075. Variations in the flux of neutrons was monitored with the DRA1 (Drachenfels) sanidine standard for which a 0Ar/39Ar plateau age of 25.03 ± 0.05 Mawas initially reported (Wijbrans et al., 1995). Here, we use the revised value of 25.26 ± 0.05 Ma (van Hinsbergen et al., 2008).  40Ar/39Ar analysis was performed using a UHV Ar-extraction line equipped with a combined MERCHANTEKTM UV/IR laser system and a VG-ISOTECHTM VG-3600 noble gas mass spectrometer. Stepwise heating analyses of samples were performed using a defocused (~1.5 mm diameter) 25-W CO2-IR laser operating in Tem00 mode at a wavelength of 10.6 µm. The VG3600 is an 18-cm radius 60° extended geometry sector field mass analyser instrument equipped with a bright Nier-type source operated at 4.5 kV. For each increment, the intensities of 36Ar, 37Ar, 38Ar, 39Ar and 40Ar were measured and the baseline readings on mass 34.5 were automatically subtracted. Intensities were corrected for the system blanks, background, post-irradiation decay of 37Ar and 39Ar and interfering isotopes. Isotopic ratios, ages and errors for individual steps were calculated and presented following McDougall and Harrison (1999), Scaillet (2000) and Renne et al. (2009) using decay factors reported by Steiger and Jäger (1977). Errors are reported at the one-sigma level unless stated otherwise. The definition and calculation of the plateau ages was performed using ISOPLOT3.75 (Ludwig, 2012). Ages were also calculated on the basis of the optimisation approach of Renne (2010) for the decay constants λε and λβ of 40K and κFCs (40Ar\*/40K of Fish Canyon sanidine) by an intercalibration of 40Ar/39Ar with the 238U/206Pb ages. The ages were calculated from the Ri-values ((40Ar\*/39ArK)i/(40Ar\*/39ArK)std) with κFCs = (1.6417 ± 0.0045) 10−3, λε = (5.757 ± 0.016) 10−11 and λβ = (4.9548 ± 0.0134) 10−10 (Renne et al., 2011). These constants give an age of 28.294 ± 0.036 Ma for the FCs. Errors were calculated with linear uncertainty propagation including the covariances given in Renne et al. (2011). Using DRA as a standard, a correction value of 1.0991 ± 0.0015, determined via the intercalibration of DRA1 and FC-2, was used in the age equation.