Appendix 3. Sample preparation and LA-ICP-MS analysis

U-Pb zircon analyses were carried out at the Pacific Centre for Isotopic and Geochemical Research (PGIR) at the University of British Columbia. Following standard mineral separation procedures from rock samples, zircons were handpicked in alcohol and mounted in epoxy, along with reference materials. Grain mounts were then wet ground with carbide abrasive paper and polished with diamond paste. Next, cathodoluminescence (CL) imaging was carried out on a Philips XL-30 scanning electron microscope (SEM) equipped with a Bruker Quanta 200 energy-dispersion X-ray microanalysis system at the Electron Microbeam/X-Ray Diffraction Facility (EMXDF). An operating voltage of 15 kV was used, with a spot diameter of 6 μm and peak count time of 17-27 seconds. After removal of the carbon coat, the grain mount surface was washed with mild soap and rinsed with high purity water. Prior to analysis the grain mount surface was cleaned with 3 N HNO3 acid and again rinsed with high purity water to remove any surficial Pb contamination that could interfere with the early portions of the spot analyses.

Analyses were conducted using a Resonetics RESOlution M-50-LR, which contains a Class I laser device equipped with a UV excimer laser source (Coherent COMPex Pro 110, 193 nm, pulse width of 4 ns) and a two-volume cell designed and developed by Laurin Technic Pty. Ltd. (Australia). This sample chamber allowed for the investigation of several grain mounts in one analytical session. The laser path was fluxed by N_2 to ensure better stability. Ablation was carried out in a cell with a volume of approximately 20 cm^3 and a He gas stream that ensured better signal stability and lower U-Pb fractionation (Eggins et al., 1998). The laser cell was connected via a Teflon squid to an Agilent 7700x quadrupole ICP-MS. A pre-ablation shot was used to ensure that the spot area on grain surface was free of contamination. Samples and reference materials were analyzed for 36 isotopes: ^{7}Li, ^{29}Si, ^{31}P, ^{43}Ca, ^{45}Sc, ^{49}Ti, Fe (^{56}Fe, ^{57}Fe), ^{89}Y, ^{91}Zr, ^{93}Nb, ^{95}Mo, ^{98}Mo, ^{139}La, ^{140}Ce, ^{141}Pr, ^{146}Nd, ^{147}Sm, ^{153}Eu, ^{157}Gd, ^{159}Tb, ^{163}Dy, ^{165}Ho, ^{166}Er, ^{169}Tm, ^{172}Lu, ^{177}Hf, ^{181}Ta, ^{202}Hg, Pb (^{204}Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb), ^{232}Th, and U (^{235}U, ^{238}U) with a dwell time of 0.02 seconds for each isotope. Pb/U and

Pb/Pb ratios were determined on the same spots along with trace element concentrations. These isotopes were selected based on their relatively high natural abundances and absence of interferences. The settings for the laser were: spot size of 34 µm with a total ablation time of 30 seconds, frequency of 5 Hz, fluence of 5 J/cm2, power of 7.8 mJ after attenuation, pit depths of approximately 15 µm, He flow rate of 800 mL/min, N2 flow rate of 2 mL/min, and a carrier gas (Ar) flow rate of 0.57 L/min.

Reference materials were analyzed throughout the sequence to allow for drift correction and to characterize downhole fractionation for Pb/U and Pb/Pb isotopic ratios. For trace elements, NIST 612 glass was used for both drift correction and trace element calibration, with sample spacing between every five to eight unknowns, and ^{90}Zr was used as the internal standard assuming stoichiometric values for zircon. NIST 610 glass was analyzed after each NIST 612 analysis and used as a monitor reference material for trace elements. For U-Pb analyses, natural zircon reference materials were used, including Plešovice (PL; Sláma et al., 2008; 337.13 ± 0.33 Ma) or 91500 (Wiedenbeck et al., 1995, 2004;1062.4 ± 0.4 Ma, 206Pb/238U date) as the internal reference material and both Temora2 (TEM; Black et al. 2004; 416.78 ± 0.33 Ma) and Plešovice and/or 91500 as monitoring reference materials; the zircon reference materials were placed between the unknowns in a similar fashion as the NIST glasses. Raw data were reduced using the Iolite 4.3 extension (Paton et al., 2011) for Igor ProTM yielding concentration values, Pb/U and Pb/Pb dates, and their respective propagated uncertainties. H. Lin carried out mineral separation, T. Ockerman conducted sample preparation and data reduction and M. Amini was in charge of LA ICP-MS analysis.

Interpretation and plotting of the analytical results (Appendix 4) employed the ISOPLOT software of Ludwig (2008). Maximum depositional ages (MDA) were assigned based on youngest statistical populations (YSP), according to the method of Coutts et al. (2019). To identify multiple source populations, we applied the Unmix routine in Isoplot 3.70 (Ludwig, 2008). For details of interpretations see Stanley and Nelson (2022).

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