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## Supplemental Material

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## Text S1. Analytical methods

### 1 Zircon U–Pb–Hf isotope analyses

Zircon grains were separated by heavy liquid and magnetic techniques, hand-picked under a binocular microscope, and mounted in epoxy resin. The internal structure of zircon grains was characterized by cathodoluminescence (CL) imaging using a HITACHI SUI1510 scanning electron microscope at the State Key Laboratory for Mineral Deposits Research, Nanjing University, China.

Uranium and Pb isotope compositions of zircon grains were measured in situ using an Agilent 7500a laser ablation system coupled with an iCAP RQ ICP–MS at the State Key Laboratory of Mineral Deposits Research, Nanjing University. The laser was operated at an energy density of  $6.5 \text{ J/cm}^2$ , a spot diameter of  $32 \text{ }\mu\text{m}$ , and a repetition rate of 5 Hz. Analyses represent 30 s of gas background followed by 40 s of sample ablation and data acquisition. The homogeneous zircon reference standard GEMOC GJ-1 ( $^{207}\text{Pb}/^{206}\text{Pb}$  age of  $608.5 \pm 0.4 \text{ Ma}$  and  $^{206}\text{Pb}/^{238}\text{U}$  age of  $599.8 \pm 4.5 \text{ Ma}$ ; [Jackson et al., 2004](#)) was analyzed twice every twelve analyses, and was used as an external standard for mass bias and instrument drift correction. The Mud Tank zircon standard was analyzed once every twelve analyses as an independent control. Analyses yielded a weighted mean  $^{206}\text{Pb}/^{238}\text{U}$  age of  $728 \pm 6 \text{ Ma}$  ( $2\sigma$ ;  $\text{MSWD} = 0.69$ ), which is consistent with the age determined by isotope dilution–thermal ionization mass spectrometry ( $732 \pm 5 \text{ Ma}$ ; [Black and Gulson, 1978](#)). The Isoplot 3.0 toolkit for Microsoft Excel was used for age calculations ([Ludwig, 2003](#)).

Lutetium and Hf isotope compositions of zircon grains were determined using a 193 nm ArF excimer laser ablation system coupled to a Nu Instruments Plasma II MC–ICP–MS at Nanjing FocuMS Technology Co. Ltd. Accuracy of the measurements was evaluated by analyzing zircon reference standards 91500 and Plešovice once every fifteen sample analyses; the standard measurements yielded weighted mean  $^{176}\text{Hf}/^{177}\text{Hf}$  ratios of  $0.282307 \pm 0.000031$  ( $2\sigma$ ; [Wu et al., 2006](#)) and  $^{176}\text{Hf}/^{177}\text{Hf}$  ratio of  $0.282482 \pm 0.000013$  ( $2\sigma$ ; [Sláma et al., 2008](#)). To calculate Hf model ages and  $\varepsilon\text{Hf}(t)$  values, a

depleted-mantle model age ( $T_{DM1}$ ) with  $^{176}\text{Hf}/^{177}\text{Hf} = 0.28325$  and  $^{176}\text{Lu}/^{177}\text{Hf} = 0.0384$  (Griffin et al., 2000), and a chondritic model age with  $^{176}\text{Hf}/^{177}\text{Hf} = 0.282772$  and  $^{176}\text{Lu}/^{177}\text{Hf} = 0.0332$  (Blichert et al., 1997) were utilized. A value of  $1.865 \times 10^{-11} \text{ a}^{-1}$  was used as the  $^{176}\text{Lu}$  decay constant in the  $\epsilon\text{Hf}(t)$  calculation (Scherer et al., 2001). An average crustal  $^{176}\text{Lu}/^{177}\text{Hf}$  value of 0.015 was used to calculate crustal model ages ( $T_{DM2}$ ) (Griffin et al., 2002).

## 2 Bulk-rock major- and trace-element, and Sr–Nd–Fe isotope analyses

Bulk-rock major-element chemistry was determined at ALS Chemex (Guangzhou) Co. Ltd. Fresh rock chips were separated from crushed bulk-rock samples in preparation for chemical analysis. All of the samples were ground in an agate mill to  $\sim 200$  mesh. Major oxides were determined by the ME-XRF-06 package. The accuracy of the analyses is  $<1\%$  for all major elements. Bulk-rock trace-element chemistry was measured by using a Finnigan Element II HR–ICP–MS at the State Key Laboratory for Mineral Deposits Research, Nanjing University following the analytical conditions and procedures described in Gao et al. (2003). The United States Geological Survey (USGS) rock standards BHVO-2, BCR-2, and AVG-1 were utilized as external standards. The analytical uncertainty for trace elements is better than 5%.

Bulk-rock Sr and Nd isotope compositions were determined using a Nu Intruments Plasma II MC–ICP–MS equipped with an Aridus II desolvating nebulizer at Nanjing FocuMS Technology Co. Ltd. following the analytical procedures described in Muhtar et al. (2020). Raw isotopic ratios were internally corrected for mass fractionation by normalizing to  $^{86}\text{Sr}/^{88}\text{Sr} = 0.1194$  for Sr and  $^{146}\text{Nd}/^{144}\text{Nd} = 0.7219$  for Nd using an exponential law. International isotopic standards (NIST SRM 987 for Sr, JNdi-1 for Nd) were analyzed once every third sample to correct for instrumental drift. The Sr–Nd isotope compositions of geological reference materials AVG-2 ( $^{143}\text{Nd}/^{144}\text{Nd} = 0.512793 \pm 0.0003$  and  $^{87}\text{Sr}/^{86}\text{Sr} = 0.703979 \pm 0.0004$ ), BHVO-2 ( $^{143}\text{Nd}/^{144}\text{Nd} = 0.512977 \pm 0.0002$  and  $^{87}\text{Sr}/^{86}\text{Sr} = 0.703481 \pm 0.0005$ ), and BCR-2 ( $^{143}\text{Nd}/^{144}\text{Nd} = 0.512636 \pm 0.0004$  and  $^{87}\text{Sr}/^{86}\text{Sr} = 0.705025 \pm 0.0004$ ) were measured once every ten

sample to ensure the accuracy of sample measurements. The measured isotope compositions of these standards are in excellent agree with previously published results within analytical uncertainty (Weis et al., 2006).

Bulk-rock Fe isotope compositions were measured on a Nu 1700 Sapphire MC–ICP–MS at the State Key Laboratory for Mineral Deposits Research, Nanjing University, China. The purification and analytical methods have been described in detail by Du et al. (2017). The analytical conditions and procedures have also been described in Brzozowski et al. (2022). A standard–sample–standard bracketing method was used to correct for mass bias and instrument drift, and Fe isotope compositions are reported as the per mil deviation ( $\delta^{56}\text{Fe}$ ) from the international standard IRMM-014 ( $\delta^{56}\text{Fe}_{\text{sample}} = [({}^{56}\text{Fe}/{}^{54}\text{Fe})_{\text{sample}} / ({}^{56}\text{Fe}/{}^{54}\text{Fe})_{\text{IRMM-014}} - 1] \times 1000$  [‰]). Analytical reproducibility on  $\delta^{56}\text{Fe}$  is better than  $\pm 0.06$ ‰ (2 standard deviations, 2SD) based on repeated analyses of several international standards against an in-house stock solution (Du et al., 2017; Brzozowski et al., 2022). The measured BHVO-2, GSP-2, AGV-2, DTS-2, and w-2a geological standards, which were also purified via the same chromatographic procedures, yield  $\delta^{56}\text{Fe}$  values of  $0.09 \pm 0.03$ ‰ ( $\delta^{57}\text{Fe} = 0.13 \pm 0.02$ ‰,  $n = 3$ , 2SD),  $0.09 \pm 0.04$ ‰ ( $\delta^{57}\text{Fe} = 0.13 \pm 0.03$ ‰,  $n = 3$ , 2SD),  $0.11 \pm 0.07$ ‰ ( $\delta^{57}\text{Fe} = 0.19 \pm 0.05$ ‰,  $n = 3$ , 2SD),  $-0.01 \pm 0.03$ ‰ ( $\delta^{57}\text{Fe} = 0.00 \pm 0.02$ ‰,  $n = 3$ , 2SD), and  $-0.01 \pm 0.01$ ‰ ( $\delta^{57}\text{Fe} = 0.06 \pm 0.03$ ‰,  $n = 3$ , 2SD), respectively, consistent with previously published results within analytical uncertainty (Craddock and Dauphas, 2011).

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