**Appendix A**

**Petrogenesis of Early Paleozoic peraluminous A-type granites from southern China**

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**Analytical methods**

Zircon U-Pb dating and trace element analytical method

To obtain precise crystallization ages, zircons of sample EP-18-02 have been selected to carry out zircon U-Pb dating. The sampling location is shown in Figure 1b. Zircons were separated by conventional techniques, including crushing, sieving and magnetic as well as liquid methods. Approximately 100 single crystals of zircon were hand-picked under a binocular microscope on the basis of size, clarity, color, and morphology. The hand-picked crystals were mounted in epoxy resin and polished to expose their centres. To select appropriate sites for in situ analyses, cathodoluminescence (CL) images were obtained using a JEOL JSM-7000F scanning electron microscope at Nanjing Hongchuang Geological Technology Co. Ltd.

Zircon U-Pb dating and trace element analysis were conducted by laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) at the State Key Laboratory for Mineral Deposits Research, Nanjing University, China, using an Agilent 7500a ICP-MS attached to a New Wave 213 nm laser ablation system. Analyses were acquired at a beam diameter of 32 μm, a 5 Hz repetition rate, and the energy of 10-20 J/cm2. A homogeneous standard zircon, GEMOC GJ-1 (207Pb/206Pb age of 608.5 ± 0.4 Ma and 206Pb/238U age of 599.8 ± 4.5 Ma; Jackson et al., 2004), was used to correct the mass discrimination of the MS and residual elemental fractionation (analyzed twice every 10 analyses). A near-concordant standard zircon, Mud Tank (intercept age 732 ± 5 Ma; Black and Gulson 1978), was used as the internal standard to optimize the reproducibility and instrument stability (analyzed once every 10 analyses). Zircon trace element standard NIST-610 was used as the external standard (analyzed twice every 10 analyses) and Zr as the internal standard due to the high concentration in zircon. The data were processed using the GLITTER software package (ver.4.4) and ISOPLOT program (ver. 3.75) (Ludwig, 2012). The corrections for common Pb were made using the algorithm of Andersen (2002). The analytical methods and standards are similar to those described by Hou et al. (2009).

Zircon Hf isotope analytical method

In-situ Hf isotope analyses of zircons on which LA-ICP-MS U-Pb ages were determined have been carried out using a New Wave ArF 193 nm laser ablation system attached to a Neptune multi-collector ICP-MS at the State Key Laboratory for Mineral Deposits Research, Nanjing University, following a procedure reported by Wang et al. (2014). Analyses were carried out with a beam diameter of 44 μm, pulse rate of 10 Hz, and beam energy of 10 J/cm2. In order to evaluate the reliability of the data, A 91500 zircon standard was analyzed during the analytical session, which yielded a weighted mean 176Hf/177Hf ratio of 0.282296 ± 8 (2σ; MSWD = 0.58), consistent with the data reported in literature within error (0.282306 ± 8; Woodhead et al., 2004). For the calculation of εHf values, we used the chondritic values of Bouvier et al. (2008). The single-stage model ages (TDM1) were calculated using the measured 176Lu/177Hf ratios based on the assumption that the present depleted mantle reservoir has a 176Hf/177Hf = 0.283250 and 176Lu/177Hf = 0.0384 (Griffin et al., 2002). The two-stage Hf model ages (TDM2) were calculated by assuming a mean 176Lu/177Hf value of 0.015 for the average continental crust (Griffin et al., 2002).

Biotite major element analytical method

The silicate mineral biotite major-element (Si, Al, FeT, Mg, Ti, Mn, Na, K, Ca) analyses were carried out at the State Key Laboratory for Mineral Deposits Research, Nanjing University. The samples were processed into polished thin sections for analyses. A JEOL JXA-8100 electron probe microanalysis (EPMA) was used to determine the major element compositions of minerals. The analyses were conducted under an accelerating potential voltage of 15 kV and by using a probe current of 20 nA and a beam size of 1 μm. peaks and backgrounds counting times for major elements are 10 s. The standards were hornblende (for Si, Ti, Al, Fe, Ca, Mg, Na and K) and fayalite (for Mn). The results were corrected using the ZAF program. The accuracy for the analyses is 1%-5%.

Whole-rock major and trace element analytical method

Fresh whole-rock samples for chemical analysis were crushed and powdered to 200-mesh using an agate mill. Then, whole-rock powders (0.5 g) were mixed with Li2B4O7 + LiBO2 + LiBr (11g), the mixture were fused into glass disks. Whole-rock major element contents were determined using a Thermo Scientific ARL 9800XP + X-ray fluorescence (XRF) spectrometer with a 50 kV accelerating voltage and a beam current of 50 mA at the Centre of Materials Analysis, Nanjing University. Loss on ignition (LOI) was determined by ignition at 1100 °C for 10 h on 2 g of powder. The analyses of standard GSR-3 indicate that the accuracy for all elements is better than 2% generally.

About 40 mg of sample powders were dissolved using a HF + HNO3 mixture in high-pressure Teflon bombs at ca. 190 °C for 48 h. Then, trace and rare earth element contents were determined using a Finnigan Element II inductively coupled plasma mass spectrometer (ICP-MS) at the State Key Laboratory for Mineral Deposits Research, Nanjing University, following the procedures described by Gao et al. (2003). Based on the analyses of rock standards (BCR-2, AGV-2), the analytical precision was estimated to be better than 5%.

Whole-rock Sr-Nd isotopic analyses

Whole-rock Sr and Nd isotopic compositions were measured using a Finnigan Triton TI thermal ionisation mass spectrometer (TIMS) and a Neptune Plus multiple collector inductively coupled plasma mass spectrometer (MC-ICP-MS) respectively at the State Key Laboratory for Mineral Deposits Research, Nanjing University, following the methods of Pu et al. (2005). Sr and Nd isotopic ratios were corrected for mass fractionation relative to 86Sr/88Sr = 0.1194 and 146Nd/144Nd = 0.7219 (O’Nions et al., 1977), respectively. During the analyses, every 10 sample analyses were followed by 1 standard measurement. Standards NBS-987 and Jndi-1 were used for Sr and Nd isotopic measurements, respectively. Measured 87Sr/86Sr values for NBS-987 and 143Nd/144Nd values for Jndi-1 are 0.710229 ± 0.000006 (2σ) and 0.512095 ± 0.000008 (2σ), respectively. For the calculation of initial 87Sr/86Sr ratios, εNd(t) and Nd model ages, the following parameter were used: λ87Rb = 1.42 × 10−11 (Steiger and Jager, 1977); λ147Sm = 6.54 ×10−12 (Lugmair and Marti, 1978); (147Sm/144Nd)CHUR = 0.1960 ± 4, (143Nd/144Nd)CHUR = 0.512630 ± 11 (2σ) (Bouvier et al., 2008); (143Nd/144Nd)DM = 0.513151, (147Sm/144Nd)DM = 0.2136 (Liew and Hofmann, 1988). The 147Sm/144Nd value of 0.118 for average continental crust (Jahn and Condie, 1995) was used for the calculation of two-stage model ages (TDM2).

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