**Supplementary Material for**

**Magmatic processes and compositional variation in granitic pluton** **construction: the Buya intrusion of West Kunlun, northwestern China**

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Appendix A. Methods

Zircon grains were separated from a representative sample of PQS, FG and ME by heavy-liquid and magnetic techniques followed by hand picking under a binocular microscope. Zircon grains were mounted in epoxy resin discs, and then polished and coated with carbon. Cathodoluminescence (CL) images of the zircons were taken using a Mono CL3+ microprobe prior to U–Pb dating and Lu–Hf analysis at the State Key Laboratory of Continental Dynamics at Northwest University, China.

Samples 18YL-1, 07HT-38 and 07HT-39 of PQS were conducted by U-Pb dating at the State Key Laboratory of Continental Dynamics at Northwest University, China. We conducted U-Pb spot dating of zircons using an Agilent 7500a ICP-MS. The ICP-MS equipped with unique Shield Torch brought about higher sensitivity. Zircon Hf isotope analysis was conducted on a Nu PlasmaHR MC-ICP-MS (Nu Instruments Ltd., UK), using a GeoLas 200M laser ablation system consisting of a ComPex102 (193 nm ArF-excimer laser, Lambda Physik) and an optical system (MicroLas). U-Pb dating of FG (Sample 12TK-16) was carried out using a New Wave-193 nm ArF-excimer laser-ablation system linked to a Neptune multiple-collector inductively coupled plasma mass spectrometer (LA-MC-ICP-MS) at Tianjin Centre of China Geological Survey. Before analysis, ICP-MS operating conditions were generally optimized using continuous ablation of reference glass NIST SRM 610, to provide maximum sensitivity for the high masses while maintaining low oxide formation (ThO+/Th+<2%) and low background. Five sample analyses were followed by one zircon 91500 and one NIST610 measurements. U, Th and Pb concentrations were calibrated by using 29Si as the internal standard and NIST SRM 610 as the external standard. 207Pb/206Pb and 206Pb/238U ratios were calculated using the GLITTER 4.0 program. The 207Pb/235U ratio was calculated from the values of 207Pb/206Pb and 206Pb/238U. In order to check the data quality, standard zircons 91500 and GJ-1 were added, respectively, which are in good agreement with the recommended ID-TIMS age of 1062.4±0.6 Ma (2σ) (Wiedenbeck et al. 1995) and 608.53±0.37 Ma (2σ) (Simon et al. 2004). Apparent and discordia U-Pb ages were calculated using the ISOPLOT (Ludwig K R, 2003). The detailed instrumental parameters and analytical procedures are documented by Yuan et al (2008).

ForLu-Hf isotope analyses of 07HT-38 and 07HT-39, conducted at the State Key Laboratory of Continental Dynamics at Northwest University, China interference of 176Lu on 176Hf was corrected by measuring the intensity of interference-free 175Lu isotope and the recommended 176Lu /175Lu ratio of 0.02669 was applied (De Biévre and Taylor 1993). Similarly, the interference of 176Yb on 176Hf was corrected by measuring 172Yb and using 176Lu /172Yb ratio of 0.5886 (Chu et al. 2002). Standard zircons 91500 and GJ-1 were used as the reference standards for calibration and monitoring the condition of analytical instrumentation. The obtained 176Hf/177Hf ratios are 0.282295±0.000027 (n=14, 2σ) for 91500 and 0.282734±0.000015 (n=16, 2σ) for GJ-1. These results are in good agreement with the recommended 176Hf/177Hf ratios of 0.2823075±58 (2σ) (Wu et al., 2006) and 0.282015±0.000019 (2σ) (Elhlou et al., 2006) for the two standards. The detailed analytical technique is described by Yuan et al. (2008). A decay constant for 176Lu of 1.865×10−11 a (Scherer et al, 2001), the present-day chondritic ratios of 176Hf/177Hf = 0.282772 and176Lu /177Hf = 0.0332 (Blichert-Toft and Albarede F, 1997) were adopted to calculate *ε*Hf(*t*) values. The notations of εHf(t), TDM1 and TDM2 are defined as same as those in Yang et al. (2007), with interpretations of single-stage depleted mantle model ages (TDM1) for positive εHf(t) values whereas two-stage crustal model ages (TDM2) were used for negative εHf(t) values. TDM1 was calculated using the measured Lu/Hf ratios and the present-day 176Hf/177Hf ratio of 0.28325 and 176Lu/177Hf of 0.0384 (Griffin et al. 2000) of depleted mantle. TDM2 was obtained under the assumption that the protolith of the host rock of a given zircon was derived from the depleted mantle and had the composition of the average continental crust with 176Lu/177Hf of 0.015 (Griffin et al. 2002). The zircon U–Pb and Lu–Hf isotopic data are presented in Tables S1 and S2.

Samples of the Buya pluton were analyzed at the State Key Laboratory of Continental Dynamics in Northwest University, Xi'an. Fresh whole rock chips were powdered to 200 mesh-size using a tungsten carbide ball mill. Major and trace elements were analyzed by XRF (Rikagu RIX 2100) and ICPMS (Agilent 7500a), respectively. Analyses of USGS and Chinese national rock standards (BCR-2, GSR-1 and GSR-3) indicate that analytical precision and accuracy for major elements are generally better than 5%. For trace element analysis, sample powders were digested using an HF+HNO3 mixture in high-pressure Teflon bombs at 190 °C for 48 h. Analytical precision is better than 10% for most trace elements. The geochemical data are showed in Table 1.

**References**

Blichert-Toft J, Albarède F (1997) The Lu–Hf isotope geochemistry of chondrites and the evolution of the mantle-crust system. Earth and Planetary Science Letters 148: 243–258

Chu NC, Taylor RN, Chavagnac V, Nesbitt RW, Boella RM, Milton JA, German CR, Bayon G, Burton K (2002) Hf isotope ratio analysis using multi-collector inductively coupled plasma mass spectrometry: an evaluation of isobaric interference corrections. Journal of Analytical Atomic Spectrometry 17: 1567–1574

De Biévre P, Taylor PDP (1993) Table of the isotopic compositions of the elements. International Journal of Mass Spectrometry and Ion Processes 123: 149–166.

Elhlou S, Belousova E, Griffin W.L, Pearson, N. J.; O'Reilly, S. Y. (2006). Trace Element and Isotopic Composition of GJ Red Zircon Standard by Laser Ablation. Geochim Cosmochim Acta, 70 (Suppl. 1), A158, 2006, 06.1383.

Griffin, W.L., Pearson, N.J., Belousova, E., Jackson, S.E., van Achterbergh, E., O'Reilly, S.Y., Shee, S.R., (2000) The Hf isotope composition of cratonic mantle: LAM–MC–ICPMS analysis of zircon megacrysts in kimberlites. Geochimica et Cosmochimica Acta 64, 133–147.

Griffin, W.L., Wang, X., Jackson, S.E., Pearson, N.J., O'Reilly, S.Y., Xu, X., Zhou, X., 2002. Zircon chemistry and magma genesis, SE China: in-situ analysis ofHfisotopes, Pingtan and Tonglu igneous complexes. Lithos 61, 237–269.Scherer, E., Münker, C., Mezger, K. (2001). Calibration of the lutetium-hafnium clock. Science 293, 683–687.

Ludwig KR (2003) Isoplot 30-A geochronological toolkit for Micro-soft Excel. Berkeley Geochronology Center Spec Pub 1–70

Simon EJ, Norman JP, William LG, Belousova W (2004) The application of laser ablation-inductively coupled plasma-mass spectrometry to in-situ U-Pb zircon geochronology. Chem Geol, 211:47-69.

Scherer E, Münker C, Mezger K (2001) Calibration of the lutetium-hafnium clock. Science 293:683–687

Yuan HL, Gao S, Dai MN, Zong CL, Günther D, Fontaine GH, Liu XM, DiWu CR (2008) Simultaneous determinations of U–Pb age, Hf isotopes and trace element compositions of zircon by excimer laser ablation quadrupole and multiple collector ICP–MS. Chemistry Geology 247:100–118

Yang JH, Wu FY, Wilde SA, Xie LW, Yang YH, Liu XM (2007) Tracing magma mixing in granite genesis: in situ U–Pb dating and Hf-isotope analysis of zircons. Contributions to Mineralogy and Petrology 153:177–190

Wiedenbeck M, Alle P, Griffin WL, Meier M, Oberli F, von Quadt, A.,Roddick, JC, Spiegel W (1995) Three natural zircon standards for U-Th-Pb, Lu-Hf, trace element and REE analyses. Geostand Newsl, 19: 1-23

Griffin WL, Pearson NJ, Belousova E, Jackson SE, O’Reilly SY, van Acherberg E, Shee SR (2000) The Hf iso- tope composition of cratonic mantle: LAM-MC-ICPMS analysis of zircon megacrysts in kimberlites. Geochimica et Cosmochimica Acta 64: 133-147

Griffin WL,Wang X, Jackson SE, Pearson NJ, O’Reilly SY, Xu X, Zhou X (2002) Zircon chemistry and magma mixing, SE China: In situ analysis of Hf isotopes, Tonglu and Pingtan igneous complexes. Lithos 61: 237-269



Figure S1. Cathodoluminescence (CL) images of representative zircon crystals with locations of LA-ICP-MS analyses. The gray scale bar in each image represents 100 μm.



Figure S2. Zircon Lu–Hf isotopic compositions of PQS and ME, showing the εHf(t) (a) and initial 176Hf/177Hf (b) versus zircon crystallization age.



**Figure S3.** Zircon Lu–Hf isotopic compositions of PQS and ME, showing the 176Lu/177Hf–176Hf/177Hf variations **(a)** and histograms of two-stage Hf model ages **(d)**.The depleted mantle (DM) evolution curve was calculated using mean present-day values of 176Lu/177Hf = 0.0384 and 176Hf/177Hf = 0.28325, after Griffin et al. (2002).