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Supplemental Material

Supplemental Text. Analytical Methods.

Table S1. LA-ICP-MS zircon U–Pb and trace element data of the Early Ordovician and Late Triassic intrusive rocks along the Bureya River.

Table S2. 40Ar/39Ar step-heating results of the Neoproterozoic-Late Triassic igneous rocks along the Bureya River.

Table S3. Major (wt.%) and trace (ppm) elements of the Early Ordovician and Late Triassic intrusive rocks along the Bureya River.

Table S4. Zircon Hf isotopic compositions of the Early Ordovician and Late Triassic intrusive rocks along the Bureya River.

Supporting Information for

Bureya-Jiamusi-Khanka superterrane linked to the Kuunga-Pinjarra interior orogen of East Gondwana and its drift toward Northeast Asia

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Contents of this file

Additional supporting information (Files uploaded separately)

Table S1. LA-ICP-MS zircon U–Pb and trace element data of the Early Ordovician and Late Triassic intrusive rocks along the Bureya River.

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Introduction

This supporting information provides the Analytical methods, and Table S1 to S4.

Analytical Methods

LA–ICP–MS U–Pb Determinations

Zircon dated in this contribution was extracted from fresh rock samples following normal separation methods at the Yantuo Mineral Separation Company (Langfang), Hebei, China. Recovered zircon grains together with chips of zircon standards Plésovice and Qinghu were mounted in epoxy discs and polished to expose the longitudinal section of crystals for analysis.

Under transmitted, reflected light, and cathodoluminescence (CL) images were collected on zircon grains to guide the LA–ICP–MS analyses.

Zircon U–Pb dating and trace element analyses of samples 17R17–1, 17R18–1, 17R13–10, and 17R4–1 were performed simultaneously using an Agilent 7500a ICP–MS equipped with a 193 nm laser, housed at the SampleSolution Analytical Technology Co., Ltd, Wuhan, China. The zircon 91500 was used as an external standard for age calibration, and the NIST SRM 610 silicate glass was applied for instrument optimization. To monitor the external uncertainties of LA–ICP–MS U–Pb measurements, analyses of secondary zircon standards GJ–1 and Plésovice were interspersed with unknowns. Eighteen analyses of GJ–1 and 16 analyses of Plésovice give weighted mean $^{206}Pb/^{238}U$ ages of 607.8 ± 0.7 (MSWD = 0.35) and 336.8 ± 0.5 Ma (MSWD = 0.25), respectively, which agree well with the recommended $^{206}Pb/^{238}U$ ages of 608.5 ± 0.4 Ma (Jackson et al., 2004) and 337.1 ± 0.4 Ma (Sláma et al., 2008) within analytical errors. The crater diameter was 32 μm during the analyses. For details on instrument settings and analytical procedures, see Yuan et al. (2004). The ICPMSDataCal (Ver. 6.7; Liu et al., 2008, 2010) and Isoplot (Ver. 3.0; Ludwig, 2003) programs were used for data reduction. Correction for common Pb was made following Andersen (2002). Errors on individual analyses by LA–ICP–MS are quoted at the 1σ level, while errors on pooled ages are quoted at the 95% (2σ) confidence level.

$^{40}Ar/^{39}Ar$ Dating

$^{40}Ar/^{39}Ar$ step-heating experiments were undertaken on three amphiboles from samples 17R3-1, 17R8-1 and 17R4-1, and on three biotites from samples 17R1-1, 17R13-1 and 17R17-1. Before analysis, minerals of amphibole and biotite with grain sizes of 200–280 μm were obtained using typical heavy liquid and magnetic separation techniques before handpicking under a binocular microscope at the Yantuo Mineral Separation Company (Langfang), Hebei, China.

All aliquots of mineral samples were wrapped in aluminum foil to form wafers, and stacked in quartz vials with the international standard YBCs (29.286 ± 0.045 Ma, Wang et al., 2014). Neutron irradiation was carried out in position H8 of 49-2 Nuclear Reactor (49-2 NR), Beijing (China), with a flux of ~ 6.5×10^{12} n $(cm^2s)^{-1}$ for 24 hours. CO_2 laser fusion technique was used for $^{40}Ar/^{39}Ar$ analyses. Isotopic measurements were made on the Noblesse mass spectrometer at the Institute of Geology and Geophysics, Chinese Academy of Sciences (IGGCAS), Beijing, China. Ca and K correction factors are $[^{36}Ar/^{37}Ar]_{Ca} = 0.000261 \pm 0.0000142$, $[^{39}Ar/^{37}Ar]_{Ca} = 0.000724 \pm 0.0000281$, $[^{40}Ar/^{39}Ar]_{K} = 0.00088 \pm 0.000023$. Ages were calculated using the decay constant ($5.543\times10^{-10}yr^{-1}$) listed by Steiger & Jäger (1977) and all errors were quoted at the 2σ level. Plateau ages were determined from three or more contiguous steps, comprising >50% of the ^{39}Ar released, revealing concordant ages at the 95% confidence level. Because no assumption was made regarding the trapped component, the preferred ages is isochron age, calculated from the results of plateau steps using the *York* regression algorithm (York, 1969). The age errors reported here are internal errors, including analytical error and errors on blank, interaction factor, mass-discrimination and J-value; the error on the total decay constant is not propagated into the age error. Uncertainties on all data reported herein are at the 95% confidence level (2σ). The data were processed by using ArArCALC (Koppers, 2002).

Major and Trace Element Analysis

After petrographic examination, 15 fresh samples (17R17-1 to 17R17-5, 17R4-1 to 17R4-4, 17R13-10 to 17R13-13, and 17R18-1 to 17R18-3) were selected, crushed, and powdered in an agate mill to ~200 mesh after the removal of weathered surfaces. X–ray fluorescence (XRF; Rigaku RIX 2100 spectrometer) and ICP–MS (Agilent 7500a with a shield torch) were used to measure the major and trace elements compositions, respectively, at the SampleSolution Analytical Technology Co., Ltd, Wuhan, China. The analytical results for USGS standards GDW07103 (GSR–1, granite), GDW07104 (GSR–2, andesite) and GDW07104 (GSR–3, basalt) indicated that the analytical precision was better than 5% for major elements and 10% for trace and rare earth elements (Guo et al., 2015).

Lu–Hf Isotope Analysis

In situ zircon Hf isotopic analyses of the dated samples (17R17–1, 17R18–1, 17R13–10, and 17R4–1) were carried out at the IGGCAS, using a Neptune multi–collector ICP–MS equipped with 193 nm laser. Hf isotopic analyses were performed using a spot size of 63 μm, a laser repetition rate of 10 Hz, and a beam density of 10 J/cm^2. The detailed analytical procedures are described in Wu et al. (2006). Raw count rates for ^{172}Yb, ^{173}Yb, ^{175}Lu, ^{176}(Hf + Yb + Lu), ^{177}Hf, ^{178}Hf, ^{179}Hf, ^{180}Hf, and ^{182}W were collected, and isobaric interference corrections for ^{176}Lu and ^{176}Yb on ^{176}Hf were determined precisely. ^{176}Lu was calibrated using the ^{175}Lu value and a correction was made to ^{176}Hf. The ^{176}Yb/^{172}Yb value of 0.5887 (Vervoort et al., 2004) and the mean β_{Yb} value (Iizuka & Hirata, 2005) obtained during Hf analysis on the same spot were applied to obtain an interference correction of ^{176}Yb on ^{176}Hf. During analyses, the ^{176}Hf/^{177}Hf ratio of standard zircon 91500 is 0.282289 ± 0.000022, respectively, which are within errors of the commonly accepted values determined by Wu et al. (2006), Blichert–Toft (2008), and Fisher et al. (2014), also using laser method. The measured ^{176}Hf/^{177}Hf and ^{176}Lu/^{177}Hf ratios were used to calculate the initial ^{176}Hf/^{177}Hf ratios, taking the decay constant for ^{176}Lu as 1.865×10^{-11}/year (Scherer et al., 2001). The pristine chondritic ratios of ^{176}Hf/^{177}Hf = 0.282793 ± 0.000011 and ^{176}Lu/^{177}Hf = 0.0338 ± 0.0001 (Iizuka et al., 2015) were adopted to calculate $\varepsilon_{Hf}(t)$ values. Single–stage Hf model ages (T_{DM1}) were calculated relative to depleted mantle with a present–day ^{176}Hf/^{177}Hf ratio of 0.28325 and a ^{176}Lu/^{177}Hf ratio of 0.0384 (Griffin et al., 2000). Two stage model ages (T_{DM2}) were also calculated based on a mafic lower crust ^{176}Lu/^{177}Hf ratio of 0.022 (Amelin et al., 1999).

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