**S1. Analytical Methodology**

## S1.1 Zircon U-Pb dating and trace element analysis of basalt

Zircons of basalt sample (AYBL09) were separated according to the standard procedure involving heavy liquids at the Yuheng Rock & Mineral Technology Service Co., LTD., Langfang, China, using conventional magnetic and heavy-liquid concentration techniques. Approximately 170 zircon grains were picked from the sample and embedded in epoxy resin. Zircon grain morphology and interior structure were examined using cathodoluminescence (CL) methods at Beijing Gaonian Linghang Co., Ltd. The most suitable area for U–Pb dating were also chosen in the zircon grains in advance, avoiding domain boundaries, cracks, and inclusions.

Zircon U-Pb isotopic and trace element data were obtained using the Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) technique at the Beijing Quick-Thermo Science & Technology Co., Ltd, China. In the LA-ICP-MS laboratory, laser sampling was performed using ESI New Wave NWR 193UC (Two Vol2) laser ablation system. An Agilent 8900 ICP-QQQ ICP-MS instrument was utilized to acquire ion-signal intensities. Individual zircon grains (mounted and polished in epoxy) were ablated in a constant stream of He mixed downstream with N2 (flow rate, 2.5 ml/min) and Ar before entering the torch region of the ICP-QQQ. After warm-up of the ICP–QQQ and connection with the laser ablation system, the ICP-MS was first tuned for robust plasma conditions in single quadrupole mode (the first quadrupole was passive) by optimizing He, Ar and N2 flow, monitoring 232Th16O+/232Th+ ratios (always ≤ 0.2%) and 238U+/232Th+ ratios (always between 0.95 and 1.05) while ablating NIST SRM 612 in line scan mode. Zircon 91500 was used as the primary reference material for all U-Pb age determinations. The energy density and laser frequency were 3.5 J/cm2 and 5 Hz, respectively. The analytical spot for zircon was 25 µm in diameter. Background subtraction and correction for laser-induced fractionation of U–Pb ratio signals were performed using the Iolite software package (Ver 3) (Paton et al., 2010). Concordia diagrams and weighted-mean age figures were made using the IsoplotR (Vermeesch, 2018).

## S1.2 Detrital zircon U-Pb dating of sandstone from the Kandilik region

Zircons of sandstone sample (AYBL13) were separated according to the standard procedure involving heavy liquids at the Langfang Chengxin Geological Service Co. Ltd, China, using conventional magnetic and heavy-liquid concentration techniques. Zircon grains were picked from the sample and embedded in epoxy resin. Zircon grain morphology and interior structure were examined using cathodoluminescence (CL) methods at Beijing Gaonian Linghang Co., Ltd. The most suitable area for U–Pb dating were also chosen in the zircon grains in advance, avoiding domain boundaries, cracks, and inclusions.

Zircon U-Pb isotopic data were obtained using the Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) technique at the Beijing Quick-Thermo Science & Technology Co., Ltd, China. The detailed procedure and information of the instrument environment were as same as the description of the analysis for zircons of the basalt.

The data obtained were processed using the software Iolite (Paton et al., 2010), including performing off-line selection and integration of background and analytic signals, as well as time-drift correction and quantitative calibration for trace element analysis and U-Pb dating. Interpreted ages are based on 206Pb/238U for <1000 Ma grains and 206Pb/207Pb for >1000 Ma grains. Concordia diagrams and weighted-mean age figures were made using the IsoplotR (Vermeesch, 2018).

## S1.3 Detrital zircon U-Pb dating of two sandstones from the Kyzyltau region

Zircons of two sandstone sample (KZLT1601 and KZLT1602) were separated according to the standard procedure involving heavy liquids at the Mineral Separation Laboratory of the Langfang Shangyi Testing Technology Co., Ltd, China, using conventional magnetic and heavy-liquid concentration techniques. Zircon grains were picked from the sample and embedded in epoxy resin. Zircon grain morphology and interior structure were examined using cathodoluminescence (CL) methods at Beijing Gaonian Linghang Co., Ltd. The most suitable area for U–Pb dating were also chosen in the zircon grains in advance, avoiding domain boundaries, cracks, and inclusions.

Zircon U-Pb isotopic data were obtained using the LA-ICP-MS technique at the School of Earth Sciences, Zhejiang University. In the LA-ICP-MS laboratory in the School of Earth Science, Zhejiang University, China, laser sampling was performed using Cetea Analyte HE with a beam spot of 35μm in diameter. A Thermofisher iCAP RQ ICP-MS instrument was utilized to acquire ion-signal intensities. NIST612 and NIST610 were used as external standards for element correction, and zircon 91500 was applied to the external standard for the U-Pb dating. In the course of studies, the zircon 91500 was analyzed twice every five sample zircon analyses (Jackson et al., 2004) with a Concordia age estimated at 1065 ± 8 Ma (2σ; MSWD = 0.51). Plešovice (337 Ma) was treated as quality control for geochronology with a weighted average 206Pb/238U age estimated at 334 ± 3 Ma (2σ; MSWD = 0.29).

The data obtained were processed using the software ICPMSDataCal (Ver. 11.8), including performing off-line selection and integration of background and analytic signals, as well as time-drift correction and quantitative calibration for trace element analysis and U-Pb dating (Liu et al., 2008). Interpreted ages are based on 206Pb/238U ages for those <1000 Ma grains and 206Pb/207Pb ages for those >1000 Ma grains. Concordia diagrams and weighted-mean age figures were made using the IsoplotR (Vermeesch, 2018), and single-spot ages with 90-100% concordance are plotted as Kernel Density Estimation (KDE) diagrams using Density Plotter (Vermeesch, 2012).

## S1.4 Whole-rock major and trace elements

Six basaltic samples (AYBL11B, AYBL11C, AYBL11D , AYBL11E, AYBL11F and AYBL11G) were first washed in deionized water, and then dried. After that, we chose fresh parts for primary bulk crushing and then all samples were pulverized to a 200-mesh in an agate mortar for chemical analysis. The major and trace elements were determined at the Wuhan Samplesolution Analytical Technology Co., Ltd., Wuhan, China. Major-element abundances were measured on fused glass beads using X-ray fluorescence (XRF) spectrophotometry (Primus Ⅱ, Rigaku, Japan). Powdered samples (< 200 mesh) were first placed in an oven at 105 ℃ for drying of 12 hours. Then, around 1.0 g dried powers were put in a muffle furnace and heated to 1000 ◦C for 2 hours to determine the loss on ignition (LOI). Then, the residuals were mixed with cosolvent of LiB4O7, LiBO2 and LiF (9:2:1) and oxidant (NH4NO3) in a Pt crucible. Then they were placed in the furnace at 1150 ℃ for 14 minutes. This melting sample was finally quenched with air for 1 minutes to produce flat discs on the fire brick for the XRF analyses.

For the trace element analysis, the power (< 200 mesh) was first placed in an oven at 105 ℃ for drying of 12 hours. Then, around 50 mg sample powder was treated in a solution of HF and HNO3 using a high-pressure Teflon bomb, heated to 190 ◦C in an oven for >24 hours until nearly dry. 1 ml of HNO3, 1 ml of MQ water and 1 ml internal standard solution of 1 ppm In were added, and the Teflon bomb was resealed and placed in the oven at 190 ℃ for >12 hours. And then the solution was transferred to a polyethylene bottle and diluted to 100 g by the addition of 2 % HNO3. Finally, they were analyzed by an Agilent 7700e ICP-MS at the Wuhan SampleSolution Analytical Technology Co., Ltd., Wuhan, China. Analytical precision and accuracy for major elements are better than 1 % by XRF, and analytical precision and accuracy for trace elements are better than 10 % by ICP-MS.

# Reference

Jackson, S. E., Pearson, N. J., Griffin, W. L., and Belousova, E. A.: The application of laser ablation-inductively coupled plasma-mass spectrometry to in situ U–Pb zircon geochronology, Chemical Geology, 211, 47-69, https://doi.org/10.1016/j.chemgeo.2004.06.017, 2004.

Liu, Y., Zong, K., Kelemen, P. B., and Gao, S.: Geochemistry and magmatic history of eclogites and ultramafic rocks from the Chinese continental scientific drill hole: Subduction and ultrahigh-pressure metamorphism of lower crustal cumulates, Chemical Geology, 247, 133-153, https://doi.org/10.1016/j.chemgeo.2007.10.016, 2008.

Paton, C., Woodhead, J. D., Hellstrom, J. C., Hergt, J. M., Greig, A., and Maas, R.: Improved laser ablation U-Pb zircon geochronology through robust downhole fractionation correction, Geochemistry, Geophysics, Geosystems, 11, https://doi.org/10.1029/2009GC002618, 2010.

Vermeesch, P.: IsoplotR: A free and open toolbox for geochronology, Geoscience Frontiers, 9, 1479-1493, https://doi.org/10.1016/j.gsf.2018.04.001, 2018.

Vermeesch, P.: On the visualisation of detrital age distributions, Chemical Geology, 312-313, 190-194, https://doi.org/10.1016/j.chemgeo.2012.04.021, 2012.