

Yang, S.X., Liu, C.F., Tai, B.Q., Liu, W.C., Xu, D.B., and Bai, F., 2025, From Oceanic Subduction to Post-Collision: Orogenic Extension and Bimodal Magmatism Along the Eastern Northern Margin of the North China Craton in the Paleozoic-Mesozoic Era: GSA Bulletin, <https://doi.org/10.1130/B38145.1>.

Supplemental Material

Supplemental File S1: Analytical methods.

Table S1: LA-ICP-MS results for zircons U-Pb ages of these samples from the study area, the Xiaohongshilazi Pb-Zn ore district of central Jilin Province, Northeast China.

Table S2: Major and trace elements for these samples from the study area, the Xiaohongshilazi Pb-Zn ore district of central Jilin Province, Northeast China.

Table S3: Whole rock Sr-Nd isotopic analysis for these samples from the study area, the Xiaohongshilazi Pb-Zn ore district of central Jilin Province, Northeast China.

$$^{87}\text{Sr}/^{86}\text{Sr}_i = ^{87}\text{Sr}/^{86}\text{Sr} - (^{87}\text{Rb}/^{86}\text{Sr}) \times (e^{\lambda t} - 1), \lambda_{\text{Rb-Sr}} = 0.0142 \text{ Ga}^{-1}. \epsilon_{\text{Nd}}(t) = [(^{143}\text{Nd}/^{144}\text{Nd})_{\text{Sample}}(t) / (^{143}\text{Nd}/^{144}\text{Nd})_{\text{CHUR}}(t) - 1] \times 10^4, \\ (^{143}\text{Nd}/^{144}\text{Nd})_{\text{CHUR}}(t) = 0.512638 - 0.1967 \times (e^{\lambda t} - 1).$$

Table S4: Zircon Hf isotopic compositions for these samples from the study area, the Xiaohongshilazi Pb-Zn ore district of central Jilin Province, Northeast China.

$$\epsilon_{\text{Hf}}(t) = [(^{176}\text{Hf}/^{177}\text{Hf})_{\text{Sample}}(t) / (^{176}\text{Hf}/^{177}\text{Hf})_{\text{CHUR}}(t) - 1] \times 10^4; \lambda_{\text{Lu-Hf}} = 1.93 \times 10^{-11} \text{ y}^{-1}. (^{176}\text{Lu}/^{177}\text{Hf})_{\text{CHUR},0} = 0.0332 \pm 2 \\ (^{176}\text{Hf}/^{177}\text{Hf})_{\text{CHUR},0} = 0.282772 \pm 29.$$

Supplementary File1

Contents:

Analytical methods

Zircon U–Pb dating. Samples were first crushed using conventional crushing and then separated using heavy liquids and a magnetic separator at the Langfang Mineral Separation Laboratory of the Bureau of Geology and Mineral Resources of Hebei Province. Zircon grains were separated through conventional magnetic and density techniques. The grains were hand-picked under a binocular microscope. Internal structures of the zircon grains were examined using the transmitted electron microscope, and imaged by backscattered electron (BSE) and cathode luminescence (CL) prior to U–Pb isotopic analyses. The BSE and CL imaging was carried out using a LEO1450VP scanning electron microscope with a MiniCL detector at the Institute of Mineral Resources, Chinese Academy of Geological Sciences, Beijing, China. Zircon analyses were performed on the Neptune multiple-collector inductively-coupled plasma mass spectrometer (Thermo Fisher Ltd.) with a 193 nm-FX ArF excimer laser-ablation system (ESI Ltd.) at the Isotopic Laboratory, Tianjin Institute of Geology and Mineral Resources. NIST610 glass was used as an external standard to calculate U, Th, and Pb concentrations of zircons, common Pb correction used the ^{208}Pb method ([Stacey & Kramers 1975](#)), and TEMORA zircon was used as an external standard to normalize isotopic fractionation during the analysis. Uncertainties of individual analyses are reported with 1σ errors; weighted-mean ages are reported at the 2σ confidence level. The age calculations and plotting of concordia diagrams were done using Isoplot ([Ludwing 2003](#)). The detailed analytical technique is described in [Li et al. \(2009\)](#).

Major and trace element determinations. Major elements were analyzed by X-ray fluorescence analysis (XRF; PHILIPS PW1480) using fused glass disks at the Langfang Regional Geological Survey, Hebei Province, China. The content of oxide was analyzed by wet chemical method, and the loss of ignition was determined by the gravity method, also, the analysis accuracy was better than 1%. Trace element and

rare earth element (REE) abundances were measured using inductively coupled plasma-mass spectrometry (ICP-MS) following the technique of [Liang & Grégoire \(2000\)](#) and [Gao et al. \(2008\)](#) with analytical precisions for most elements better than 5% for Zr, Hf, Nb, and Ta, values were within 10% of certified values.

Whole-rock Sr-Nd isotopic analysis. Samples were analyzed on a Finnigan MAT262 multi-receiver mass spectrometer in the Analytical Testing Research Center, Beijing Research Institute of Uranium Geology, following the analytical procedures described by Liu et al. ([2021](#)). During the analysis, Sr, Sm, and Nd isotopic compositions were normalized to $^{86}\text{Sr}/^{88}\text{Sr} = 0.119400$, $^{149}\text{Sm}/^{152}\text{Sm} = 0.516858$, $^{143}\text{Nd}/^{144}\text{Nd} = 0.511860$, and $^{146}\text{Nd}/^{144}\text{Nd} = 0.721900$. Further, Rayleigh's law was applied to correct for isotopic mass fractionation. The results of Sr–Nd isotope analyses are presented in Supplementary Table S3.

In-situ zircon Hf isotopic analyses. Two samples were selected for zircon Hf isotopic analysis. They were taken from the same zircons and sites used in the U–Pb dating. In situ zircon Hf isotopic analyses were performed using a Neptune MC-ICP-MS with a 193 nm laser system at the Key Laboratory of Continental Tectonics and Dynamics, Institute of Geology, Chinese Academy of Geological Sciences in Beijing, China. During analyses, we adopted a spot size of 32 μm , ablation time of 27 s, and ablation rate of 8 Hz. The detailed analytical technique was described by Amelin et al. ([2000](#)) and Wu et al. ([2006](#)). The results of Hf isotope analyses are presented in Supplementary Table S4.

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