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**Research Advances**

# Discovery of Neoproterozoic Rocks in the Dunhuang Block: Clues to Correlation with Rodinia

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## Objective

Rodinia was a supercontinent that comprised nearly all the current existing continents/blocks on Earth to form a coherent large landmass during the Meso-Neoproterozoic. Thus, discovery of Meso-Neoproterozoic rocks in a certain Precambrian block can provide important clues for studying the assembly and break-up history of Rodinia.

The Dunhuang Block, located at the southernmost part of the Central Asian Orogenic Belt (CAOB), is similar to other microcontinents with Precambrian basement rocks that have been recognized within the CAOB. Previously the block has been considered as a unified crystalline basement composed of microcontinental blocks or fragments that were pieced together during the early Precambrian, prior to 1.78 Ga, and subsequently overprinted by Paleozoic magmatic and metamorphic processes during the complicated amalgamation and collision of the CAOB. The supracrustal rocks in the Dunhuang Block are known as the Dunhuang Group, the U-Pb ages of detrital zircon from metasedimentary rocks of which show a prominent Mesoproterozoic–Neoproterozoic age population of 1.0–0.82 Ga, suggesting that the block was likely involved in the assembly and break-up of Rodinia.

In this study, we report for the first time the discovery of Neoproterozoic rocks in the Dunhuang Block, which may provide some clues for the correlation of the block with Rodinia.

## Methods

Five pyroxene-amphibolite samples have been collected from the western Dongbatu area of the Dunhuang Block. In-situ U-Pb dating and trace elements analysis of zircons were carried out using an Agilent 7500a ICP-MS instrument equipped with a 193 nm ArF–excimer laser at the State Key Laboratory of Continental Dynamics, Northwest University, Xi'an, China. A fixed beam diameter of 32 μm with a laser repetition rate of 6 Hz was adopted throughout this study. The raw data were calculated using the GLITTER 4.0 program (Macquarie University) with the Harvard zircon 91500 used as an external standard reference material to correct for both instrumental mass bias and depth-dependent elemental and isotopic fractionation. Concentrations of trace elements were calibrated using $^{29}Si$ as an internal standard and NIST SRM 610 as an external standard.

Zircon Hf isotope analysis was performed on a Nu Plasma HR MC-ICP-MS (Nu Instruments Ltd., UK) equipped with a GeoLas 2005 193 nm ArF–excimer laser-ablation system. Data were acquired using a beam size of 44 μm and He was used as the carrier gas. The laser pulse repetition rate was 8 Hz, and the applied energy density was 15 mJ/cm$^2$. Time-dependent drifts of Lu-Hf isotopic ratios were corrected using a linear interpolation according to the variations of 91500 and GJ-1.

## Results

The pyroxene–amphibolite samples were collected from the western part of the Dongbatu area (Fig. 1a). The rocks are composed principally of hornblende (50%–55%), plagioclase (45%–50%) and diopside (5%–7%), with minor accessory minerals of zircon, apatite and titanite. The rocks commonly intrude into the Paleoproterozoic (> 1.6 Ga) supracrustal rocks of the Dunhuang Group, and were in turn intruded by Paleozoic (ca. 404 Ma) light-colored quartz–feldspathic veins.

Zircons from one pyroxene–amphibolite sample (15DH61) are prismatic or ellipsoidal in shape and range in size from 80–120 mm. In CL images, they present discernible compositional zoning in their cores (Fig. 1b), indicating a magmatic origin. Twenty cores of zircon grains were analyzed. They have moderate to high Th (73–4729 ppm), U (98–2067 ppm) and Pb (18–533 ppm) contents and high Th/U ratios. On the concordia diagram, the 20 analyses are distributed on or near the concordia curve, suggesting that the zircons experienced variable Pb loss during the later tectonothermal events; they yield an upper intercept age of 830 ± 13 Ma (MSWD = 1.0), which is identical to the weighted average $^{206}Pb/^{238}U$ age of 831 ± 29 Ma (Fig. 1c). Therefore, 830 Ma is interpreted as the emplacement age of the precursor of the pyroxene-amphibolite sample.

Although 15 zircons from sample 15DH61 have variable $^{176}Hf/^{177}Hf$ ratios ranging from 0.282577 to 0.282415, they yield uniform positive $\varepsilon_{Hf}(t)$ values of +3.78– +11.23 at 830 Ma and their corresponding one-stage model ages range from 932 Ma to 1216 Ma with an average of 1096 Ma. (Fig. 1d).

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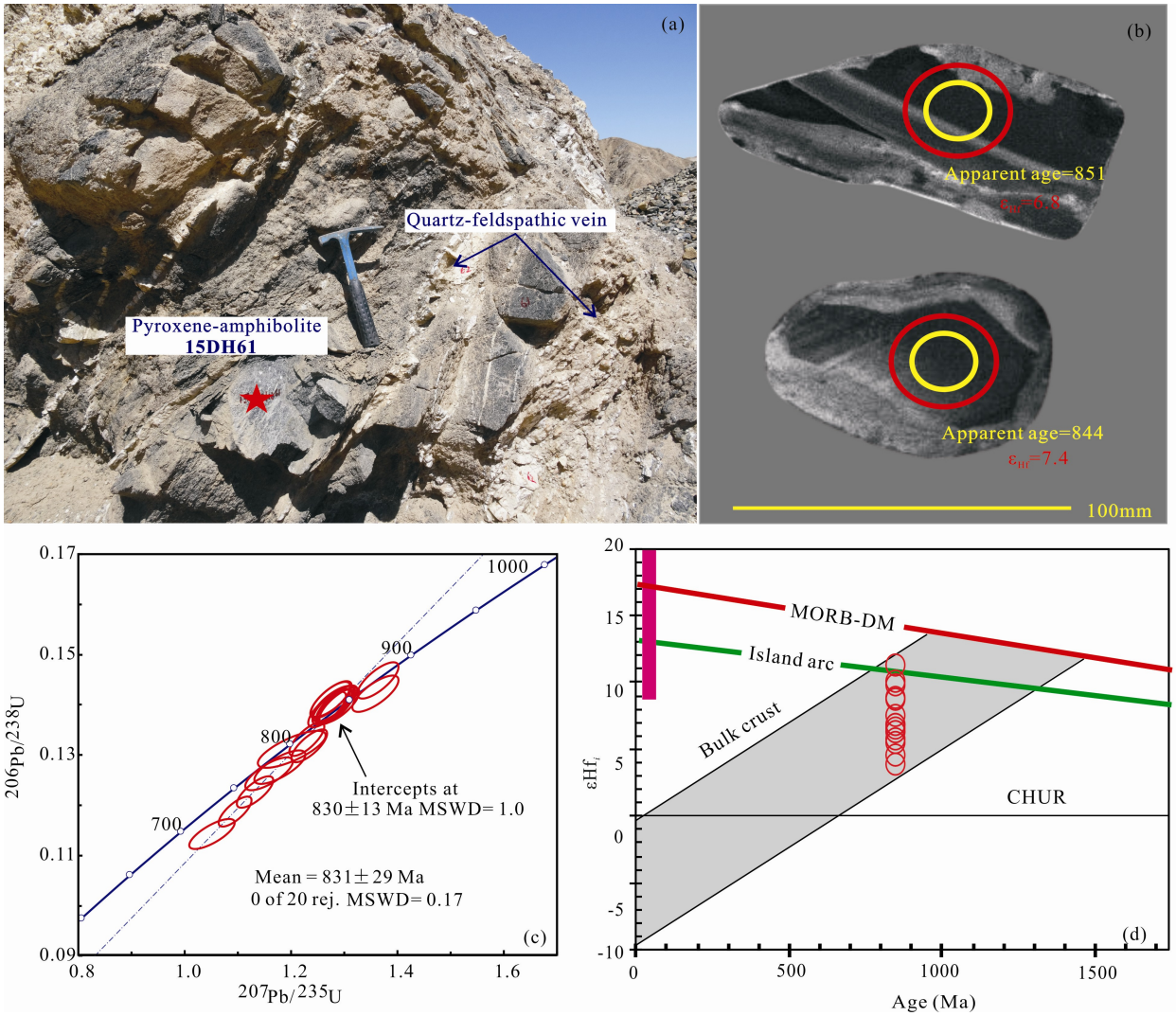


Fig. 1. Field photograph of the Neoproterozoic rocks in the Dunhuang Block (a) representative cathodoluminescence (CL) images of zircons from a Neoproterozoic rock (15DH61); concordia diagrams of zircon U-Pb dating (c) and Hf isotopic composition in zircons (d) from the Neoproterozoic rock.

## Conclusions

Pyroxene–amphibolite rocks with an age of ca. 830 Ma have been identified for the first time in the Dunhuang Block. Ca. 830 Ma zircons from the pyroxene–amphibolite sample present uniform positive $\varepsilon_{Hf}(t)$ values and their one-stage Hf model ages are close to the time of zircon growth from magma, indicating that their host rocks were probably derived from a depleted mantle source. The discovery of Neoproterozoic mafic rocks in the Dunhuang Block suggests that the block experienced long-term magmatism (3.1–0.8 Ga) during the period of the Precambrian. The block also recorded Neoproterozoic magmatism, which was widespread in the Tarim Craton, South China, Qilian–Qaidam, India and Australia in relation to the breakup of Rodinia.

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