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Research paper

SHRIMP zircon dating and LA-ICPMS Hf analysis of early Precambrian rocks from drill holes into the basement beneath the Central Hebei Basin, North China Craton

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ABSTRACT

The Central Hebei Basin (CHB) is one of the largest sedimentary basins in the North China Craton, extending in a northeast–southwest direction with an area of >350 km^2. We carried out SHRIMP zircon dating, Hf-in-zircon isotopic analysis and a whole-rock geochemical study on igneous and metasedimentary rocks recovered from drill holes that penetrated into the basement of the CHB. Two samples of gneissic granodiorite (XG1-1) and gneissic quartz diorite (J48-1) have magmatic ages of 2500 and 2496 Ma, respectively. Their zircons also record metamorphic ages of 2.41–2.51 and ~2.5 Ga, respectively. Compared with the gneissic granodiorite, the gneissic quartz diorite has higher ΣREE contents and lower Eu/Eu* and $(La/Yb)_n$ values. Two metasedimentary samples (MG1, H5) mainly contain ~2.5 Ga detrital zircons as well as late Paleoproterozoic metamorphic grains. The zircons of different origins have ε_{Hf} (2.5 Ga) values and Hf crustal model ages ranging from 0 to 5 and 2.7 to 2.9 Ga, respectively. Therefore, ~2.5 Ga magmatic and Paleoproterozoic metasedimentary rocks and late Neoarchean to early Paleoproterozoic and late Paleoproterozoic tectono-thermal events have been identified in the basement beneath the CHB. Based on regional comparisons, we conclude that the early Precambrian basement beneath the CHB is part of the North China Craton.

1. Introduction

Geological, geochemical and geochronological studies revealed many common features in the exposed early Precambrian rocks of the North China Craton (NCC) (Wan et al., 2011a; Zhai and Santosh, 2011; Zhao and Zhai, 2013 and references therein), which are summarized as follows: (1) the NCC underwent a long and complex tectono-magmatic history back to 3.8 Ga, with 2.8–3.8 Ga rocks having been identified in several areas; (2) juvenile additions of crust from mantle sources were generated in the late Mesoarchean to early Neoarchean and constitute an important crust formation event; (3) the NCC is different from several other cratons in having experienced extensive late Neoarchean tectono-thermal events that resulted in recycling of more ancient crustal material, besides juvenile crustal additions; (4) all or parts of the NCC experienced an extensional tectonic event during the latest Neoarchean as a mark of cratonic stabilization; (5) Paleoproterozoic geological processes in the NCC were much more complex than thought before, with 2.4–2.49 Ga metamorphism and 2.0–2.35 Ga magmatism having

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been identified in many areas; (6) late Paleoproterozoic (1.8–1.95 Ga) tectono-thermal events occurred widely in the NCC and led to a unified craton towards the end of the Paleoproterozoic. However, the NCC is extensively covered by Mesoproterozoic and younger sedimentary sequences. Zircon dating of rocks recovered from drill holes into the basement was carried out in only a few basins. One such study revealed late Paleoproterozoic magmatism and metamorphism in basement rocks beneath the Songliao basin in the northeastern NCC (Pei et al., 2007), whereas another study indicated that the Ordos basement in the western NCC was involved in a widespread late Paleoproterozoic tectono-thermal event (Hu et al., 2012; Wan et al., 2013).

The Central Hebei Basin (CHB) is one of the largest basins in the NCC, and we carried out SHRIMP zircon dating, Hf-in-zircon isotopic analysis and a whole-rock geochemical study of magmatic and metasedimentary rocks recovered from drill holes that penetrated its basement.

2. Geological background

The CHB extends in a northeast–southwest direction with an area of >350 km^2 (Fig. 1). Its basement is entirely covered by Mesoproterozoic and younger sedimentary rocks. Based on drill core data and geophysical investigations (NCOCP, 2012), the basement is composed of magmatic (mainly granitoids) and supracrustal rocks (mainly amphibolite, biotite plagioclase gneiss and schist) with greenschist- to upper amphibolite-facies metamorphism and local anatexis. The bottom of the basin shows up-and-down elevations with the greatest depth being >5000 m. In some areas the early Precambrian basement constitutes buried hills that are controlled by northeast–southwest faults and extend roughly in the same direction as the basin.

Early Precambrian rocks occur extensively around the CHB. In the northwest and west of the basin there are the early Precambrian Fuping and Zanhuang complexes that contain 1.8–1.9,

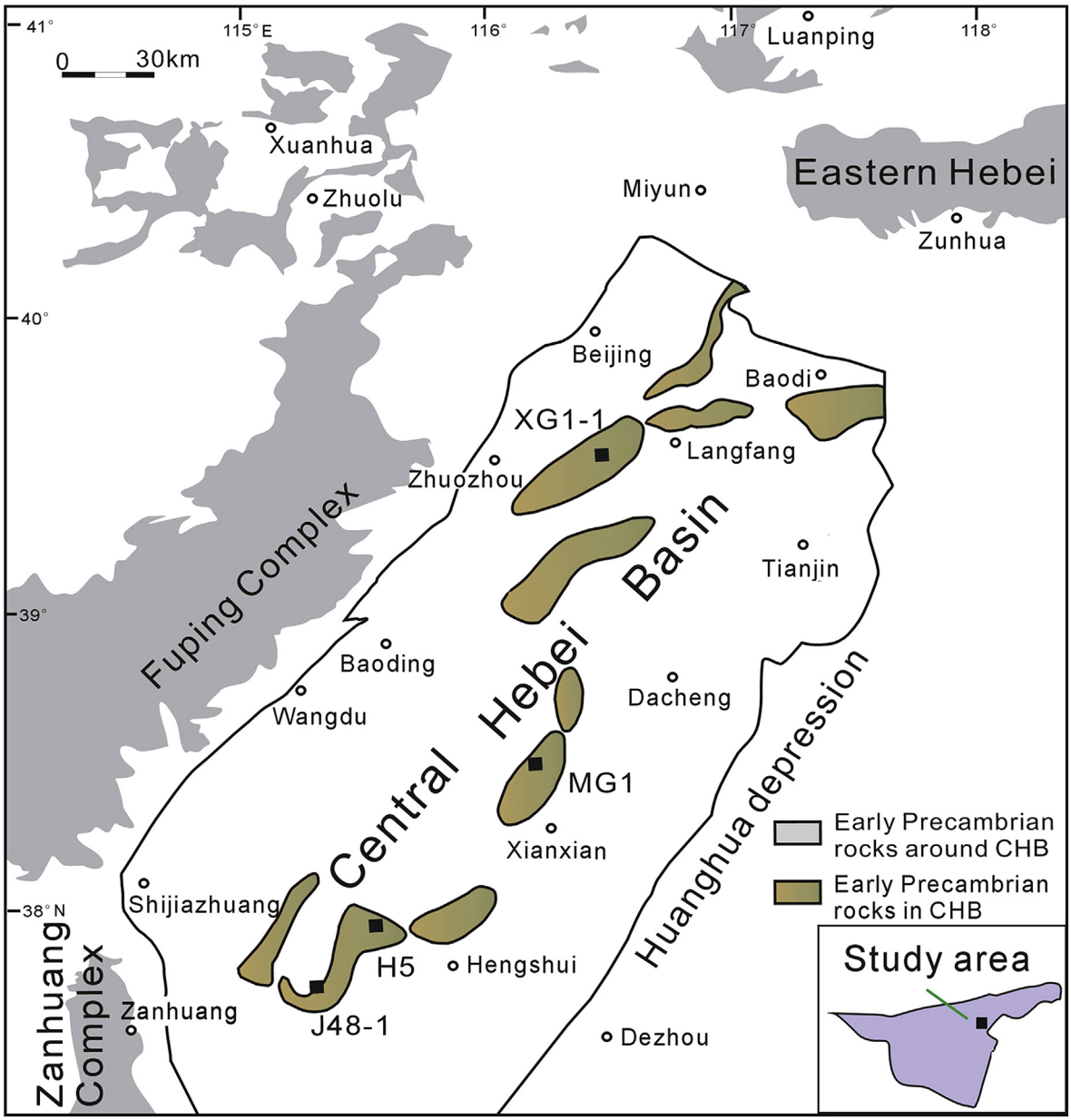

Figure 1. Geological map of the Central Hebei Basin and surrounding areas (modified after NCOCP, 2012), showing sample locations in this study. The identification of early Precambrian rocks within the Central Hebei Basin is based on drill core data and geophysical investigations.