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Long-term cooling/drying record of North China since the middle Pleistocene from geochemical evidence of a 150 m deep drill core, Beijing plain, China

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ABSTRACT

The Quaternary strata in North China primarily consist of fluvial sediments, which react strongly to East Asian Monsoon circulation. However, the records of the Quaternary climate change history in terms of these fluvial sedimentations were limited which impeded understanding the East Asian Monsoon evolution in North China. Thus, a 150 m deep drill core was collected from Changping in the Beijing plain to reconstruct the Quaternary palaeoenvironmental changes. The core was chronologically well constrained using palaeomagnetic and thermoluminescence dating. The magnetostratigraphic result indicated that the Brunhes/Matuyama boundary is at 134.2 m (0.78 Ma) and the age at the bottom of the core is 1.07 Ma. The thermoluminescence (TL) dating of the upper sand at ~2 m was 10.4 ka. The chemical weathering history since the middle Pleistocene in Beijing plain was reconstructed by using geochemical proxies including selected major element pairs, chemical index of alteration and Al_2O_3–CaO* –(Na_2O + K_2O) diagrams. The CIA value of the Changping core ranged from 50.3 to 69.4 (average 59.2), which indicated that the sediment has experienced incipient to intermediate chemical weathering during the middle Pleistocene. The result of A–CN–K figure shows a high plagioclase to K-feldspar ratio in the source, which would be indicative of a granodiorite (Gd) source from Jundu Mountains north of the Beijing plain. All the geochemical results revealed a long-term gradual decrease of weathering since the middle Pleistocene, which implied a long-term increasing aridification/cooling in the Beijing plain.

1. Introduction

In recent decades, Quaternary palaeoenvironmental changes in North China were mainly revealed from the extensive studies of the Chinese loess–palaeosol sequences deposits (e.g. Liu and Ding, 1998; An et al., 2001; Yang et al., 2006; Liu et al., 2007; Sun et al., 2010). The Quaternary loess sediment in the North China offers a record of East Asian monsoon circulation. However, studies of the fluvial sediment are rare. In order to comprehensively understand the Quaternary palaeoenvironmental changes in the East Asian monsoon region, we should explore the palaeoclimatic records of these fluvial sedimentations. Previous studies of Quaternary fluvial sedimentation history in China have mainly focused on the stratigraphy of coastal zones (Zhu et al., 1980; Wu and Li, 1987; Yang and Lin, 1991; Chen and Stanley, 1995; Li et al., 2000). Continuous long-term palaeoenvironmental records with reliable age-dating constraints in the terrestrial zone are relatively rare (Yang et al., 2006; Ao et al., 2010; Zhang et al., 2013). Consequently, current information from fluvial sediments is insufficient to better understand the Quaternary palaeoenvironmental changes of North China and the evolution of the East Asian monsoon.

Beijing plain is located in the northwest North China Plain, and its environment is influenced by the East Asian Monsoon circulation (Fig. 1a). In the present study, a 150 m drill core with an average recovery rate of ~93% was taken from Changping (40°8′22.6″ N, 116°12′17.1″ E) for geochemical analyses. We measured compositions of major and trace elements of the sediments to reconstruct the chemical weathering and palaeoenvironmental variability in North China since the Middle Pleistocene. By comparing the data with the northwest loess and other records in East Asian Monsoon areas, we attempt to

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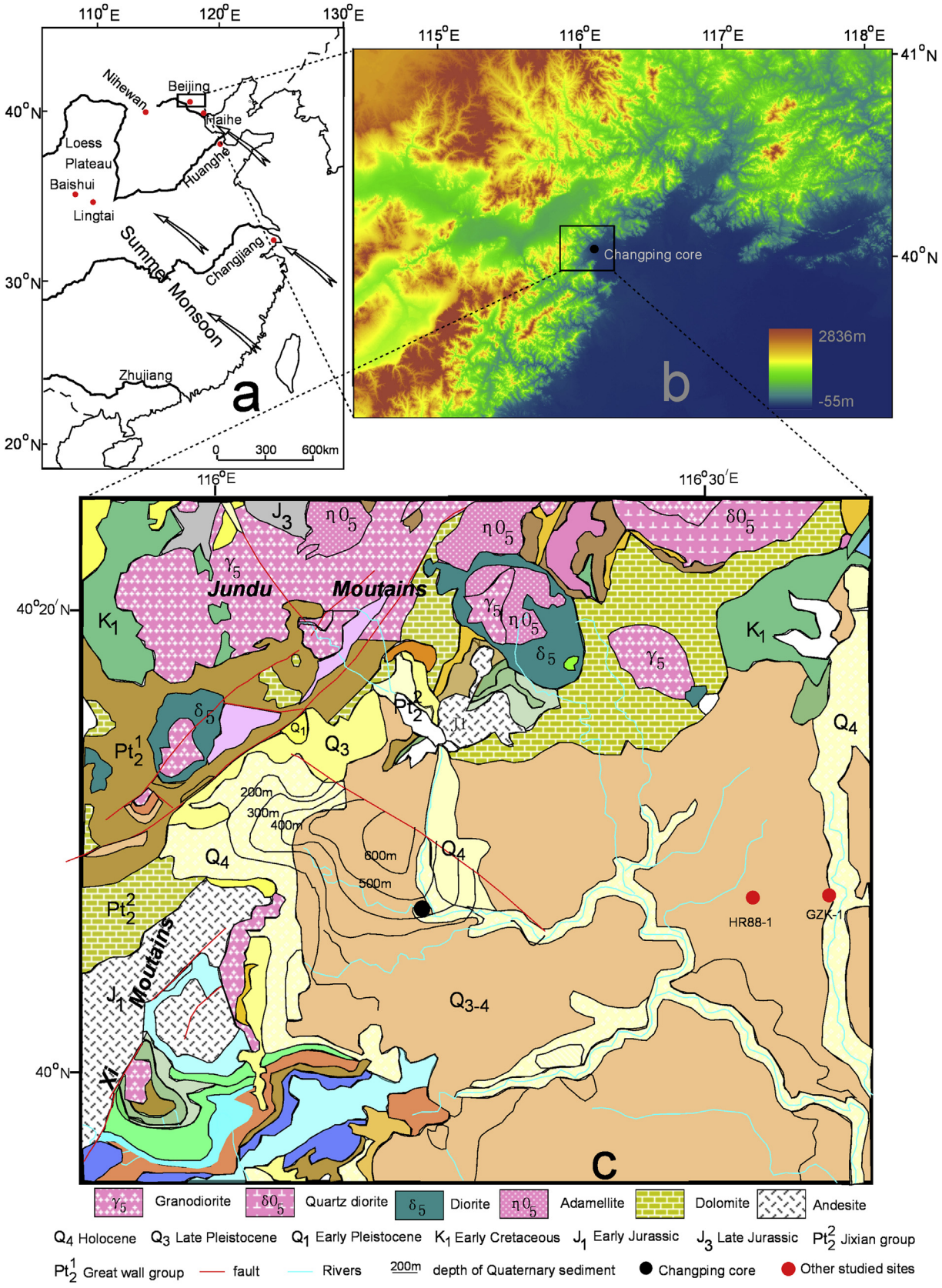

Fig. 1. a. Map of China and studied sites; b. Digitial elevation map of the Beijing plain; c. Geologic map showing the location of Changping drill core.