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Metamorphic evolution and geochronology of the Dunhuang orogenic belt in the Hongliuxia area, northwestern China

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ABSTRACT

Garnet-bearing mafic granulites and amphibolites from the Hongliuxia area of the southern Dunhuang orogenic belt, northwestern China, commonly occur as lenses or boudinages enclosed within metapelite or marble, which represent the block-in-matrix feature typical of orogenic mélange. Three to four generations of metamorphic mineral assemblages are preserved in these rocks. In the high-pressure amphibolites, prograde mineral assemblages (M1) occur as inclusions (hornblende + plagioclase + quartz ± chlorite ± epidote ± ilmenite) preserved within garnet porphyroblasts, and formed at 550–590 °C and 7.7–9.2 kbar based on geothermobarometry. The metamorphic peak mineral assemblages (M2) are composed of garnet + hornblende + plagioclase + quartz + clinopyroxene, as well as titanite + zircon + rutile + apatite as accessory minerals in the matrix, and are estimated to have formed at 640–720 °C and 14.1–16.0 kbar. The first retrograde assemblages (M3) are characterized by "white-eye socket" symplectites (hornblende + plagioclase + quartz ± biotite ± epidote ± magnetite) rimming garnet porphyroblasts, which formed at the expense of the garnet rims and adjacent matrix minerals during the decompression stage under *P–T* conditions of 610–630 °C and 5.6–11.8 kbar. The second retrograde assemblages (M4) are intergrowths of actinolite and worm-like quartz produced by the breakdown of the matrix hornblendes, and formed under *P–T* conditions of ~490 °C and ~2.8 kbar. For the high-pressure mafic granulites, the prograde assemblages (M1) are represented by plagioclase + quartz preserved within the garnet porphyroblasts. The metamorphic peak assemblages (M2) are garnet + matrix minerals (clinopyroxene + plagioclase + quartz + hornblende + rutile + zircon) and were estimated to have formed at ~680 °C and ~15.4 kbar. The retrograde assemblages (M3) are characterized by fine-grained patches of hornblende + plagioclase + quartz rimming the garnet porphyroblasts, as well as hornblende rimming clinopyroxene in the matrix, and were inferred to have formed at ~620 °C and ~4.2 kbar. For the metapelitic gneiss, the metamorphic peak assemblages are the garnet porphyroblasts plus the matrix minerals (biotite + plagioclase + quartz + ilmenite + zircon), which were estimated to have formed at ~630 °C and ~8.9 kbar. The mafic granulites and amphibolites record fairly similar clockwise *P–T* paths that include nearly isothermal decompression processes, which suggest that they experienced subduction and subsequent rapid tectonic exhumation. SIMS and LA-ICP-MS U–Pb dating of zircons and 40Ar/39Ar dating of hornblende suggest that the metamorphism occurred at ~430–390 Ma. Field occurrences, different protolith ages of the mafic granulites and amphibolites, and the considerable gap in peak *P–T* conditions between the amphibolite and mafic granulite boudinages and their country rock may suggest a mélange accumulation process during the Paleozoic caused by the Silurian–Devonian orogeny, which is possibly associated with the closure of the Liuyuan ocean, a branch of the Paleo-Asian ocean near the southern Central Asian Orogenic Belt.

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1. Introduction

The Tarim craton is located in northwestern China (Fig. 1; BGMX, 1993). The basement rocks can only be observed along its margins (Lu et al., 2008; Shu et al., 2011; Xu et al., 2013; C.L. Zhang et al., 2013; J.X. Zhang et al., 2013; Zong et al., 2013) because of the extensive Cenozoic cover (>85%). The Central Asian Orogenic Belt (CAOB), the result of a major accretionary orogen (Xiao et al., 2015a), formed through the convergence and accretion of numerous orogenic components over multiple phases of amalgamation (Xiao et al., 2015b). The Dunhuang orogenic belt is located at the east of the Tarim craton (Fig. 2) and remains poorly known. A great deal of debate persists on its tectonic attribution. Some researchers argued that it originated from the Tarim craton (e.g., Mei et al., 1998; Long et al., 2014), whereas others proposed that it was part of the North China craton (e.g., Zhang et al., 2012; J.X. Zhang et al., 2013), and other workers considered it as the southernmost part of the CAOB (e.g., Meng et al., 2011; Zong et al.,

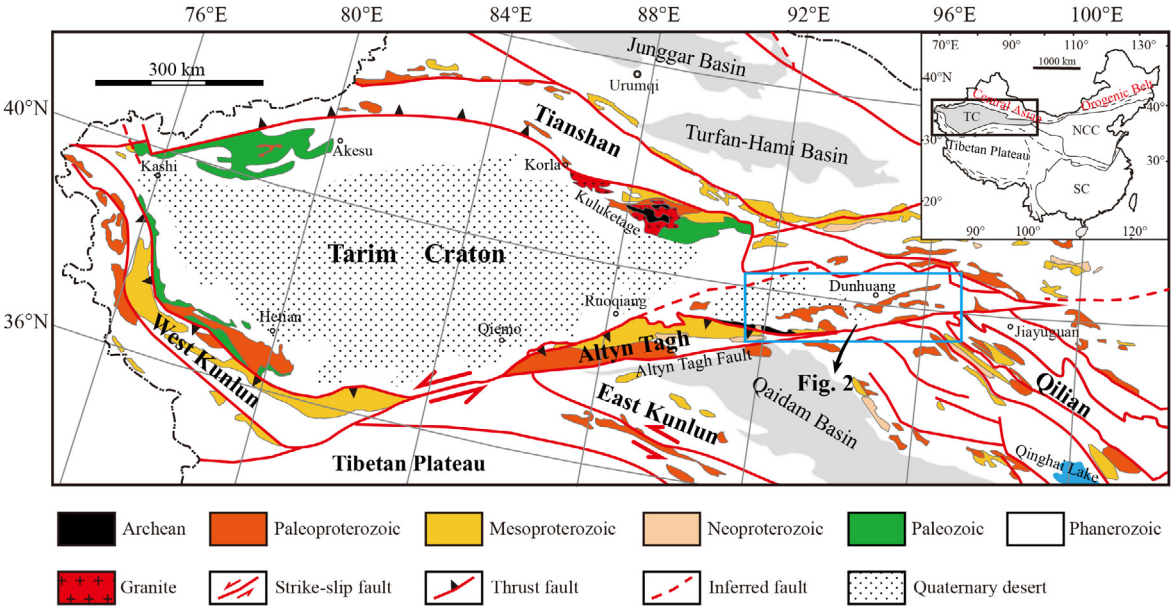

Fig. 1. Geological sketch map of the Tarim craton and adjacent orogenic belts (modified after IGCAGS, 2002 and J.X. Zhang et al., 2013). Legend: AR, Archean; PP, Paleoproterozoic; MP, Mesoproterozoic; NP, Neoproterozoic; PL, Paleozoic; PH, Phanerozoic.

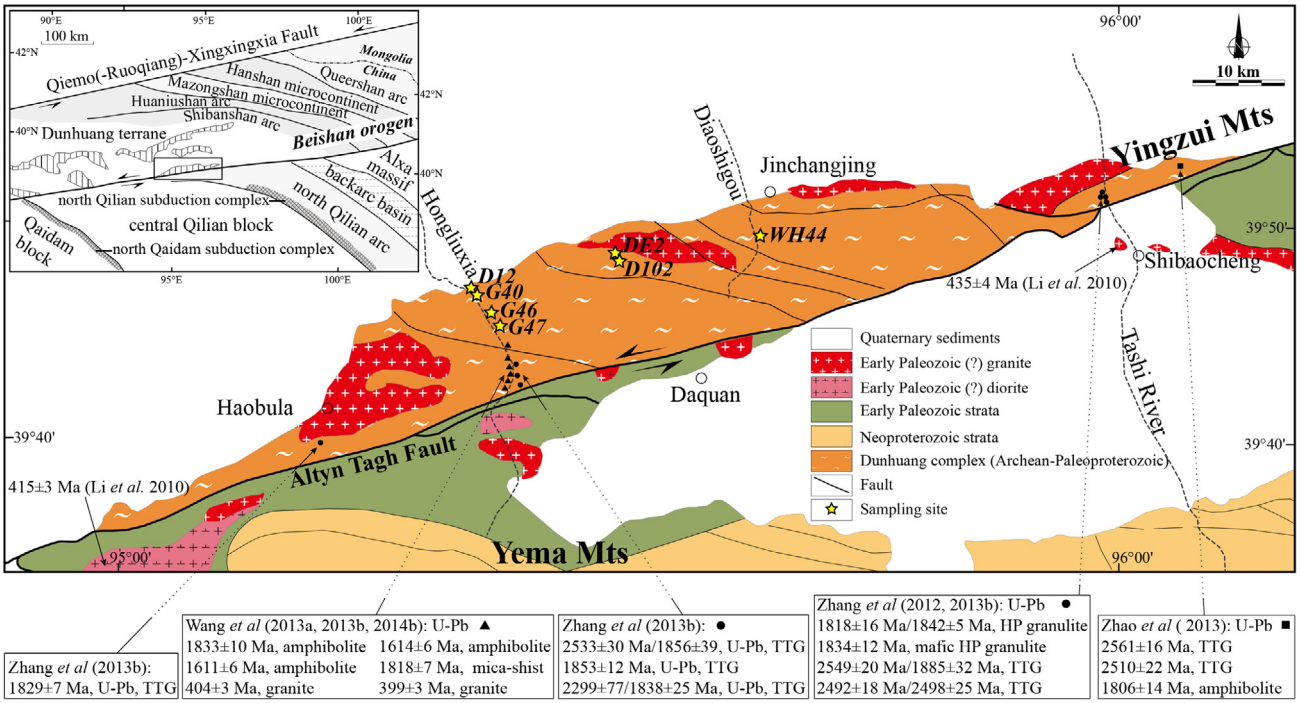

Fig. 2. Simplified geological map of the Hongliuxia area (modified after the 1:1,000,000 Geological Map of Gansu Province) of the southern Dunhuang orogenic belt. Sampling locations are shown. The small inset figure shows a simplified tectonic map of the Dunhuang orogenic belt and adjacent terranes (modified after Yang et al., 2001; Xiao et al., 2010 and Liu et al., 2011).