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Diverse *P–T* paths of the northern Dabie complex in central China and its reworking in the early Cretaceous

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ABSTRACT

The northern Dabie complex (NDC) in the Dabie orogen, central China, is a high-temperature migmatite terrane. It is composed mainly of banded gneiss, migmatite, and minor amphibolite, granulite, retro-eclogite, marble and spinel peridotite, and intruded by the early Cretaceous massive granitoid plutons and subordinate mafic–ultramafic rocks. Whether or not the NDC experienced a high-pressure or ultra-high-pressure (HP/UHP) metamorphic history has been a long standing issue. However, in the last 10 years, an increasing number of retrograde UHP eclogite relics and marbles and HP granulites have been identified throughout the NDC. This, together with the discovery of microdiamond preserved as inclusions in zircons within eclogite relics and gneisses and numerous age dates of 220–240 Ma and ~130 Ma from the NDC, supports the notion that at least part of the NDC was subjected to Triassic continental subduction and HP/UHP metamorphism, the youngest ages being related to an intense overprinting of ultrahigh-temperature (UHT) granulite facies metamorphism in the early Cretaceous.

Distinct peak UHP conditions (⩾2.5 GPa and ~800 °C; ~3.5 GPa and ⩾750–800 °C; ⩾4 GPa and ⩾900 °C or ~750 °C) have been inferred from oriented Qtz or Ab + Kfs + Qtz needles in Ca–Na clinopyroxene of retrograde eclogite, Ti-Chu-bearing assemblage preserved in marble, rod-like Cpx–Rt–Ap inclusion in garnet of retrograde eclogite, and microdiamond inclusions in zircon of tonalitic gneiss and retrograde eclogite from the NDC. The overprinted UHT (>900 °C or ~1000 °C) metamorphism is indicated by Osm growth in garnet, Pgt exsolution in clinopyroxene of retrograde eclogite, and Spl + Crd + Qtz symplectite in felsic granulites. Diverse *P–T* paths of an overall clockwise evolution are suggested with post-peak decompression or heating followed by decompression-cooling, and consist of two distinct paths. Opx + Pl inclusions in garnet and zircon in retrograde eclogite relics indicate that the lower continental crust in the NDC underwent Triassic subduction. The NDC shows overprinted UHT granulite facies metamorphism, thus consists of two metamorphic events in contrast to the single event of the central Dabie UHP eclogite belt (CDB). Distinct peak *P–T* conditions may be attributed to the lack of suitable mineral assemblages for geobarometry. The overall clockwise *P–T* paths consist of a peak HP/UHP event with overprinted UHT event suggesting that the NDC experienced Triassic subduction and intense intracontinental reworking in the early Cretaceous. The latter stage may be associated with a heat pulse due to asthenospheric upwelling and lithospheric thinning as a result of Cretaceous mantle superwelling and the westward subduction of the Pacific plate.

1. Introduction

As the largest ultrahigh-pressure (UHP) metamorphic belt recognized in the world, the Dabie–Sulu orogenic belt in east-central China is thought to have formed by continental subduction and collision between the North China and Yangtze blocks in the Triassic (240–220 Ma) (Li et al., 1993, 1996; Ames et al., 1996; Chavagnac and Jahn, 1996; Cong, 1996; Liou et al., 1996, 2004, 2009; Hacker et al., 1998, 2006; Jahn, 1998; Jahn et al., 2003; Zheng et al., 2003; Liu et al., 2006; Zhang et al., 2009). The discovery of UHP metamorphic coesite and microdiamond in eclogite of the Dabie orogenic belt over 20 years ago (Okay et al., 1989; Wang et al., 1989; Xu et al., 1992), has led to extensive studies of the orogen. One of the key advances has been the recognition of coesite inclusions in zircons in ortho- and paragneisses in the belt,

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demonstrating that the continental crust underwent regionally deep subduction and in situ UHP metamorphism (Tabata et al., 1998; Ye et al., 2000a; Liu et al., 2001a,b).

The Dabie orogen is generally divided into four petrotectonic units from north to south: the north Huaiyang belt (a meta-flysch unit), the northern Dabie complex (NDC) (a migmatite terrane), the central Dabie UHP eclogite belt (CDB), and the southern Dabie Susong low-temperature high-pressure (HP) blueschist-facies unit (Fig. 1). All the units are fault-bounded and contain post-tectonic Cretaceous massive granitoid batholiths (Jahn, 1999). Different from the CDB, as a high-temperature migmatite terrane (Zhang et al., 1996), the NDC was subjected to intense early Cretaceous tectonism including magmatic intrusions concomitant amphibolite to granulite facies metamorphism, and accompanied by extensive partial melting and migmatitization. The intensity of this event masked possible earlier metamorphic events. Thus, until recently, the tectonic nature of the NDC in particular whether Triassic subduction and HP/UHP metamorphism played a role has been an issue (Ernst et al., 2007; Jahn and Chen, 2007; Zhang et al., 2009). Different proposals have been put forward for the NDC such as: (1) it is the upper part of the subducted plate (Maruyama et al., 1994; Ernst and Liou, 1995); (2) it belongs to a Palaeozoic magmatic arc complex (Zhai et al., 1995) or part of the hanging wall of the North China block (Zhang et al., 1996) without UHP metamorphism; (3) it represents a Cretaceous extensional magmatic complex (Hacker et al., 1998, 2000; Ratschbacher et al., 2000); (4) it represents a Jurassic migmatite dome (metamorphic core complex) involving Triassic subduction and UHP metamorphism (Faure et al., 1999; Zhong et al., 1999); (5) it is an extension of the Yangtze craton unaffected by the Triassic UHP metamorphism (Bryant et al., 2004); or (6) it belongs to part of the Yangtze plate that experienced Triassic deep subduction and UHP metamorphism (Tsai and Liou, 2000; Xu et al., 2000, 2005; Liu et al., 2001c,d, 2005, 2007a,b; Malaspina et al., 2006).

In the last 10 years, an increasing number of retrograde UHP eclogite relics and marbles or HP granulites have been reported from the NDC (Tsai and Liou, 2000; Su et al., 2000, 2001; Xu et al., 2000, 2002; Zhang et al., 2000; Zhou et al., 2000; Liu et al., 2001c,d, 2005; Xiao et al., 2001, 2005; Faure et al., 2003; Xie et al., 2004a; Malaspina et al., 2006). Among these are the discovery of microdiamond in eclogite relics (Xu et al., 2003, 2005) and its preservation as inclusions in zircons within retrograde eclogite relics and gneisses (Liu et al., 2007a,b). Abundant ages of 220–240 Ma from the NDC (Liu et al., 2000, 2005, 2007a,b; Xie et al., 2001, 2004b; Jiang et al., 2002; Ge et al., 2003; Zhao et al., 2004, 2007, 2008), indicate that at least part of the NDC was subjected

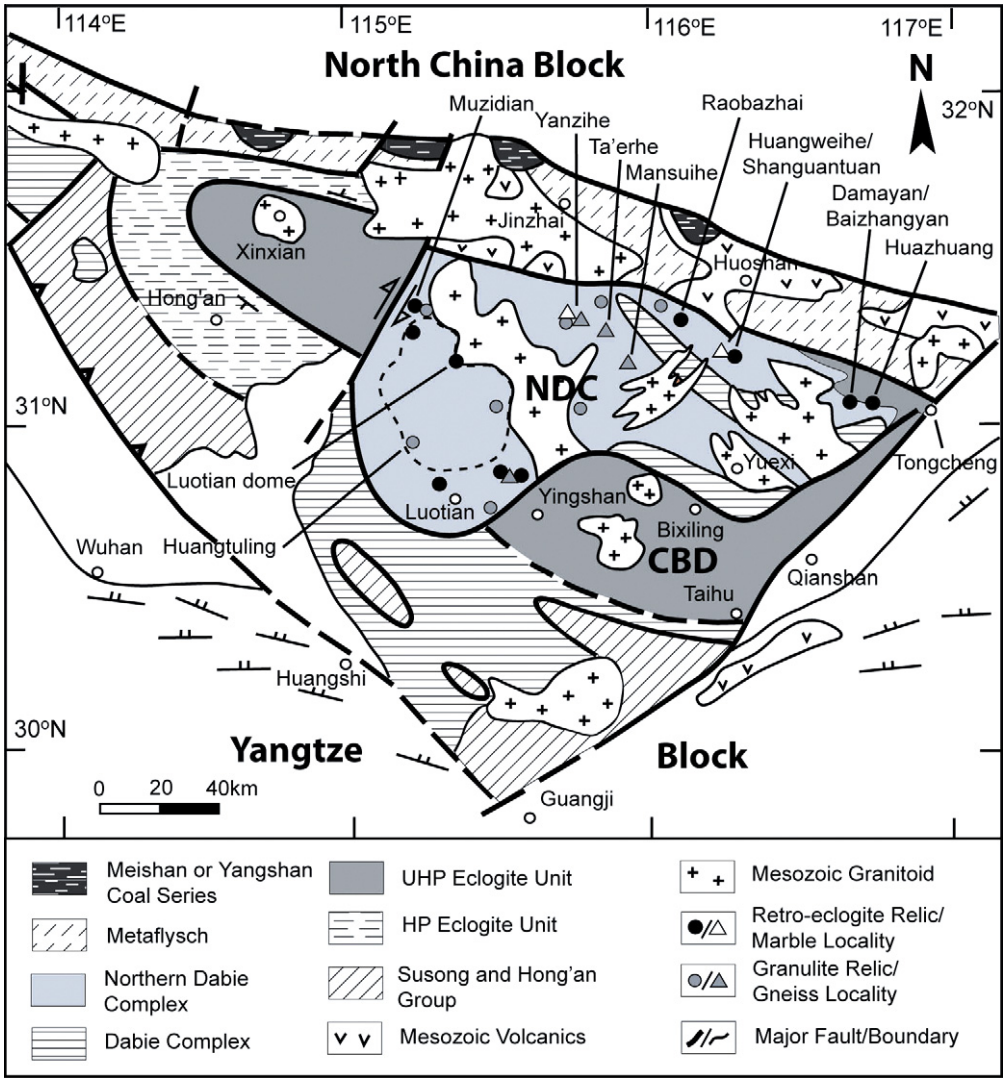

Fig. 1. Regional tectonic units of the Dabie orogen in central China (after Xu et al., 2002), and the north-eastern corner of the NDC (after Zhang et al., 2009), showing the locations of the retrograde eclogite relics recognized from the NDC.