

LIN Wei, JI Wenbin, SHI Yonghong, CHU Yang, LI Qiuli and WANG Qingchen, 2013. Multi-Stage Exhumation Processes of the High-Pressure to Ultra-High-Pressure Metamorphic Rocks: In the View from the Extensional Structures of Tongbai-Dabieshan Orogenic Belt of Eastern China. *Acta Geologica Sinica* (English Edition), 87(supp.): 486-488.

## Multi-Stage Exhumation Processes of the High-Pressure to Ultra-High-Pressure Metamorphic Rocks: In the View from the Extensional Structures of Tongbai-Dabieshan Orogenic Belt of Eastern China

LIN Wei<sup>1,\*</sup>, JI Wenbin<sup>1</sup>, SHI Yonghong<sup>2</sup>, CHU Yang<sup>1</sup>, LI Qiuli<sup>1</sup> and WANG Qingchen<sup>1</sup>

*1 State Key Laboratory of Lithospheric Evolution, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing 100029, China*

*2 Hefei University of Technology, 193 Tunxi Road, Hefei 230009, Anhui, China*

Exhumation of deeply buried high-pressure (HP) to Ultra-high-pressure (UHP) terranes remains as a puzzle in lithospheric dynamic processes. A subduction channel and the decoupling of the exhumed slice from the rest of the slab have been considered the most important model for the exhumation of the HP-UHP metamorphic rocks (Ernst, 2005; Guillot et al., 2009). In fact, the exhumation processes on Eastern China are more complex than what we had considered (Faure et al., 1999; Lin et al., 2005, 2009). According to our more than ten years field and laboratory works, at least three stages of the HP-UHP metamorphic rocks exhumation have been separated. These three stages exhumations have different tectonic background and related geodynamics.

During the Early Mesozoic, the North China and South China blocks have convergent motion and generated the Tongbai-Dabieshan HP-UHP orogenic belt (Fig.1; Mattauer et al., 1991; Hacker et al., 1998; Faure et al., 1999; Zheng et al., 2003; Liou et al., 2009). According to our structural analysis, we considered that the HP and UHP metamorphic rocks of the Tongbai -Dabieshan massifs experienced multi-stage exhumation processes. Three independent exhumation stages, from younger to elder, have been identified:

1. The late stage of exhumation ( $E_3$ )-Cretaceous NE-SW trending metamorphic core complex (MCC) of the central Dabieshan domain and Tongbaishan antiform with the age of deformation around 130 Ma (Fig. 1; Wang et al., 2011); NW-SE trending mineral and stretching lineation with top-to-the-NW kinematics indicated the NW-SE Cretaceous extension. Comparing with the extension tectonics that was expressed by the MCC, syntectonic granite, graben or half graben basins in the

entire east China, we proposed that the occurrence of the Tongbaishan antiform and central Dabieshan MCC were shared the same tectonic settings as the destruction of the North China Craton or lithosphere thinning under the Late Mesozoic regional extension in the eastern China (Lin et al., 2013).

2. The middle stage of exhumation ( $E_2$ )-Late Triassic extensional domal structures with an WNW-ESE long axis: as a destructed dome, it was separated from the Cretaceous MCC of central Dabieshan; NNW-SSE mineral and stretching lineations were indicated by phengite, amphibole and quartz with the top-to-the-NNW sense of shear; in spite of similar geometry and kinematics with  $E_3$ , this  $E_2$  was recognized by geometry and geochronological results; the geodynamic of this extensional structure was considered as the post-collisional collapse around 230-205 Ma (Eide et al., 1994; Hacker and Wang, 1995; Webb et al., 1999; Hacker et al., 2000).

3. The early stage of exhumation ( $E_1$ ) of HP-UHP metamorphic rocks. As the earliest exhumation stage, this deformation was mainly recorded at the limb and the foreland of HP-UHP orogenic belt of Tongbai-Dabieshan (Fig. 1). The geometry of the  $E_1$  event constitutes by a series synforms and antiforms with the axial planes have WNW-ESE direction. Even this early stage deformation had largely modified by the later events, the N-S or NNE-SSW trending mineral and stretching lineation is conspicuous. Along the lineation, the deformations are different in different tectonic units. On the southern part of the orogenic belt, top-to-the S or SW kinematics were well indicated by northeastward verging folds in the foreland and sigmoidal shape of quartz vein and mafic rocks in the HP unit. Top-to-the N or NE sense of shear is preserved at

\* Corresponding author. E-mail: linwei@mail.iggcas.ac.cn

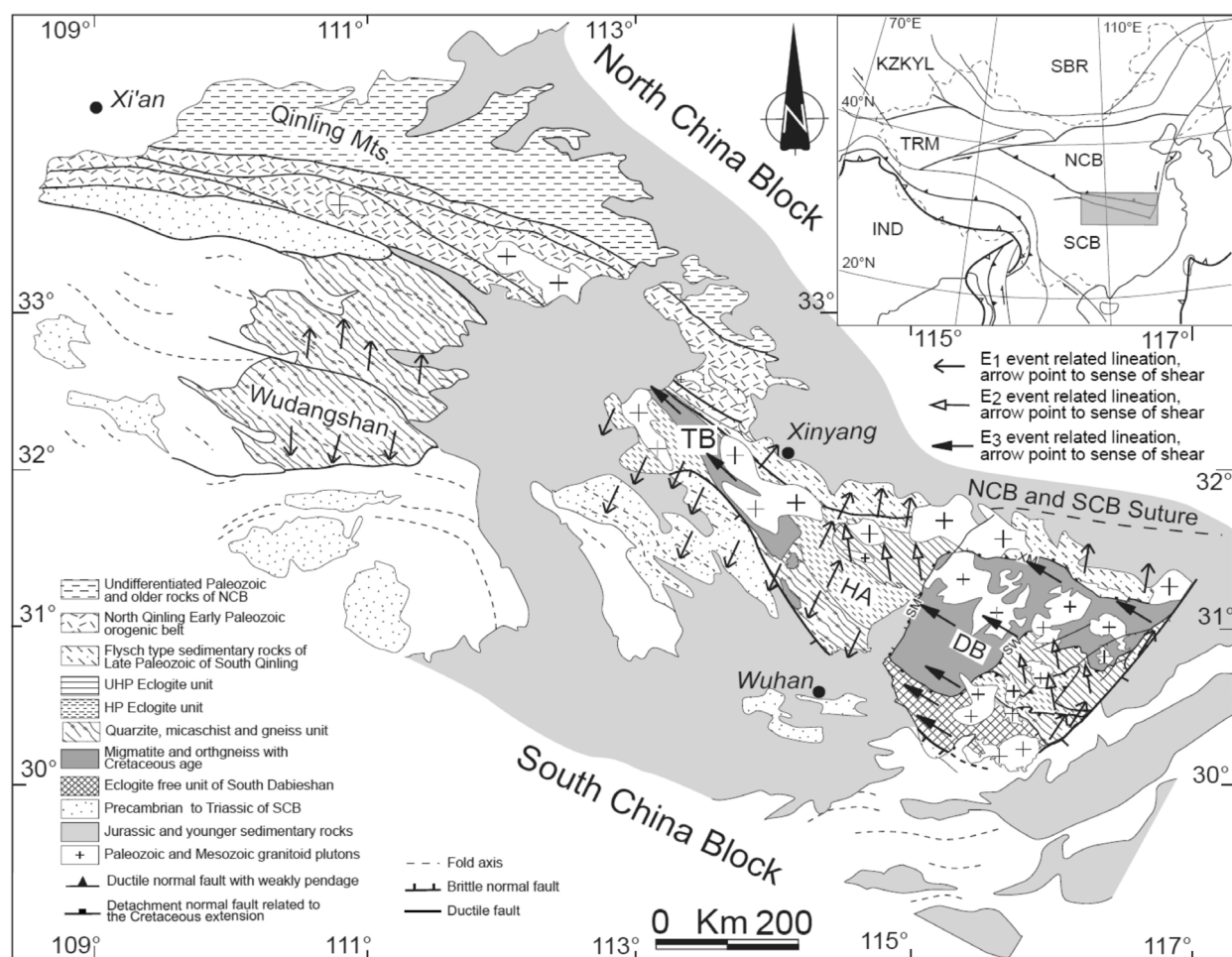


Fig. 1 Kinematic maps for the different stages exhumation events in the Qinling-Dabieshan belt (Modified from Zhai et al., 1998). TB: Tongbaishan massif; HA: Hong'an massif; DB: Dabieshan massif; SM: Shangma fault; XM: Xiaotian-Mozitan fault; SW: Shuihou-Wuhe shear zone; KZKYL: Kazakhstan; SBR: Siberia; TRM: Tarim; IND: India; NCB: North China Block; SCB: South China Block

the northern units of Tongbai-Hong'an massifs, near the Xinyang City. These features of deformation make us interpreted the existence of a syn-collisional subduction channel and the decoupling of the exhumed slice from the rest of the slab (Faure et al., 1999, 2003; Lin et al., 2005, 2009; Ernst, 2005; Guillot et al., 2009). Because of lack of the geochronological work, the age of this early stage exhumation are poorly constrained. The peak metamorphic of the HP eclogite with the age around 250-235 Ma on Tongbai-Hong'an HP massif indicated the period of this event (Cheng et al., 2011 and references therein).

Detail structural analysis and geochronological work could make us well understand the exhumation processes on the HP-UHP orogenic belt. Extensional structures research in HP-UHP metamorphic belt led to new constraints and the improvement our understanding of many tectonics or geodynamic models developed for this deep subduction of continental rocks and their exhumation processes.

**Key words:** Multi-stage exhumation, HP-UHP metamorphic rocks, Tongbai-Dabieshan orogenic belt, Eastern China

## References

- Cheng, H., Zhang, C., Vervoort, D.J., Wu, Y.B., Zheng, Y.F., Zheng, S., and Zhou, Z.Y., 2011. New Lu-Hf geochronology constrains the onset of continental subduction in the Dabie orogen. *Lithos*, 121: 41-54.
- Eide, E.A., McWilliams, M.O., and Liu, J.G., 1994. <sup>40</sup>Ar-<sup>39</sup>Ar geochronology and exhumation of high-pressure to ultrahigh-pressure metamorphic rocks in east-central China. *Geology*, 22: 601-604.
- Ernst, W.G., 2005. Alpine and Pacific styles of Phanerozoic mountain building: subduction-zone petrogenesis of continental crust. *Terra Nova*, 17: 165-188.
- Faure, M., Lin, W., Schärer, U., Shu, L., Sun, Y., and Arnaud, N., 2003. Continental subduction and exhumation of UHP rocks. Structural and geochronological insights from the Dabieshan (East China). *Lithos*, 70: 213-241.
- Faure, M., Lin, W., Shu, L., Sun, Y., and Schärer, U., 1999.

- Tectonics of the Dabieshan (eastern China) and possible exhumation mechanism of ultra high-pressure rocks. *Terra Nova*, 11: 251-258.
- Guillot, S., Hattori, K., Agard, Ph., Schwartz, S., and Vidal, O., 2009. Exhumation Processes in Oceanic and Continental Subduction Contexts: A Review. S. Lallemand and F. Funicello (eds.), *Subduction Zone Geodynamics*. Springer-Verlag Berlin Heidelberg, pp. 175-205.
- Hacker, B.R., Ratschbacher, L., Webb, L., Ireland, T., Walker, D., and Suwen, D., 1998. U/Pb zircon ages constrain the architecture of the ultrahigh-pressure Qinling-Dabie Orogen, China. *Earth and Planetary Science Letters*, 161: 215-230.
- Hacker, B.R., and Wang, Q., 1995. Ar/Ar geochronology of ultrahigh-pressure metamorphism in central China. *Tectonics*, 14: 994-1006.
- Hacker, B.R., Ratschbacher, L., Webb, L.E., McWilliams, M.O., Ireland, T., Calvert, A., Dong, S.W., Wenk, H.R., and Chateigner, D., 2000. Exhumation of ultrahigh-pressure continental crust in east central China: Late Triassic-Early Jurassic tectonic unroofing. *Journal of Geophysical Research*, 105(B6): 13339-13364.
- Lin, W., Faure, M., Chen, Y., Ji, W.B., Wang, F., Wu, L., Charles, N., Wang, J., and Wang, Q.C., 2013. Late Mesozoic compressional to extensional tectonics in the Yiwulüshan massif, NE China and its bearing on the evolution of the Yinshan-Yanshan orogenic belt. Part I: Structural analyses and geochronological constraints. *Gondwana Research*, 23: 54-77.
- Lin W, Faure M, Wang Q, Monié P, and Panis D. 2005. Triassic Polyphase deformation in the Feidong-Zhangbaling Massif (eastern China) and its place in the collision between North China and South China blocks. *Journal of Asia Earth Sciences* 25: 121-136.
- Lin, W., Shi, Y., and Wang, Q., 2009. Exhumation tectonics of the HP-UHP orogenic belt in Eastern China: New structural-petrological insights from the Tongcheng massif, Eastern Dabieshan. *Lithos*, 109: 285-303.
- Liou, J.G., Ernst, W.G., Zhang, R.Y., Tsujimori, T., and Jahn, B. M., 2009. Ultrahigh-P minerals and metamorphic terranes-The view from China. *Journal of Asian Earth Science*, 35: 199-231.
- Mattauer, M., Matte, P., Maluski, H., Xu, Z., Zhang, Q.W., and Wang, Y.M., 1991. Paleozoic and Triassic plate boundary between North and South China: new structural and radiometric data on the Dabie-shan, eastern China. *Comptes Rendus Académie des Sciences Séries II*, 312: 1227-1233.
- Wang, Y.S., Xiang, B.W., Zhu, G., and Jiang, D.Z., 2010. Structural and geochronological evidence for Early Cretaceous orogen-parallel extension of the ductile lithosphere in the northern Dabie orogenic belt, East China. *Journal of Structural Geology*, 33: 362-380.
- Webb, L., Hacker, B.R., Ratschbacher, L., McWilliams, M.O. and Dong, S., 1999. Thermochronologic Constraints on Deformation and Cooling History of High- and Ultrahigh-Pressure Rocks in the Qinling-Dabie Orogen, Eastern China. *Tectonics*, 18: 621-638.
- Zhai, X.M., Howard, W.D., Hacker, B.R., and You, Z.D., 1998. Palaeozoic Metamorphism in Qinling Orogen, Tongbai Mountains, Central China. *Geology*, 26: 371-374.
- Zheng, Y.F., Fu, B., Gong, B., and Li, L. 2003. Stable isotope geochemistry of ultra high pressure metamorphic rocks from the Dabie-Sulu orogen in China: Implications for geodynamics and fluid regime. *Earth Science Review*, 62: 105-161.