Comprehensive Study of Metamorphic Core Complex in Southern Liaodong Peninsula, NE China

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Abstract. Through this work and comprehensive research on a large amount of previous data, four metamorphic core complexes were identified in the south of Liaodong peninsula, which were respectively Jinzhou metamorphic core complex, Wanfu metamorphic core complex, Xinfang metamorphic core complex and Lizifang metamorphic core complex. Xinfang metamorphic core complex and Lizifang metamorphic core complex were discovered and proposed for the first time. They have kinematic unity, geometric asymmetry, tectonic - magma joint activity and the difference in formation time.

1 Introduction

The Liaodong peninsula region is the most intense and typical area of the Mesozoic lithosphere thinning of the north China craton, and the epitome of the Mesozoic regional tectonic evolution of the north China craton [1,2]. A large number of extensional structures of different types have been recorded in the southern region of Liaodong peninsula in the east of the north China craton, among which metamorphic core complex is one of the most important extensional structures. Through this work and a comprehensive study of a large amount of previous data, four metamorphic core complexes are distinguished. They are Jinzhou metamorphic core complex, Wanfu metamorphic core complex, Xinfang metamorphic core complex and Lizifang metamorphic core complex (Fig.1). They have kinematic unity, geometric asymmetry, tectonic - magma joint activity and the difference in formation time.

2 Jinzhou metamorphic core complex

Jinzhou metamorphic core complex is located in the southern part of the Liaodong peninsula in the east of the north China platform and on the east side of the tanlu fault. It was first proposed by Meng qingcheng et al in the 1:50000 regional survey of Sanshilipu completed in 1994. Later, Yang zhongzhu (1996), Liu junlai (2006), Guan huimei (2008) and others conducted in-depth research on it [3-5] (Fig.1b-①).

2.1 Composition

Jinzhou metamorphic core complex as a typical type of the cordillera metamorphic core complex, with three layer structure (upper plate weak deformation of sedimentary rock, footwall plutonic metamorphic rock and detachment fault zone in central), consists of five parts (upper the Neoproterozoic - Paleozoic weak deformation of sedimentary rock formation and Mesozoic extensional basin, the middle of detachment fault zone, the lower the Archean mylonites, gneissic complex and syntectonic Mesozoic granitic intrusive mass). Jinzhou metamorphic core complex is a special structural unit in the boundary of main detachment fault zone of Jinzhou-Dongjiagou arc from NNE to NEE.

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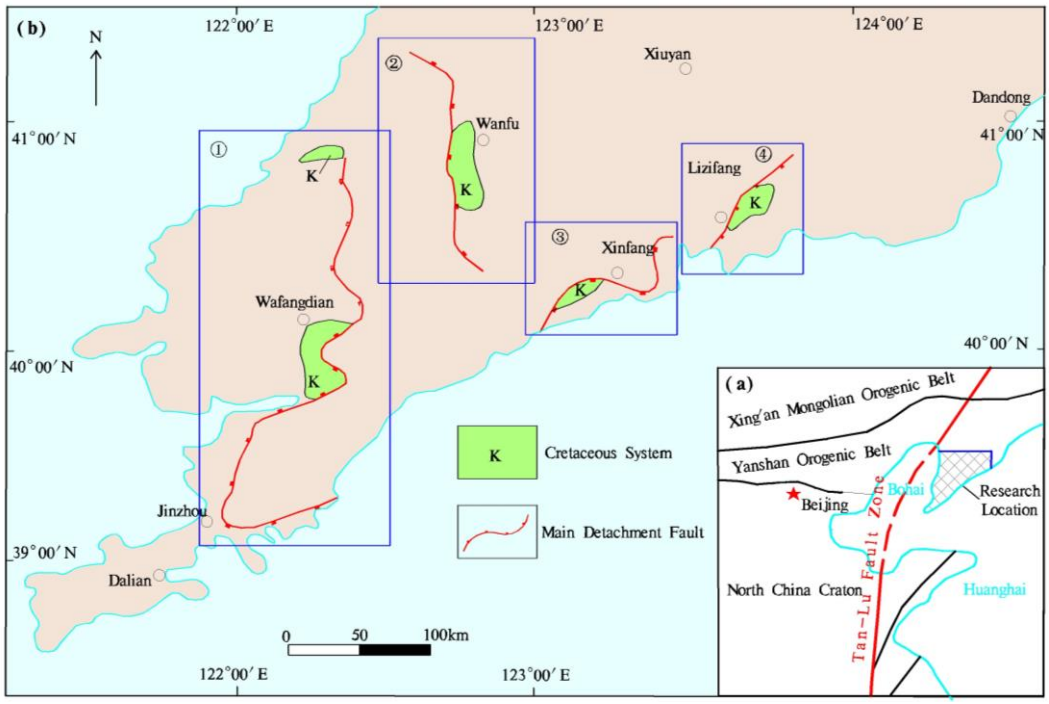

Fig.1 (a). Geotectonic location map of the study area;(b). Distribution map of metamorphic core complex in the south of Liaodong peninsula; ①Jinzhou metamorphic core complex; ②Wanfu metamorphic core complex; ③Xinfang metamorphic core complex; ④ Lizifang metamorphic core complex

2.2 Kinematic characteristic

The direction of tectonic movement of the metamorphic core complex in Jinzhou is obvious. The general trend of the west side is NWW, and the dip angle is mostly 10° to 30°. The southeast side inclines to SE, with a dip angle of 15-30°. The lineation trend is relatively stable, from SEE to NWW, and the dip angle varies greatly with different positions. The west side of the metamorphic core complex tends to be from NW to NWW, with a dip angle of 10 to 20°; the southeast side of the metamorphic core complex tends to be from SE to SEE, with a dip angle of 15 to 30°. According to the macroscopic movement indicators observed in the field, such as rotating debris spot, S-C fabric, shear fold, sheath fold and so on, it indicates that the upper disc rock slides and extends from SEE to NWW relative to the lower.

2.3 Time of formation

Previous researches on Jinzhou metamorphic core complex have done a lot of work. The syntectonic rocks and syntectonic feldspar veins in the basement ductile shear zone were all of late Triassic (223 ~ 269 Ma) [3], indicating that the extensional structure was formed in late Triassic. Meanwhile, in the area of Wafangdian, the detachment fault zone was cut by early Cretaceous granitic porphyry mass (140 Ma). In the area of Wanjialing, there were early mylonite traps in early Cretaceous porphyritic monzonite, indicating that the detachment fault zone was formed before early Cretaceous. For limited the formation time of Jinzhou metamorphic core complex, granite dykes without deformation were collected in the basilar ductile shear zone of souther Daheishan, and the dating result was 121±1 Ma (Zircon U-Pb LA-ICP-MS), which also indicated that the metamorphic core complex in Jinzhou was formed before the early Cretaceous. In conclusion, Jinzhou metamorphic core complex was formed in the late Indochinese - early Yanshan period.

3 Wanfu metamorphic core complex

Wanfu metamorphic core complex was first proposed and further studied by Liu junlai research group in recent years [5]. It is located to the east of the line of Jinzhou—Gaixian in Liaodong peninsula (Fig. 1b-②).

3.1 Composition

Like typical Cordillera metamorphic core complex, Wanfu metamorphic core complex has typical three layer structure, The footwall (composed of the archean gneiss and the granitic rocks invaded therein), the detachment fault (composed of the main detachment fault and the underlying myronite series), and the upper wall (composed of sedimentary rocks, shallow metamorphic rocks and volcano-sedimentary fault basins).

3.2 Kinematic characteristic

The movement direction of Wanfu metamorphic complex is obvious, except for the NW-NE trend of the exposed part in Jiaheshan area, the general trend is S-N. The statistical results of occurrence data obtained from different parts of the metamorphic core complex show that the surface texture is inclined to the east, the dip

angle is 20 ~ 30°, and the occurrence is 130∠15. In the rocks, there are eyeball structures, feldspar rotating-residual spots, σ fabric, shear bands, S-C fabric, pressure shadow structure, domino structure, etc. These structures clearly indicate the movement characteristics of the hanging disc from NWW to SEE.

3.3 Time of formation

A series of 40Ar/39Ar ages of mylonites in ductile shear zone have been determined by predecessors, among which amphibole ages are 119 ~ 113Ma, Muscovite ages are 112 ~ 104Ma, biotite ages are 114 ~ 110 Ma, and potassium feldspar ages are 112 ~ 105 Ma [2]. The 40Ar/39Ar dating data of amphibolite, mica and feldspar in the exfoliated fault zone show that the time of activity of the exfoliated fault zone of Wanfu metamorphic complex is 129 ~ 119 Ma, while the time of overall denudation uplift is 119 ~ 104 Ma.

4 Xinfang metamorphic core complex

The Xinfang metamorphic complex is newly confirmed in this work. The structure is located in Xinfang- Lijiatun area, Wulu town, northeasten Zhuanghe city (Fig. 1b-③).

4.1 Composition

The Xinfang metamorphic core complex has typical three layer structure (upper plate weak deformation of sedimentary rock, footwall plutonic metamorphic rock and detachment fault zone in central), consists of four parts (the Neoproterozoic - Paleozoic weak deformation of sedimentary rock, the central part of the detachment fault zone, footwall Archean mylonite, gneissic complex and syntectonic Mesozoic granitic intrusive mass).

4.2 Kinematic characteristic

The angularite surface texture of the Xinfang metamorphic core complex varies with the location, and it inclines laterally around the core fornix, with a dip angle of 20-40°, and the linear occurrence is relatively stable, generally trending towards east-west direction, with a occurrence of 240-290°∠12°-30°. Ductile shear rheological fold, S-C fabric, stone sausage structure, rotary fragmentation system, eyeball structure, cracked fabric, shearing strip, book oblique structure, etc. can be seen in the outcropping in the field, all of which indicate the motion characteristics of NEE→SWW on the plate.

4.3 Time of formation

The formation time of metamorphic complex can be determined by the magma activity in the region. The U-Pb zircon age was measured to be 174±2Ma, which was the early Jurassic, indicated that it was formed after 174±2 Ma. At the same time, samples were collected from amphibole black cloud granite porphyry intruded into the ductile shear zone without deformation and metamorphism, and the U-Pb age of zircon was 128±0.7Ma, early Cretaceous, indicating that core complex was formed before 128±0.7Ma. Combined with the ductile shear zone intruded by the late Jurassic Jiangyoufang rock mass, the formation time was limited between the early Jurassic and late Jurassic.

5 Lizifang metamorphic core complex

Lizifang metamorphic core complex is also proposed for the first time in this work. It is located in the northeast of Lizifang town, Zhuanghe city (Fig. 1b-④).

5.1 Composition

Lizifang metamorphic core complex has three layers, namely, the upper detachment disc, the lower detachment disc and the intermediate detachment fault. It consists of five parts: upper Paleoproterozoic cap, Mesozoic faulted basin, central detachment fault zone, footwall Archean metamorphic basement and syntectonic intrusive rocks.

5.2 Kinematic characteristic

The occurrence of metamorphic core complex of chestnut seed chamber is relatively stable, inclined to SE-SEE, and the occurrence is 105-150°∠15-30°. Besides the development of mylonite, mineral stretching (growth) lineation is also widely seen. The new minerals sericite and chlorite in mylonite lineation are arranged in the direction of fibrous aggregate or elongated or rotated in the direction of large-grained feldspar and quartz, the occurrence is 100-140°∠10-30°. In mylonite belt, S-C fabric, rotating fragmentary system, shear fold, eye - ball structure and residual fragmentary tugtail are developed. These structures clearly indicate the motion characteristics of NWW→SEE in the hanging disc.

5.3 Time of formation

The magmatic activity developed in this region is also used to limit the formation time of metamorphic core complex. The late Jurassic rock mass belongs to the pre-tectonic rock mass, which suffered from the metamorphism and deformation transformation of the detachment fault zone. While the Cretaceous rock mass (124±2Ma) belongs to the post-tectonic empositional rock mass, which retains the characteristics of the original rock without the shear deformation. Therefore, we can define the formation of Lizifang metamorphic core complex between late Jurassic and early Cretaceous.

6 Discussion on formation mechanism

The metamorphic core complex in the south of Liaodong region was preliminarily discussed according to the geometry characteristics, kinematics direction, the common activity of tectono-magma and the difference of formation time of each extensional structure. It is

considered that Jinzhou and Xinfang metamorphic core complex were formed in the extensional environment after the closing of late Indo-chinese and early Yanshanian paleo-asian oceans and were influenced by the subduction of the ancient Pacific plate. Wanfu and Lizifang were formed in the early Cretaceous Craton failure peak, and the dynamics source was related to the subduction of Izanagi plate to Eurasia plate.

7 Conclusion

(1) Based on the comprehensive study of metamorphic core complex in southern Liaodong peninsula, four ones were identified as Jinzhou, Wanfu, Xinfang and Lizifang. Xinfang and Lizifang metamorphic core complex were discovered and proposed for the first time.

(2) The macroscopic kinematics characteristics show that Jinzhou and Xinfang metamorphic core complex was shear slip from east to west about hanging side relative to footwall, Wanfu and Lizifang metamorphic core complex is shear slip from west to east.

(3) According to a large number of chronological data and contact relationship of geological bodies, the core complex in the southern Liaodong peninsula is divided into two extensional tectonic periods: the first is the late Triassic to early Jurassic, forming the Jinzhou and Xinfang metamorphic core complex; The second is the early Cretaceous, forming Wanfu metamorphic core complex and Lizifang metamorphic core complex.

(4) Jinzhou and Xinfang metamorphic core complex was formed after the closing of the late Indo-china to early Yanshan period Paleo-Asian Ocean, and was also influenced by the subduction of the ancient Pacific plate. Wanfu and Xinfang metamorphic core complex were formed in the early Cretaceous Craton destruction peak, and the dynamics source was related to the subduction of Izanagi plate to Eurasia plate.

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