CAI Zhourong, HUANG Qiangtai, LI Jianfeng, XIANG Junyang and LU Lijuan, 2017. The aggregation characteristics and formation mechanism of nanoparticles in ductile shear zone. *Acta Geologica Sinica* (English Edition), 91(supp. 1): 263-264.

The aggregation characteristics and formation mechanism of nanoparticles in ductile shear zone

CAI Zhourong[1, 2], HUANG Qiangtai[1,2, *], LI Jianfeng[3], XIANG Junyang[1, 2] and LU Lijuan[1,2]

1 *School of Marine Sciences，Sun Yat-sen University，Guangzhou 510006，China*
2 *Guangdong Key Laboratory of Offshore Oil Exploration and Development，Guangzhou 510006，China*
3 *Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, Guangzhou 510640, China*

1 Introduction

Nanoparticles are widely found in the ductile shear zone and it is considered to have a close relation with faulting. The sizes of these nanoparticles are generally less than 100 nm. They have a variety of morphologies like globular structure rod-like and tubular, by the order aggregating of these nanoparticles various aggregations were formed(De Paola et al, 2015; Siman-Tov et al, 2013; Han et al, 2007). At present, nanoparticles were found in several ductile shear zones of China, such as South China Wugong Mountain fault, Tan-Lu fault zone and Red River fault zone. However the research of it is still in the stage of geometry and Kinematics, and further study about the relation between its formation mechanism and its relationship with faults, and earthquake activity are still needed importantly(Sholz, 1980). This article is based on the detailed analysis of the aggregation characteristics and morphologies of nanoparticles that founded in Red River fault zone, though the Simulation experiment of high temperature and high pressure, to analyze the cause of formation and aggregation process of the nanoparticles developed in ductile shear zone..

2 Methods and conclusion

The Red River fault zone, which is located in the southwest of China, and starts from Eryuan to Dali, Red River and other regions is identified as the boundary fault of Yangtze block and indosinian block. With a length of thousands kilometers on the land part of the fault, it runs towards the direction of southeast and finally extends into the sea(Tapponnier et al, 1990; Leloup et al, 1995; Harrison et al, 1992). The width of the fault zone is 30 to 60 km. This fault zone is a typical ductile shear zone, generally experienced deformation and metamorphism, formed the mylonite and cataclasite etc. We gone across the ductile shear zone of Red River Fault three times in different sections to do the field geologic investigation, and systematically collected mylonite, schist and gneiss samples for scanning electron microscopy (SEM) analysis, to observe the characteristics and developmental situation

of nanoparticles.We also did a Simulation experiment of high temperature and high pressure for the study of the aggregation and formation mechanism of nanoparticles.

By scanning electron microscopy (SEM) analysis, we found two types of nanoparticles from our samples: one of them are nearly spherical, with the characteristics of high roundness and uniform particle sizes,and haven't undergone deformation. Another kind of nanoparticles has experienced crystal growth or deformation existing in many forms. These types may corresponds to different developmental stages of nanoparticles: graining stage and alienation stage (Sun et al, 2008). Nanoparticles that experienced crystal growth present many reunion characteristics, including spheroidal aggregation, tubular aggregates, coralloid aggregation, strawberry hemangioma aggregation , floriform aggregation , radiated aggregates , clavate aggregation , lamellar aggregation, membranaceous aggregation and worm-like aggregation. Most of these aggregations were found for the first time. Through the analysis of the spectrum, we found that nanoparticles of Red River fault are mainly composed of C, Si, Al O K ,containing a small amount of Ca、Mg、Fe、Ti、Na. So presumably most of the nanoparticles are silicate minerals. They are composed of lithium aluminium silicate, potassium feldspar, plagioclase albite ,mica and other mineral.

For further study, we had carried out the Paterson experiment of high temperature and high pressure on the rocks which didn't found nanoparticles. Experimental

* Corresponding author. E-mail: huangqiangtai@qq.com.

results showed that rocks fracture under strong differential stress, nano-sized concave-convex appeared on the mineral surface(Similar to the particle surface grain refinement) when the rocks deform and experience the deforming dislocation glide . Subsequently the semi-brittle fracture and the sliding, rubbing, grinding on the surface of the fracture cause nano-sized concave-convex breaking away from the mineral surface and forming nanoparticles. The aggregation characteristics of nanoparticles may be related to temperature during and after their formation, the nanoparticles that found in Red River ductile shear zone are silicate minerals,with small amounts of carbonate minerals. The fault zone can produce a lot of heat during tectonic movement, resulting in increased temperature. When the temperature of the rock surface reaches the critical value, nanoparticles will start to melt and destroy the original structure then form new aggregates. This is also the reason why individual nanoparticles can't be observed in these aggregates.

Acknowledgements

This study is supported by Natural Science Foundation of China (Project No. 41206035,41602231) and The National Nature Science Foundation of Guangdong Province (Project No. 2015A030313157).

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