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Structures, microfabrics, fractal analysis and temperature-pressure estimation of the Mesozoic Xingcheng-Taili ductile shear zone in the North China craton

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The ductile shear zone in Xingcheng-Taili area (western Liaoning Province in China) is tectonically located in the eastern section of the northern margin of the North China craton, and dominantly comprises deformed granitic rocks of Neoarchean and Triassic to Late Jurassic age, which were affected by shearing within middle- to low-grade metamorphic conditions. Because a high-temperature metamorphic overprint is lacking, microstructures attesting to low-temperature ductile deformation are well preserved. However, the rocks and its structures have not been previously analyzed in detail except by U-Pb zircon dating and some geochemistry. Here, we describe the deformation characteristics and tectonic evolution of the Xingcheng-Taili ductile shear zone, in order to understand the mode of lithosphericscale reactivation, extension and thinning of the North China craton.

The ductile deformation history comprises four successive deformation phases: (1) In the Neoarchean granitic rocks, a steep gneissosity and banded structures trend nearly E–W (D_1). (2) A NE-striking sinistral structure of Upper Triassic rocks may indicate a deformation event (D_2) in Late Triassic times, which ductile deformation structures superimposed on Neoarchean granitic rocks. (3) A gneissose structure with S-C fabrics as well as an ENE-trending sinistral strike-slip characteristic (D_3) developed in Upper Jurassic biotite adamellite and show the deformation characteristics of a shallow crustal level and generated mylonitic fabrics superimposed on previous structures. (4) Late granitic dykes show different deformational behavior, and shortening with D_4 folds. The attitude of the foliation S and mineral stretching lineation of three main types of rocks shows remarkable differences in orientation.

The shapes of recrystallized quartz grains from three main types of granitic rocks with their jagged and indented boundaries were natural records of deformation conditions (D_1 to D_3). Crystal preferred orientation of quartz determined by electron back scatter diffraction (EBSD) suggest sinistral strike-slip displacement within a temperature at about 400 to 500˚C. Quartz mainly shows low-temperature fabrics with dominant {0001}-slip system. As the deformed rocks show obvious deformation overprint, we have estimated flow stresses from dynamically recrystallized grain sizes of quartz separately. But coincident fractal analysis showed that the boundaries of recrystallized grains had statistically self similarities with the numbers of fractal dimension from 1.153 to 1.196 with the range of deformation temperatures from 500 to 600˚C, which is corresponding to upper greenschist to lower amphibolite facies conditions. Together with published flow laws to estimated deformation rates between the region of 10^{-11} - 10^{-13} S^{-1}depending on the temperature 500 ˚C, and the paleo-stress was calculated with grain size of recrystallized quartz to be at 5.0 to 32.3 MPa. Even though the deformation history and kinematics are different, progressive microstructures and texture analysis indicate an overprint by the low-temperature deformation (D_3).

Typical regional-dynamic metamorphic conditions ere deduced by mineral pair hornblende-plagioclase and phengite barometry identified within the ductile shear zone. The hornblende-plagioclase pair of porphyritic granitic gneiss gives metamorphic conditions of T=450–500 ˚C and p=0.39 GPa, which indicate a metamorphic grade of lower-amphibolite facies conditions and a depth of around 13 km estimated following a normal lithostatic pressure.

All of the structural characteristics indicate that the Xingcheng-Taili ductile shear zone represents a mainly ENE-striking sinistral ductile strike-slip zone, which formed after intrusion of the Upper Jurassic biotite adamellite and transformed and superimposed previous deformation structures. This deformation event might have occurred in Early Cretaceous times and was related to the lithospheric thinning and extension, due to roll-back of the Pacific plate beneath the eastern North China craton.