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Microstructural and fabric characterization of brittle-ductile transitional deformation of middle crustal rocks along the Jinzhou detachment fault zone, Northeast China

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Detachment fault zones (DFZs) of metamorphic core complexes generally root into the middle crust. Exhumed DFZs therefore generally demonstrate structural, microstructural and fabric features characteristic of middle to upper crustal deformation.

The Jinzhou detachment fault zone from the Liaonan metamorphic core complex is characterized by the occurrence of a sequence of fault rocks due to progressive shearing along the fault zone during exhumation of the lower plate. From the exhumed fabric zonation, cataclastic rocks formed in the upper crust occur near the Jinzhou master detachment fault, and toward the lower plate gradually changed to mylonites, mylonitic gneisses and migmatitic gneisses. Correspondingly, these fault rocks have various structural, microstructural and fabric characteristics that were formed by different deformation and recrystallization mechanisms from middle to upper crustal levels. At the meanwhile, various structural styles for strain localization were formed in the DFZ. As strain localization occurs, rapid changes in deformation mechanisms are attributed to increases in strain rates or involvement of fluid phases during the brittle-ductile shearing.

Optical microscopic studies reveal that deformed quartz aggregates in the lower part of the detachment fault zone are characterized by generation of dynamically recrystallized grains via SGR and BLG recrystallization. Quartz rocks from the upper part of the DFZ have quartz porphyroclasts in a matrix of very fine recrystallized grains. The porphyroclasts have mantles of sub-grains and margins grain boundary bulges. Electron backscattered diffraction technique (EBSD) quartz c-axis fabric analysis suggests that quartz grain aggregates from different parts of the DFZ possess distinct fabric complexities. The c-axis fabrics of deformed quartz aggregates from mylonitic rocks in the lower part of the detachment fault zone preserve Y-maxima which are ascribed to intermediate temperature deformation (500-630˚C), whereas complicated fabric patterns (e.g. asymmetric single girdles) are formed in fault rocks from the upper part of the DFZ. The increasing fabric complexity is here interpreted as the result of progressive superposition of fault rocks by shearing either at relatively shallow levels or high rate of strain, during exhumation of the lower plate and shear zone rocks.

The above observations and interpretations imply that dislocation creep processes contribute to the dynamic recrystallization of quartz in the middle crustal brittle-ductile transition. Progressive shearing as a consequence of exhumation of the lower plate of the MCC contributed to the obvious structural, microstructural and fabric superpositions. Strain localization occurs as the progressive shearing proceeded. Transition of mechanisms of deformation and dynamic recrystallization during strain localization may be resulted from changes in temperature conditions, in strain rates or addition of minor amount water.