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Strain localization mechanism of graphitic carbon-bearing rocks: Constraints from microstructure, texture and graphite geothermometry

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Abstracts:

Graphitic carbon-bearing rocks can occur in low- to high-grade metamorphic units. In low-grade matamorphic rocks, graphitic carbon is often associated with brittle fault gouge whereas in middle- to high-grade metamorphic rocks, graphitic carbon commonly occurs in marble, schist or paragneiss. Previous studies showed that carbonaceous material gradually ordered from the amorphous stage, e.g. graphitization, is mainly controlled by increasing thermal metamorphism and has a good correlation with the metamorphic temperature. Besides, this ordered process is irreversible and the resulting structure is not affected by late metamorphism. Subsequently, the degree of graphitization is believed to be a reliable indicator of peak temperature conditions in the metamorphic rock. In this contribution, based on detailed field observations, the variably deformed and metamorphosed graphitic gneisses to phyllites, located within the footwall and hanging-walls unit of the Cenozoic Ailaoshan-Red River strike-slip shear zone are studied. According to lithological features and temperature determined by Raman spectra of carbonaceous material, these graphitic rocks and deformation fabrics are divided into three types. Type I is represented by medium–grade metamorphism and strongly deformed rocks with an average temperature of 509 °C and a maximum temperature of 604 °C. Type II is affected by low-grade metamorphism and deformed rocks with an average temperature of 420 °C. Type III is affected by lower–grade metamorphism and occurs in weakly deformed/undeformed rocks with an average temperature of 350 °C. Slip–localized micro–shear zone and laterally continuous or discontinuous slip planes constituted by graphitic carbon aggregates are developed in Types I and II. The electron back–scattered diffraction (EBSD) lattice preferred orientation (LPO) patterns of graphitic carbon grains were firstly observed in comparison with LPO patterns of quartz and switch from basal <a>, rhomb <a> to prism <a> slip systems, which indicate increasing deformation temperatures. According to the graphitic slip–planes, micro–shear zones and mylonitic foliation constituted by graphitic carbon minerals, we also propose that the development of fine–grained amorphous carbon plays an important role in rheological weakening of the whole rock during progressive ductile shearing.

Key Words: graphitic carbon, strain localization, graphitic thermometry, slip–localized micro–shear

zone, rheological weakening