Geophysical Research Abstracts,
Vol. 11, EGU2009-8773-2, 2009
EGU General Assembly 2009

Timing of initiation of left-lateral shearing along the Ailao Shan-Red River shear zone: microstructural and geochronological constraints from high temperature mylonites in Diancang Shan, SW China

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The high grade metamorphic massifs (e.g. Xuelong Shan, Diancang Shan, Ailao Shan in China and Day Nui Con Voi metamorphic massif in Vietnam) along the Ailao Shan-Red River shear zone in Southwestern China bear much information on the large-scale left-lateral strike-slip shearing in eastern Tibet during Indian-Eurasian plate collision and post-collisional accommodation process in late Oligocene-early Miocene. The metamorphic massifs are narrow zones bounded by brittle faults. Low-grade metamorphic rocks are lying on the west and sedimentary rocks to the east. Rocks in these massifs are partly sheared with widespread occurrence of high temperature mylonites that have subhorizontal stretching lineations. Left-lateral shearing is indicated by mesoscale and microscale shear indicators in the mylonites. Debates exist on the timing of initiation and duration of left-lateral shearing, and mechanism of exhumation of the high grade metamorphic rocks along Ailao Shan Red River shear zone.

The Diancang Shan complex, a typical metamorphic massif, is constituted by three units, i.e. a central high strain shear zone, a western low-grade metamorphic volcanic-sedimentary sequence in the Lanping basin, and an eastern superimposed retrograde metamorphic belt. The central high grade metamorphic complex consists of metamorphic rocks of amphibolite facies conditions. High-grade metamorphic mineral assemblages and structural elements indicate a deep level crustal metamorphism and deformation of the rocks. L-tectonites are typical indicators of high-temperature deformation in the highly sheared granitic mylonites. Widespread occurrence of different shear criteria (e.g. sheared veins, sigmoid and delta -porphyroclasts) suggests that these gneisses experienced very intensive high-temperature progressive left-lateral strike-slip shearing.

A large synkinematic augen monzogranitic intrusion is recognized in the central belt by the present work. The intrusion has an obvious porphyritic texture, in which very huge crystals (up to 3 cm in diameter) of feldspars occur as phenocrysts in a fine grained matrix of quartz + plagioclase + K-feldspar + biotite + mica. The monzogranites are sheared and form high temperature mylonites. Their well-developed lineation and inter-layering with paragneisses resulted from high-temperature shearing during or subsequent to emplacement. Macrostructural analysis revealed that the high temperature granitic mylonites are mainly confined to the shear zone, experienced shear deformation and extended along the shear zone. Feldspar phenocrysts in the monzogranite intrusions have different shapes like sigmoid, delta and S-C fabrics indicating left-lateral shearing.

A sequential and progressive process from magmatic crystallization, through late-crystallization metasomatism, to crystalline plasticity is evidenced by rock microstructures. Early crystallization is characterized by porphyritic structures, especially by growth zoning in feldspar grains. Evidences for late magmatic metasomatism are widespread in the mylonitic rocks. An early phase of K-metasomatism is indicated by the replacement of plagioclase by K-feldspar, which is best documented by plagioclase left-over grains in marginal zones of K-feldspar megacrysts. Patches of these left-over grains are often optically continuous and hence can be related to originally larger plagioclase grains. K-feldspar grains are further metasomatized by relatively potassium-rich plagioclase to form myrmekite structure. In some cases, myrmekites seem to be stress-induced because their distribution and orientation can be attributed to bulk left-lateral shearing.

The granitic intrusion and its wall rocks are highly sheared by late- or post intrusive high temperature plastic deformation. Quartz grains often have irregular grain boundaries implying high temperature grain boundary migration. Rectangular quartz ribbons, augen-shaped grain aggregates, quartz sigmoid, and quartz grains with straight boundaries and triple junctions are also indicative of intensive high temperature deformation. Feldspar grains are elongated or partly twinned, and some are dynamically recrystallized into fine grains in the matrix.

Magmatic zircon grains from the sheared monzogranite samples are dated with SHRIMP II. Zircon grains have perfect oscillatory zonations of magmatic crystal growth with Th/U ratio generally higher than 0.3. They give a concordant age of 30.88 $\pm$ 0.32 Ma, the age of magmatic crystallization.

Structural and microstructural analysis, and thermochronological dating of the monzogranitic mylonite from Diancangshan, reveal the synkinematic emplacementhat of the large area porphyritic monzogranite. Its crystallization, metasomatism and tectonic deformation is a continuous and progressive process. The crystallization age of the zircon grains provides the lower limit for left-lateral shearing, or the onset of left lateral shearing at 30.88 $\pm$ 0.32Ma, thus in the Oligocene. It is noteworthy that this age is the age of a sheared pluton that was previously classified as Proterozoic paragneiss deformed by regional sinistrial shearing along the ASRR. The new age implies that the components and ages of formation of this so-called Proterozoic metamorphic complex must be reconsidered. From the above evidences, we would argue that the Proterozoic Diancangshan metamorphic complex has to be grouped into at least two units, a paragneisses unit and a Cenozoic plutonic rock unit.