Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

SCG082-03 Room: Exibition hall 7 subroom 2 Time: May 24 09:30-09:45

Metamorphism of the Sanjiang region in Yunnan province, SW China.

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Several micro-continents had been collided in the Sanjiang region in Yunnan province, SW China. We studied two areas geologically and petrologically, Cangshan area in the east and Nujiang area in the west. The Cangshan area is considered to represent a possible northern extension of the Ailao Shan - Red River shear zone, the collision boundary between South China craton and Indochina craton. The Nujiang area is also considered as the collision boundary between Indochina craton and Shan-Thai craton. Detailed studies of the metamorphic rocks from the both areas give us useful information to understand the tectono-metamorphic evolution during the Asian continental growth.
The metamorphic rocks from the Cangshan area demonstrate greenschist- to upper amphibolite-facies conditions. The mineral assemblages of metamorphic rocks changes systematically from east to west. Based on the change in mineral assemblages of the pelitic to psammitic rocks, the Cangshan area can be divided into the following four metamorphic zones; zone A Chl + Ms in the east, zone B Grt + Bt + Ms and Grt + St + Bt+ Ms, zone C Grt + Sil + Bt, zone D Chl + Ms in the west. The estimated P-T condition of zone C is 800-850 C, 10-11 kbar from Ky-bg Grt-Sil-Bt gneiss. Reaction textures and chemical zoning of garnet suggest a clockwise P-T path, and the geothermal gradient suggests a medium pressure type.
The metamorphic rocks from the Nujiang area suggest greenschist- to amphibolite-facies conditions. The mineral assemblages of metamorphic rocks changes systematically from west to east. . Metamorphic grade of mafic rocks also grade into the east. Based on the changes in mineral assemblages of the metapelites, the Nujiang area can be subdivided into the following five metamorphic zones; zone I Chl + Ms in the west, zone II Grt + And + Bt + Ms, zone III Grt + Sil + Bt, zone IV Grt + Crd +Bt, zone V Ms in the east. The estimated P-T conditions are 700-830 C, 4-6 kbar (Grt-Sil-Crd-Bt gneiss) and 650-780 C (Grt-Crd-Bt gneiss) in the zone IV. Several metamorphic reaction textures suggest heating process at low pressure condition, and the metamorphic field gradient is confirmed as a low pressure type.
In the Cangshan area, the chondrite normalized REE patterns show three different patterns; LREE enriched pattern, flat pattern like E-MORB and depleted REE pattern with Eu positive anormaly. The epsilon Sr (eSr) values, normalized at 250Ma, are from -13.57 to 127.78 and epsilon Nd (eNd) values are from -8.04 to 5.84, respectively. They are divided into high-NdI group and low-NdI group. High-NdI group is similar to mafic rocks from the Red River area. Low-NdI group suggests a cumulate origin because it shows depleted REE patteren. In the Nujiang area, the chondrite normalized REE patterns also indicate two patterns; LREE enriched pattern and flat pattern like E-MORB. The eSr values, normalized 250Ma, are from -1.90 to 139.17 and eNd values are from -1.68 to 4.33. In the Red River area, where's tectonics related to the Cangshan area, the chondrite normalized REE patterns indicate two different patterns; LREE enriched pattern and flat pattern like E-MORB. The eSr values, normalized 250Ma, are from 2.60 to 49.60 and eNd values are from -0.41 to 3.18.
Estimated medium pressure geothermal gradients and geochemical characteristics of the metamorphic rocks from the Cangshan area are similar to those of the Red River area. These

similarities suggest both areas related to the same collision tectonics. On the other hand, metamorphic rocks from the Nujiang area were formed by simple heating process under the upper crustal condition. The differences of metamorphism indicate that the Sanjiang region formed by multi-stage collision tectonic events during the growth of Asian continent.