Abstract

Collision of Indian continental plate with Asian continental plate caused deformation of a vast region in both the plates resulting in spectacular Himalayan mountain range and Tibetan Plateau. Himalayan-Tibetan orogenic system has been active for last ~ 50 Ma and provided an excellent natural laboratory to understand collision related processes. Trans Himalayan zone consisting of the suture between the two plates also contains pre-syn- and post-collision metamorphic and magmatic rocks. The change in sedimentation from the marine to continental environments also is preserved in various sections of Trans Himalaya.

The Ladakh region of Trans Himalaya, area of the present study, is probably the best sector in the entire 2500 km long collision zone, because it has preserved almost the complete history of Paleozoic Indian passive margin to the post collision molasses. There have been several episodes of volcanism in the Ladakh region represented by the volcanic rocks of varying chemistry. These rocks form linear suites and their inter-relationship as well as their relationship with the plutonic volcanism is not clear. These vary from island-arc type Dras volcanics to baslatic-andesitic Shyok volcanics to the rhyolite of Khardung volcanics. To gain understanding of the temporal relationship between the different volcanics, the cooling history of the plutonic rocks of Ladakh batholith and effect of collision related deformation on the trapped ophiolites are the main objectives of this study. The ^{40}Ar-^{39}Ar technique used in the present study is temperature sensitive and provides clues of tectono-thermal history experienced by different rocks. The results thus obtained help in building a scenario for the tectono-thermal evolution of Trans Himalaya in Ladakh sector in particular and India-Asia collision zone in general.

Samples were collected in five main traverses across Ladakh sector in north west Trans Himalaya, covering Indus Suture ophiolites, Dras volcanics, Ladakh batholith, Khardung volcanics and Shyok Suture volcanics. A total number of thirty samples were analyzed for ^{40}Ar-^{39}Ar isotopic composition including seven serpentinites and one ultramafic rock. Serpentinites and ultramafic rock did not yield useful results due to high amount of trapped gasses masking the signal. Mineral separation was done from the plutonic rocks

of the Ladakh batholith. A biotite and a muscovite, from granodiorite and leucogranite respectively, were also analyzed along with their whole rock samples. The fine-grained rocks from the other volcanic units were analyzed as whole rock samples.

Basalts from Indus Suture ophiolites show post collision resetting of Ar isotopic signatures. These samples show a rapid cooling initially and slower subsequent cooling. This is interpreted to be due to a large-scale tectonic event with an associated temperature increase sufficient to reset the argon clock of these older suture ophiolites. The initial rapid cooling indicates the termination of this event and the subsequent slow cooling could be due to exhumation through erosion if these were subjected to burial by this tectonic event. The ages for this event registered by these two sample were ~38 Ma and ~46 Ma. The difference in ages indicates the protracted nature of this event. However, not all the ophiolites of Indus Suture Zone are affected by subsequent reheating as revealed by a pillow lava which yielded an age of ~ 128 Ma.

Muscovite from Himia leucogranite of the Ladakh batholith yielded good plateau ages of ~ 29 Ma. A biotite of Leh granodiorite yielded a good plateau ages of ~ 44 Ma. The whole rock age spectra of these rocks yield maximum plateau-like ages of ~ 38 Ma & ~ 46 Ma respectively. These cooling ages indicate high post-collision thermal regime in suture zone.

Shyok Suture volcanics, which range from basalt to andesite, show disturbed and complex age spectra. However, all samples from Shyok suture volcanics yielded consistent age spectra. These age spectra indicate strong tectono-thermal events between ~ 25 to 12 Ma, superimposed on older signatures. The rhyolitic Khardung volcanics in juxtaposition with Shyok volcanics in Shyok-Nubra valley did not yield similar patterns in the age spectrum. They yielded plateau ages and plateau-like ages between ~ 52 Ma and ~64 Ma. The contrast in age spectra of the two nearby volcanic units is very significant. A sample taken from the Karakoram fault zone along the Nubra river yielded a good plateau age of ~ 14 Ma. Based on the similarity of Shyok volcanics and its corresponding volcanic units of Kohitan in the west, to island-arc, and Khardung volcanics and other magmatic rocks to the east of it to continetal arc, it has been proposed that the two evolved independently along the Asian plate boundary. Other geological evidences have also indicated that continental arc and island arc evolved independently and simultaneously. This requires that pre-collision margin of Asian plate was made up of small portion of oceanic crust at its western end. The juxtaposition of the two type of rocks were facilitated by the Karakoram strike slip fault at ~ 14 Ma

By synthesizing the thermochronological data from this study and those from other regions of the collision zone, a general scenario of the India-Asia collision zone and a sequence of crustal accommodation is proposed. Deformation has been propagating away from the plate boundaries with time since the initiation of the collision. The corresponding accommodation of crust also has been taking place away from the plate boundaries with time. The major episodes of crustal accommodation and deformation are manifested in the uplift of Tibetan plateau and the formation of large-scale thrusts in Himalayas. Most of the present accommodation of crust seems to be taking place in eastward motion along the large-scale strike slip faults in Tibet and in consequent detachment zone.