Neotectonic and Climatic Variations During the Late-quaternary Sediments of the North-west Himalayan Sector

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The formation and rise of the Himalayas has a significant effect in resetting the climatic regimes of larger part of the globe more so in the Southern Asian regions. By the Late Miocene (11-7.5 Ma), the Himalayas had attained substantial height which not only modified the high/low wind pressure zones but also acted as barrier for the monsoon clouds resulting in substantial increase in precipitation in the Indian sub continent. The coupled effect of tectonics (uplift, movement along thrust/fault belts etc.) and climate (high precipitation south of higher Himalaya and cold desertic conditions in trans Himalaya) and thereby the surface geological processes (weathering, erosion, deposition etc) have been modifying the landscape of the northern regions of India (sediment records of the Bay of Bengal, Arabian sea and Indian ocean are the testimonies to these processes). The net result of this tectono-climatic intervention formed several glaciers in the northwestern sector of India and signatures of these are nicely preserved in the fluvio-lacustrine sedimentary deposits distributed in patches throughout in this region. These Quaternary deposits provide a rich platform to study the signatures of palaeoclimate and neo-tectonics and their relation with the regional and global climate.

The fluvio-lacustrine sedimentary sequences of the Ladakh and the Spiti valley have been mapped and geomorphic features, neotectonic evidences, mineral magnetic characteristics along with OSL/AMS chronology were studied to generate a tectono-climatic history during the late Quaternary in this region. The broad sedimentary architecture suggests the formation of these palaeolakes due to landslide driven river damming e.g. Spituk and Lamayuru in the Ladakh region and Koito, Kaurik, Sumdo, Retti in the Spiti valley. The OSL chronologies and the AMS dates of the Ladakh sections bracket the lacustrine regimes from ~15 to 3 ka BP. In general the sections vary from few meters to tens of meters and the thinly laminated clay beds (lacustrine phase) are interlayered with sand and silty beds (fluvial phases).

In Spiti region the chronologies for lake formation in the upper valley are 14-6 ka and lower valley are 50-30 ka. The review of published palaeoclimatic palaeolake chronology of Spiti Valley indicates that the lakes were probably formed during the wetter conditions related to Marine Isotope Stage III and II. The increased precipitation

during these phases induced excessive landsliding and formation of dammed lakes along the Spiti River. The sedimentary records of the lacustrine sections show several warm and cold climatic phases with 4 warm spells, being prominent (between 11-12 ka; around 10 ka and two minor warm phases between 8.4-9.2 ka BP). The lakes were terminated at ~7 ka in the Spiti valley with the reoccurrence of the tectonic/seismic activity and gave way to a fluvial phase which exists till toady.

Multiple levels of soft-sediment deformation structures (seismites) are recorded from the Quaternary sediments of the Spituk-Leh, along Indus Suture Zone (ISZ) and the Khalsar palaeolakes, along Shyok Suture Zone (SSZ) and Karakoraum Fault (KF). 9 levels of seismites from Spituk-Leh and 8 levels from Khalsar sections are recorded. The deformed sediments comprise of clay, silts and sand and are restricted to a single stratigraphic layers bounded by undeformed beds suggesting synsedimentary deformation. The release of stress along the ISZ, SSZ and KF, may have been responsible for inducing seismicity in the area during the late Quaternary times which may have caused liquefaction as a direct consequence of permanent deformation of ground surface due to earthquakes of large magnitudes (>5 intensity). In the Spiti valley two major tectonic/seismic events at ~12 and ~7 ka BP (OSL ages of the palaeoseismic structures associated with the lacustrine deposits), which were also responsible for the formation and also draining away of the lakes by triggering landslides by a combined effect of the abrupt monsoon years and tectonic disturbances.