An Outline of the Late Quaternary Stratigraphy and Palaeoclimate of Ladakh Region – H.S. Saini, Geological Survey of India, Faridabad (*Email: hssainigsi@gmail.com*)

Ladakh is a high altitude, oxygen deficient, cold and arid region in NW Himalaya, drained by glacial –fed, perennial Indus River system. The region receives around 10 Cm of annual precipitation, mainly as snow and the temperature vary between –30° C in winters to 30° C in summer. At times, heavy downpour due to cloudburst also occurs.

Control of arid climate is pronounced on the landforms, drainage and vegetation of the area. Vegetation is sparse and population density is very low. Road approach gets disrupted during October-March due to snowfall. The landscape is sculptured by glacier, fluvial and wind actions.

Ladakh lies on the southwest of Tibetan plateau and comprises Karakoram, Ladakh, Zanskar ranges. It is bounded by Shyok suture in north and Indus suture in south. Ladakh range is a NW-SE trending range of Ladakh Granitoid Complex with peaks attaining up to 6 km elevation through. Kahrdungla (5440m), Digar La (5420m), Changla (5360m) are important passes. Zanskar Range lying south of the Indus river is constituted by rocks of Indus Group, Lilang Group, Schuppen Zone and Rupshu Group, ranging in age from Pre-Cambrian to Cretaceous.

The drainage in Ladakh is represented by the Indus and its tributaries namely, Zanskar, Shyok, Nubra, Tangste rivers. Most of these lie parallel to the mountain ranges i.e. along NW-SE and follow the major fault lines.

The Quaternary sequences are scattered in river valleys and hill slopes as loose to semi-consolidated alluvial, glacial, fluvio-glacial, lacustrine and debris deposits in the form of terraces, alluvial fans, moraines, debris/mud flows etc. The terraces are up to 80 m high and made up of river borne as well as moraines sediments. A regional framework of late Quaternary stratigraphy and paleolcimate has been developed by field study of sedimentary archives and OSL dating of representative sections. The Quaternary deposits were studied around Karoo, Sumdo, Leh-Spituk, Bazgo, Saspol along Indus river, along Leh –Khardung-Khalsar road, around Darbuk in Tangste valley, in Hanle valley and along the NW margin of Pangong Tso.

The oldest galcio-fuvial deposits indicative of cold climate of stage MIS 5d occur in Hanle valley and Leh-Khargung valleys whose OSl ages cluster between 100-104 ka. A slightly younger sequence stratified T_3 terrace in Darbuk area and alluvial fans of Phyang nalla (Indus river) deposited during ca. 98 –79 ka suggest fluctuating warm and cold conditions and correspond to global stages MIS 5 C & b.

Channel activities in represented by sand and pebble association indicative of warmer condition begun to appear ca. 80 ka and continues till ca.71 ka with pulses of cold climate in the later stage. It was only after around 74 ka, the cool condition was established and continued uninterrupted till 58 $\pm$3 ka and even later. This phase defines the first glacial maximum (MIS 4). The Leh section suggests that cooling in this area had commenced earlier than the global cooling and had at least in three warm and cold pulses.

Signatures of last interstadial climate (MIS3) are prominent in Tangste Valley , Darbuk area which was partially refilled with of sand-boulder sediments of T_2 terrace by fluvial action between ca. 45-39 ka. The phase represents warmer climate, enhanced monsoon or glacial melting. The corresponding warm phase in Leh area, is constrained between ca 49-46 ka. A cold pulse of uncertain duration is suggested by laminated lacustirne clays at ca.34 ka in Darbuk area.

The Leh area witnessed cold condition of last glacial maximum (LGM, MIS 2) during 24-18 ka when lacustrine clays were formed in Indus valley and moraines in Leh-Khardungla valley and Khalsar area.

Exposure of terraces and lake floor sediments which were deposited since ca. 7±0.6 ka suggest that Pangong Tso lake has witnessed significant contraction after ca. 3.6±0.3 ka. Presence of evaporate bearing terraces on the NW margin of lake support the dry condition and shrinkage of lake.

The above study though attempts to provide a broad, regional chronology of the Late Quaternary deposits of Ladakh but also highlights the gigantism of problems in developing intra and inter-valley startigraphy vis-a vis global events. Ladakh area offers great opportunities in the Quaternary research.

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