Abstract

The dynamic Himalaya is the result of collision of the Indian and the Asian plate. The signatures of climatic and tectonic events during its evolution are preserved in the form of various geomorphic features. This thesis deals with the methodological aspects of luminescence dating of fluvial sediments in the Himalaya. The results are then used to understand some aspects of the past climate and seismic events in Himalaya.

Optically Stimulated Luminescence (OSL) dating relies on the premise that daylight exposure of the constituent minerals during their pre-depositional transport photo-bleaches the geological signal to a zero or near zero level. In case of fluvial sediments, the daylight is attenuated due to variety of factors such as depth of water column and turbidity. This implies that the fluvial sediments are in general partially and heterogeneously bleached at the time of their deposition. Luminescence dating methods such as the Single Aliquot Regeneration (SAR) method now enable an understanding of the bleaching history of a sample and help in the isolation of the most bleached grains for age estimation.

The present study examined the feasibility of using OSL dating for a variety of fluvial environments from Himalayan terrain. The basic effort was towards examining the validity of the basic assumptions of luminescence dating technique using samples with age constraints. In this process new protocols were developed, tested and applied. The aim and scope of the thesis can be summarized in two broad categories–

1. Methodological aspects

Sensitivity changes during the measurement of natural OSL is not accounted for, in conventional SAR protocol. Such a change could imply systematic offsets in SAR ages. This aspect was examined for a large variety of sediments using 110°C TL peak as a surrogate for OSL sensitivity. Results indicated that sensitivity changes could range from 20-50% and therefore corresponding offsets in ages could occur.

A practical handicap in applying SAR protocol is that it consumes considerable measurement time. This implies a low data throughput. Recently, a practical solution towards increasing the data throughput was suggested. This involved construction of a Standard Growth Curve (SGC) from a small set of growth curves, on which sensitivity corrected natural luminescences from large number of aliquots are read to estimate the paleodose. This process minimizes time by eliminating the need of carrying out a full SAR cycle that comprises the construction of a growth curve for

each aliquot. A detailed investigation suggested that reliable SGC-SAR based ages can be obtained for cases where regression coefficient of SGC is greater than 0.9.

2. Feasibility of sediment dating from Himalayan terrain, chronology and its Implications– Breaching of a landslide induced natural lake is quite common in Himalayas and results in flash floods. This provides high velocity, high bed load and high suspension load flows. A feasibility study for the dating of sediments transported under these conditions was examined using samples of a known catastrophic flood event in Himalaya. This was the 1970 flood in the Alaknanda basin. A suite of samples at various distances downstream from the origin of flood over a distance of ~250 km were collected. No systematic change in bleaching was found although mean grain size of the sample decreased as the distance of travel of the sediment. However samples deposited during receding phase of flood has indicated significant bleaching up to 90% and gave a notional luminescence age of ~ 400 a, indicating the magnitude of 'zero error' in luminescence dating of such sediments.

The extent of daylight bleaching for the slack water deposit in Raiwala near Haridwar was also examined. The difference between mean and least 10% of paleodoses suggested that samples were partially bleached and the SAR protocol could still provide realistic ages. Almost 1.5 meter of sediment was deposited in a time period of ~2.3ka to ~800 years having 14 flood couplets in total. The results accorded well with paleoclimate records.

Fan sediments comprise gravel and coarse-grained sands. Typical transport distance in the case of Himalaya fans sediments is of the order of few km and the bleaching in such sediments is expected to be partial. It has been suggested that mega fan aggradation in Ganga plain occurred during the time of the initiation of humid climate that was preceded by a long arid phase when huge amount of sediment from the Himalaya were transported into the Ganga plain. The data suggested that the mega fan sediments are relatively better bleached as compared to piedmont fan sediments. Our results concluded that the studied section of the mega fan sedimentation postdate the Last Glacial Maximum and occurred in three episodes during ~14 – 8 ka. This accorded well with the paleoclimate records. The possible cause of well-bleached mega-fan sediment is explained by the prolonged daylight exposure during weathering in arid period. Chronology of the younger piedmont fan suggests its formation during ~2 – 1 ka.

During tectonic uplift of the riverbed, the river incises into the bedrock and leaves a thin veneer (~1-2 meter) of sediments on incised bedrock. Samples from such strath terraces in Tista valley were taken for feasibility of luminescence dating with respect to bleaching. A poor bleaching indicated by wide dose distribution. However, minimum 10% SAR ages provided a stratigraphically consist inverted age sequences. The luminescence ages suggest that the

Darjeeling-Sikkim-Tibet wedge is going through a cycle of various phases of mountain building processes. There were two deformation fronts active between 20–5 ka; one near the Main Boundary Thrust and the other on south of the mountain front. The results suggested that the region close to the Main boundary thrust in Tista valley is neo-tectonically active and out of sequence thrusting occurred due to various phases of mountain building processes. Luminescence SAR ages have indicated a varying incision rates of 3–10 mm/year by river Tista in the studied section.

Overall the present thesis established that reliable ages using Luminescence Dating could be estimated for sediments from wide range of depositional environment. Radiocarbon dating has limited applicability in the region on account of contamination and hence reliable chronology of these sediments was not possible till this work. The present thesis examined the bleaching aspects of luminescence dating and the implication of SAR analysis in sediments from the Himalaya. This study therefore provides a basis for the application of Luminescence Dating and concludes that it can play a significant role in studies related to paleoclimate and tectonic in the Himalayan region.