Chapter 7

Conclusions and Future Outlook

7.1. Conclusions and Future Outlook

The objective of the present work was to improve the existing Single Aliquot Regeneration (SAR) protocol, ascertain the bleaching history of the fluvial sediments and develop criteria for the identification of well-bleached aliquots. Finally the ages thus obtained were used to reconstruct the palaeoclimatic and palaeoseismic history of the studied area.

In the SAR protocol, change in sensitivity is monitored by a fixed text dose that follows after the natural OSL measurement and there is no provision to ascertain and monitor the sensitivity change prior to natural OSL measurement. There is a possibility of change in natural sensitivity due to preheat and OSL measurement. Hence an appropriate correction needs to be done for obtaining reliable chronology. This correction is called the natural correction factor (ncf). The present study has shown that ncf can vary between 20 – 30% and in few cases can be as high as 50%. If the samples are not corrected for natural sensitivity changes, it may lead to higher age estimate (~7 – 38%). Based on the above study a modified SAR protocol was developed called as Natural Sensitivity Corrected- Single Aliquot Regeneration (NSC-SAR) protocol. This was successfully applied in all the samples that were investigated in the present study. However, the study done so far is limited to linear and polynomial nature of the growth curves. This needs to be employed on samples that show exponential and exponential + linear nature of growth.

In conventional SAR protocol, enormous TL/OSL reader time is consumed. On an average a sample of ~10 ka would require 4 – 5 days of machine time due to multiple cycles of irradiation, preheat and OSL measurements. It reduces the data throughput in case of partially bleached fluvial sediment in which a large number of aliquots are required for statistical analysis of the distribution of paleodoses. The application of SGC provides an opportunity to produce large number of paleodoses in a short time. The SGC analysis can be applied to any set of sample, where the regression coefficient of a SGC based on 20 aliquots is >90%. Application to samples with lower regression coefficients is likely to be less accurate if one wishes to apply this on very young fluvial sediments where minimum paleodose is considered for age estimation. Most importantly, it was demonstrated that SGC works very well for samples that had minimum lithological variability (single provenance). Considering this, SGC has limited applicability for the Himalayan sediments that originate from complex lithologies.

In high-energy fluvial system, sediments suffer from inadequate bleaching during the flash flood events. A systematic sampling of 1970's flood sediment along the downstream of the Alaknanda river (source to the ~250 km downstream) yielded ages ranging from 0.4 ± 0.04 ka to 4.3 ± 1 ka. Based on the bleaching study, it was observed that during flash flood events, the distance of sediment transport has limited influence on the extent of pre-depositional bleaching. Instead, it is the nature of transport (suspension load) and depositional environment (flood plain) that is important for erasing the geological luminescence to a residual level.

The paleoflood history has been reconstructed from the Alaknanda basin at Srinagar where five floods of increasing magnitude were recorded since last 6 ka. The 1970's flood was highest in magnitude. Further it was observed that except for 0.8 ka and 1970, all paleofloods were originated in the higher Himalayan crystalline.

Slack water deposit at Raiwala have provided the record of past flood events in the upper catchment of the Ganga river. A total of 14 floods of increasing magnitude were identified since last 2.6 ka. The results shows that a maximum of 6 floods of high magnitude occurred between 2.6 to 1 ka implying recurrent interval of high magnitude flood was once in a 260 years. The frequencies of flood increased from 1 ka to 0.8 ka during which 8 floods were recorded suggesting one major flood after every 25 years. Absence of flood sediment above 0.8 ka event indicates decrease in the flood magnitude in the upper Ganga catchment.

In the study area the incised fan sequence has preserved three events of alluvial fan aggradations that are bracketed between 14 ka and 8 ka suggesting prevalence of transitional climatic conditions during their formation. The younger piedmont fan aggradations occurred after a prolong hiatus. Luminescence chronology bracketed the piedmont fan sedimentation between 2 ka and 1 ka. This implies that the development of piedmont fan postdate the mid-Holocene aridity in the Ganga plain.

In the recent times there is significant evidences to suggest that sesimicity is concentrated around MBT and MFT. This is very well demonstrated in the Sikkim-Darjiling Himalaya where raised fluvial terraces and gravel bed indicate that the region was active during the Quaternary. However, the geomorphic manifestation of sesimicity lacked absolute chronology.

In the present study activity along the MBT and its splays are chronologically constrain. The ages from fault gouge of South Kalijhora Thrust (SKT) (0.5 km south of Main boundary thrust) and main frontal thrust (MFT) indicated that lesser Himalaya experienced a regional phase of tectonic activity around 40 ka. Following this, the active deformation front subsequently moved north of the mountain front to the footwall of the MBT around 20 ka. Subsequent deformation and topography building near the MBT then caused additional blind imbricate faults to develop south of the mountain front at 14 ka and 6 ka. The two active fronts may have, therefore, evolved in a coupled manner; with the building of a critical taper in the footwall of the MBT.

Further evidence of seismicity are obtained comes from the raised fluvial terraces. Chronology of the fluvial terraces suggests that there were three major event of incision caused by the tectonic activity associated with the splays of MBT viz. the AJT and SKT. These events are dated to 7.7 ka, 4.4 ka and 1.4 ka respectively. This would imply that the terrain is uplifting at rates varied between 3-10 mm yr^{-1}.

As seen from the results from various geological archives discussed above, the sediments have shown partial bleaching. Even though minimum ages have shown considerable luminescence ages supported by paleoclimate records except in a known event of flash flood in 1970, it needs a detailed study. Present study was limited to the grain size of 90-150 micron or more; however, more fine textured grains can be taken for age estimation in a known event on the account of higher suspension time of finer material than coarse textured minerals. Recently developed Linearly modulated OSL (LM-OSL) is capable of isolating rapidly bleaching and slowly bleaching component in a shine down curve. Even though initial part of the shine down curve is analyzed for age computation, which is fairly a rapidly bleaching part of the curve, LM-OSL combining with SAR will add new dimensions.

As discussed earlier, Paleoclimatic signatures studied in alluvial fan is limited to ~14 ka. In the present work, only a part of the alluvial fan was studied, however, it needs exhaustive study to infer about the older records that can be done by studying core samples at higher depth.

Terraces are interplay of tectonic and climatic processes. It was the first time when the geochronology of a terrace in the Himalaya was used for paleoclimatic inferences. This prompts to identify and mapping of the young terraces in the Himalaya to get the paleoflood records in the Holocene. It might contribute to resolve the dilemma of tectonic or climate in such a dynamic area.