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Liquefaction and Fluidization of lacustrine deposits from areas in Lahaul-Spiti and Ladakh Himalaya: geological evidences of Paleosismicity along active fault zones

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Earthquakes are natural phenomenon hazardous to mankind, causing extensive damage to structure, property and human life. Only during past few years (in geological term), understanding of some of the physical processes causing the earthquakes have been attempted. After California earthquake a concerted efforts have been made to identify seismic-hazard zones and the seimogenic fault along with their past behaviors especially the recurrence intervals to predict their future reactivation. Instrumental seismology started only by the end of 19^{th} Centaury, therefore, the seismic data predating the network of earthquake monitoring stations can only be acquired with the help of late-Quaternary geological records. These geological records are important source of information for the frequency and location of large earthquakes. Although the estimation of the magnitude of historical earthquakes is empirical and incomplete but it is necessary to get as much information as one can get. The best site for the paleosismic studies are young lakes and lake sediments.

Soft-sediment deformational structures (seismites) are important diagnostic features for the paleosismic studies. Generally, the seismites are a result of local vigorous fluidization and the hydroplastic deformation formed during liquefaction. Fluidization occurs when the drag exerted by moving pore fluid exceed the effective weight of the grains and the particles are lifted, the grain framework destroyed and the sediment strength is reduced to zero. The fluidization takes place almost penecontemporaneous with sedimentation and presence of fluidization implies that the sediments were in a liquid state. However, the liquefaction is the apparent mode of formation of structures during shaking of sediments near sediment interface followed by normal sedimentations. It is marked by the sudden breakdown of a metastable, loosely packed grain framework causing the grain temporarily suspended in the pore fluid and settling rapidly through the fluid until a grain-support structure is reestablished. Various studies reveal that the soft-sediment structures due to fluidization and liquefaction can form only for the earthquakes of larger magnitude ($M_b > 6.5$) because of the fact that the records are of the direct consequence of permanent deformation of ground surface reflecting the deformation at main-shock depth on the seismogenic fault.

The region of eastern Ladakh, Spiti Basin and the upper Sutlej River basin are the most seismically active part of the western Tethyan Himalaya in the past 25-30 years and exhibit the most diverse deformation similar to that of the Southern Tibet and is dominated by N- and NNE-trending normal faults. The concentrations of the earthquake in this region is predominantly related to the Kinnaur earthquake of January 19, 1975 and its aftershock shows that the greatest concentration of earthquakes occur in a well defined NE-trending seismic zone sub parallel to the strike of Leo-Pargil Horst and the Kaurik-Chango Fault Zone. The soft-sediment deformational studies of the fluvial and fluivo-lacustrine sequences from the Sangla valley, near Sumdo village of Himachal Pradesh and near Saspol village of Ladakh indicate that the Kaurik-Chango Fault zone is a seismogenic fault causing the earthquakes in the geologic past. The deformational structures have also been dated by the TL luminescence techniques near the Sumdo village, constraining the paleosismic activities having magnitude more than 6 between 90,000 years (third activity) to 26,000 years (last geological evidence) indicating a recurrence of earthquakes to be approximately 10,000 years.