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Clay mineralogy of rock-avalanche-dammed lake sediments near Sangla (Baspa Valley) and Chango (Spiti Valley) in the Higher Himalaya, NW India

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Of the three major rivers originating in the Mount Kailash area in Tibet, the Brahmaputra and Indus rivers cross the Himalaya at its syntaxes; only the Sutlej River cross-cuts the orogen in its central part. As a result, the Sutlej Valley forms a natural cross-section perpendicular to the general trend of the Himalaya, exposing all the tectonic units in the orogen. The valley serves as a natural laboratory for using climatic and geomorphological data to determine the interaction and interdependence of endogenetic *versus* exogenetic processes. In this study, the (clay) mineralogy of sediments from two rock-avalanche dammed lakes in the Sutlej region, with different catchment area characteristics, have been compared.

Baspa Valley: The Baspa River flows into the Sutlej River from the east, with a catchment area in the Higher Himalayan tectonic unit. Most of the catchment lies in (structurally lower) metamorphic/magmatic rocks of the Higher Himalayan Crystalline; only the eastern part comprises Tethyan Zone sedimentary rocks. In the Baspa Valley, near Sangla village, more than 100 m of lake sediments has accumulated behind a rock-avalanche dam. ^{14}C data from organic remains indicate a late Holocene age for the lake, which was filled-up within some 2,500 years. The exposed lake sediments, close to the dam, comprise about 95 m of finely laminated pelitic and silty sediments, with minor thin, sandy layers. The sediments are covered by a thin layer of fluvial gravel, indicating that the lake was completely filled before subsequent inci-

sion by the Baspa River during backward erosion. The altitude of the catchment area relevant for the Sangla lake ranges from 2,550-6,600 m.

Pollen from clay samples in the lowermost part of the lake, close to the dam, show a relatively diverse flora (65 taxa), indicating a considerably warmer and more humid climate than at present (e.g. 25 taxa of ferns and fern allies). A clay sample from directly above the lake sediments contains a less diverse flora (23 taxa), indicating dryer or cooler conditions during the final stages of lake filling.

Spiti Valley: The Spiti River flows into the Sutlej River from the NW, with a catchment area also situated in the Higher Himalayan tectonic unit. In contrast to the Baspa Valley, the major part of the catchment comprises Tethyan zone sandstones and carbonate rocks, with only minor occurrences of magmatic intrusions. Before the Spiti joins the Sutlej River it crosses a deeply cut, wide gorge, where, near Chango village, more than 160 m of lake sediments have been deposited behind a huge rock-avalanche. ^{14}C ages from the base indicate a Late Pleistocene age (Bookhagen et al. 2005). The sediments form white, very monotonous, silty clays with only very thin intercalated gravel beds. The altitude range of the catchment part relevant for the Sangla lake ranges from some 3,000 to 6,100 m.

Fine-grained Sangla and Chango lake sediments were sampled for mineralogical analyses; bulk samples and separated clay fractions were analyzed by X-ray diffraction. The mineralogy of the 9 samples from the Sangla palaeo-lake remains the same throughout the profile. Semi-quantitative estimates (Schultz, 1964) of the top and bottom samples indicate 19% quartz, 5% K-feldspar, 9% plagioclase, 64% muscovite, 3% chlorite (top) and 15% quartz, 3% K-feldspar, 10% plagioclase, 56% muscovite, 16% chlorite (bottom). The mineralogy of the 14 samples from the Chango sequence is very similar, except for rather high calcite and dolomite modal percentages, reflecting the carbonates in the source area.

Sedimentary clays can be used as indicators for palaeoclimatic conditions; the presence of only chlorite and muscovite (or illite) in the samples indicates a relatively cold and dry climate, with dominantly physical weathering (Chamley, 1989), whilst chemical weathering (hydrolysis) would lead to the formation of mixed-layer or expandable clay minerals.

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