SOIL DEVELOPMENT ON GLACIAL AND GLACIOFLUVIAL DEPOSITS IN CENTRAL AND EASTERN NEPAL IN RELATION TO CLASSIFICATION AND LANDSCAPE HISTORY

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Forty soils developed from glacial and glaciofluvial deposits between 2,700 and 5,000masl in the Langtang/Helambu (Central Nepal) and Mt. Everest (Eastern Nepal) regions were investigated to provide information about soil classification, zonal distribution, changes with elevation and climatic conditions, and their relation to the landscape history. The soils are mainly developed from deposits of the last main glaciation, and of Postglacial and Holocene advances. Parent materials consists of metamorphic rocks (mica, schists, gneisses). The soils were classified as Entisols, Inceptisols, and Spodosols according to the U.S. Soil Taxonomy (Bäumler 1994).

Chemical and clay mineralogical analyses indicate a strong influence of the elevation on soil types, and soil forming processes, integrating several factors of climatic conditions and bioclimatic zones (Table 1). Inceptisols predominate in the hill zone and lower tropical mountain zone between 2,000 and 3,000m. They are replaced by Spodosols in the subalpine forest zone and alpine shrub zone up to 4,500m. Eroded sites and locations above 4,500m show shallow and stony Entisols.

A decrease in the intensity of weathering with increasing elevation is shown by the decreasing clay content of the main weathering horizons (Fig. 1), which demonstrates the influence of climate on soil development. From the regression coefficients, an average decrease of clay content of 4.7 % per 1,000m can be calculated between 2,500 and 5,000masl. In masl comparison, the thermal gradient is 5.4 °C per 1,000m (Dobremez 1976).

Independent of it, iron fractionation and the calculation of weathering indices resulted in the differentiation of soils into groups of different soil development. One group of younger soils, with their main zone of weathering in the top horizons, were mainly developed from deposits of the last main glaciation and the Holocene Period. The relative-age estimates of this group of soils could be supported by the radiocarbon analysis of charcoal and buried A horizons (Bäumler et al. 1995). The other group of considerably older, highly-weathered soils was presumably derived from interglacial deposits (Bäumler et al. 1991). In the Solu and Khumbu Himal, indications on the history of the landscape are given by the distribution of these two groups of soils with different intensities of weathering. The highly-weathered soils of the second group are located at higher slope positions in the valleys than soils developed from deposits of the last main glaciation (Bäumler et al. 1991). This might indicate on ice marginal grounds, as the older soils are preserved and were not truncated or eroded by ice.

In the Langtang valley (Central Nepal), the group of young soils could be additionaly separated into initial soils developed from deposits of the Little Ice Age or even earlier, and a group of Inceptisols and Spodosols. Those soils are developed on the moraines of the Lirung glacier, deposited between 3,100 and 500 yr. This could be supported by radiocarbon data, which also give evidence of climatic fluctuations at about 6,000 and 4,400 yr. characterised by accelerated solifluction and deposition of eolian material following warmer periods with humus accumulation and soil formation (Bäumler et al. 1995).

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Table 1: Bioclimatic (altitudinal) Zones and their Characteristic Vegetation Cover (Bäumler and Zech 1994).

Altitude (masl)	Bioclimatic Zonation
6000 m	Climatic snowline (5600-5800 m)
5000 m	Alpine zone (alpine turf vegetation)
	Apine zone (dwarf brush vegetation)
	forest line (4000-4200 m)
4000 m	Subalpine zone (coniferous forests with *Betula utilis* and *Rhododendron spec.*)
	Upper tropical mountain zone (mixed forests)
3000 m	Lower tropical mountain zone (deciduous and evergreen
	Tropical mountain forests of Conifers and *Quercus spec.*)
2000 m	Hill zone (mixed forests of *Quercus spec.*)
	Subtropical zone (coniferous mixed forests of *Pinus roxburghii*)
1000 m	Tropical zone (semideciduous forests of *Shorea robusta*)

Figure 1. Correlation between the clay content in the main zone of weathering of soils, developed from deposits of the last main glaciation and earlier and the elevation of the corresponding locations