



Neogene vegetation and past climate change in the Thakkhola-Mustang Graben (central Nepal).

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The Thakkhola-Mustang Graben, which reflects Neogene extensional tectonics in the Tibetan Plateau and Himalaya, lies north of the Dhaulagiri-Annapurna ranges and south of the Yarlung-Tsangpo Suture Zone. The basement of Thakkhola-Mustang Graben is made up of Tibetan-Tethyan sedimentary rocks of Paleozoic and Mesozoic ages, which are unconformably overlain by continental debris (more than 850 m) of Neogene to Quaternary age. Stratigraphically, the Thakkhola-Mustang Graben sediments have been divided into five formations namely the Tetang Formation, the Thakkhola Formation, the Sammargaon Formation, the Marpha Formation and the Kaligandaki Formation. Different approaches have been made to study the Neogene sediments in this graben. In this study, we mainly focused on sedimentological and palynological studies of the Thakkhola-Mustang Graben, which provides a basis for discussing the paleo-environmental evolution of the southern continental margin of the Tibetan Plateau towards the end of the Miocene.

Field mapping, profile logging, stable carbon and oxygen isotope analysis, and palynological studies were carried out to understand the depositional environment and the paleoclimate. The methodology developed by Zetter (1989) was followed for the pollen extraction. Pollen samples were processed in the laboratory and were studied under the light microscope (LM), which were later transferred to the scanning electron microscope (SEM).

A variety of sedimentary environments are recognized including alluvial fan, lacustrine, braided river and glacio-fluvial. Neogene sediments are composed of braided fluvial deposits with lacustrine deposits in different level of the succession. Most of the pollens were found in the lacustrine layers of the Tetang and Thakkhola formations. Pollen analysis shows that the sediments contain dominant alpine trees like *Abies*, *Pinus*, *Keteleeria*, *Picea* *Tsuga* and *Quercus* with some steppe elements like *Artemisia*, *Compositae*, *Chenopodiaceae*, *Plantago* and *Poaceae*. The results show that during this period, the southern part of Tibet was covered mainly by steppe vegetation, indicating dry climate. Organic plant material from the Thakkhola and Tetang formations yielded stable carbon isotope ($d_{13}C$) values between -21.87 to -26.64 permil, indicating the presence of C3 vegetation. However, the $d_{13}C$ values from the carbonates range between -0.62 to 11.08 permil, which shows the mix vegetation of C3 and C4 plants. It is presumed that the paleoclimate during the sediment deposition time of the Thakkhola-Mustang Graben was significantly warmer than the present-day climate. Further study of pollen with LM and SEM is necessary.

Reference:

Zetter, R., 1989, Methodik und Bedeutung einer routinemäßig kombinierten lichtmikroskopischen und rasterelektronenmikroskopischen Untersuchung fossiler Mikrofloren. Cour. Forsch.-Inst. Senckenberg, Frankfurt am Main, 109, 41-50.