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Landscape evolution of the northeastern Tibetan plateau – relict surfaces and fluvial margins

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The actively uplifting Tibetan plateau has a profound impact on climate and displays a landscape marked by geomorphological action. This is because the uplift is counteracted by intense fluvial incision of some of the world's largest rivers and their tributaries that drain the plateau. Glaciers and glacial landforms occur predominantly in and around the highest elevation areas. By investigating the imprints of glacial and fluvial erosion we can enhance our understanding of the long-term landscape evolution, as well as illuminate the paleoglaciology of the Tibetan plateau. We here present an investigation of the large-scale geomorphology of the northeastern Tibetan plateau and its implication for landscape evolution and paleoenvironmental reconstructions.

The northeastern part of the Tibetan plateau is characterized by a plateau surface at c. 4300 m asl with higher mountain groups reaching up to 1500 m above the surrounding plateau surface. We used SRTM 90 m digital elevation model, satellite images and Google Earth imagery to map the large-scale geomorphology for an area of c. 135.000 km^2 centered around the Bayan Har mountains. Our mapping reveals a clear pattern of substantial glacial erosion on the highest, central parts of the mountain areas and decreasing amounts of glacial erosion with decreasing elevation and increasing distance away from these centers of glaciation. Beyond the areas of glacial erosion,

there is a low-relief fluvial landscape that typifies the rest of the plateau surface. The plateau margins are formed by steep fluvial valleys which cut backwards into the gentle sloping relict plateau surface. Thus, the overall landscape may be divided into three classes; (i) glacially eroded surfaces in the highest areas, (ii) a relict, low-relief plateau surface, and (iii) a steep, fluvial landscape juxtaposing the former two classes.

The distribution of the different landscapes indicates the following temporal evolution of the landscape. The glacial landforms indicate a repeated glaciation of the mountain areas. The steep fluvial valleys consuming the relict plateau surface represent an ongoing adjustment of the river channels to the actively uplifting plateau margin. The pattern of abandoned fluvial erosion of the northern part of the study area supports the notion of a stepwise uplift. This is because progressively younger uplift of the northern parts of the area induced a piracy of originally N-flowing rivers to currently ESE-flowing rivers along major faults (such as we infer for the Huang He river). It is noteworthy that the outline of the relict landscape, that is the pronounced break in slope between the low-relief relict landscape and the young fluvial landscape, coincides almost completely with the outline of a hypothesized former ice sheet, the Huang He ice sheet. We have not been able to confirm the presence of geomorphology or stratigraphy that would support this reconstruction. If true, however, our notion of outline conformance could indicate that the Huang He ice sheet may actually have been larger than suggested and that glacial traces are being consumed by the fluvial incision triggered by plateau uplift.