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The Ice Age glaciation (Isotope Stage 4-2) in the southern slopes of Mt. Everest, Cho Oyu, Lhotse and Makalu (Himalaya)

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In the Khumbu- and Khumbakarna Himalaya an ice stream network and valley glacier system has been reconstructed for the last glacial period (Würmian, Last Ice Age, Isotope Stage 4-2, 60- 18 Ka BP, Stage 0) with glaciogeomorphological and sedimentological methods. It was a part of the glacier system of the Himalaya and has communicated across transfluence passes with the neighbouring ice stream networks toward the W and E. The ice stream network has also received inflow from the N, from a Tibetan ice stream network, by the Kyetrak-Nangpa-Bote Koshi Drangka in the W, by the W-Rongbuk glacier valley into the Ngozumpa Drangka, by the Central Rongbuk glacier valley into the Khumbu Drangka and by the antecedent Arun Nadi transverse-valley in the E of the investigation area. The ice thickness of the valley glacier sections, the surface of which was situated above the snow-line, amounted to 1000-1450 m. The most extended parent valley glaciers have measured approx. 70 km in length (Dudh Koshi glacier), 67 km (Barun-Arun glacier) and 80 km (Arun glacier). The tongue end of the Arun glacier has flowed down to c. 500 m and that of the Dudh Koshi glacier to c. 900 m asl. At heights of the catchment areas of 8481 (or 8475) m (Makalu), i.e. 8848 (or 8872) m (Mt. Everest, Sagarmatha, Chogolungma) this is a vertical distance of the Ice Age glaciation of c. 8000 m. The steep faces towering up to 2000 m above the névé areas of the 6000-7000 m-high surfaces of the ice stream network were located 2000-5000 m above the ELA. Accordingly, their temperatures were so low, that their rock surfaces were free of flank ice and ice balconies. From the maximum past glacier extension (Stage 0) up to the current glacier margins (recent), 13 (altogether 14) glacier stages have been differentiated and in part 14C-dated. They were four

glacier stages of the late glacial period (I-IV), three of the neoglacial period (V-‘VII) and six of the historical period (VII-XII=recent). By means of 130 medium-sized valley glaciers the corresponding ELA-depressions have been calculated in comparison with the current courses of the orographic snow-line. The number of the glacier stages since the maximum glaciation approx. agrees with that e.g. in the Alps and the Rocky Mountains since the last glacial period. Accordingly, it is interpreted as an indication of the Würmian age (last glacial period) of the lowest ice margin positions. The current climatic, i.e. average glacier snow-line in the research area runs about 5500 m asl. The snow-line depression (ELA) of the last glacial period (Würm) calculated by four methods has run about 3870 m asl, so that an ELA-depression of c. 1630 m has been determined. This corresponds to a lowering of the annual temperature by c. 8, i.e. 10˚C according to the specific humid conditions at that time.

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