← *Photo 34.* Viewpoint at 3990 m asl on the Baltoro glacier which is covered with a very coarse surface moraine of edged granite boulders (□, for scale: porters with their loads crossing the boulders). We are in the confluence area of the western Urdokas glacier (35°43′ 20″ N/76°14′ 90″ E), looking SSE to the superstructure of the Urdokas Peak (No.27, altitude of the major summit: 5988 m). (– –) is the highest demonstrable prehistoric glacier level; (◓) mark glacigenic roundings of the bedrock granite from that time. (↓) indicate glacier valley flanks undercut through lateral erosion by the present-day glacier, which has melted back to only minor dimensions. The rock slopes, shaped by the LGM-glaciation, are thus steepened from their lower slopes upwards. This forces rock crumblings, so that the present-day glaciation remoulds the prehistoric glacigenic forms. Photo M.Kuhle, 22.8.1997.

← *Photo 35.* Taken at 3920 m asl from the Baltoro glacier in the confluence area of the western-most Urdokas Peak N-glacier (35°43′ 30″ N/76°13′ 50″ E) facing S, looking up this orographic left tributary glacier to the 6368 m-summit (No.29, Urdokas Group). (– –) is the LGM glacier level of the prehistoric ice stream network. (◓) mark rock roundings of the bedrock granite belonging to this stage of the maximum glaciation. Undercut by the present-day glacier, the rock flanks show numerous fresh crumblings (↓), producing the surface moraine boulders (□). Some of them form glacier tables on the sheer ice. In the foreground three porters for scale. Photo M.Kuhle, 22.8.1997.

→ *Photo 36.* Panorama taken from the orographic left lateral moraine (■) of the present-day Baltoro glacier, here completely covered by a decimetres- to metres-thick polymict surface moraine (□ on the right side), seen from a viewpoint (35°43′ N/76°13′ 45″ E) at c. 3860 m asl at the locality Robutze: in the WSW a northern satellite of the 6251 m-high Liligo Peak (No.28); below are detritus cones (▶) mainly consisting of displaced and remoulded morainic detritus; in front lies the Liligo glacier (□ on the left) only just reaching the Baltoro glacier; in the W stand Paiju Peak (No.11, c. 6600 m-high) and the 6756 m-high Choricho (No.22); the c. 6600 m-high Kruksum (No.19) lies towards the NNE, on the right side of the glacigenically rounded granite walls of the Trango group (the two ◓ on the right). (– –) indicates the LGM-glacier level at 5900 and 6100 m asl. The highest flank polishings reach as far as this altitude (◓). The lateral moraine (■) between the large, polymict, massive-crystalline boulders (○) and the sedimentary rocks shows noticeably more matrix and a finer one than the surface moraine (□ right). Photo M.Kuhle, 22.8.1997.

→ *Photo 37.* Panorama taken from the orographic left margin of the Baltoro glacier (□ black) at the exit of the Liligo valley (35°42′ 45″ N/76°12′ 20″ E; 3850 m asl). The left side of the panorama shows the orographic left margin of the Baltoro glacier, looking upwards. It runs in an ENE-direction. In the centre of the photo, i.e. in the S, the heavily advancing tongue of the Liligo glacier (□ white), blackened by the surface moraine, can be seen. Half-right it comes into contact with the Baltoro glacier margin (□ large). No.28 is the summit superstructure of the 6251 m-high Liligo Peak. The right margin of the photo lies in a WSW-direction looking down the Baltoro valley. (◓) are glacigenic flank smoothings. Depending on the rock they occur differently: the polishing on a thinly stratified rock (◓ on the left) is preserved more smoothly and that one on the coarsely stratified granite more roughly (◓ right). The postglacial fluvial rock gullies (⇓) provide the substratum for the youngest small debris bodies in the form of fans or cones (▼). (○) is the modern, i.e. only a few years old, gravel floor (sander) of the Liligo glacier, being in the process of build-up. (□ on the left) marks a debris slope consisting of surface moraine (person on the right of the left □ for scale). Behind the debris slope is visible the dark-grey ramp of sheer ice on which surface moraine slides down (▽). (□ large) are metres-thick fluvial sands lying on the glacier ice. Photo M.Kuhle, 9.9.1997.


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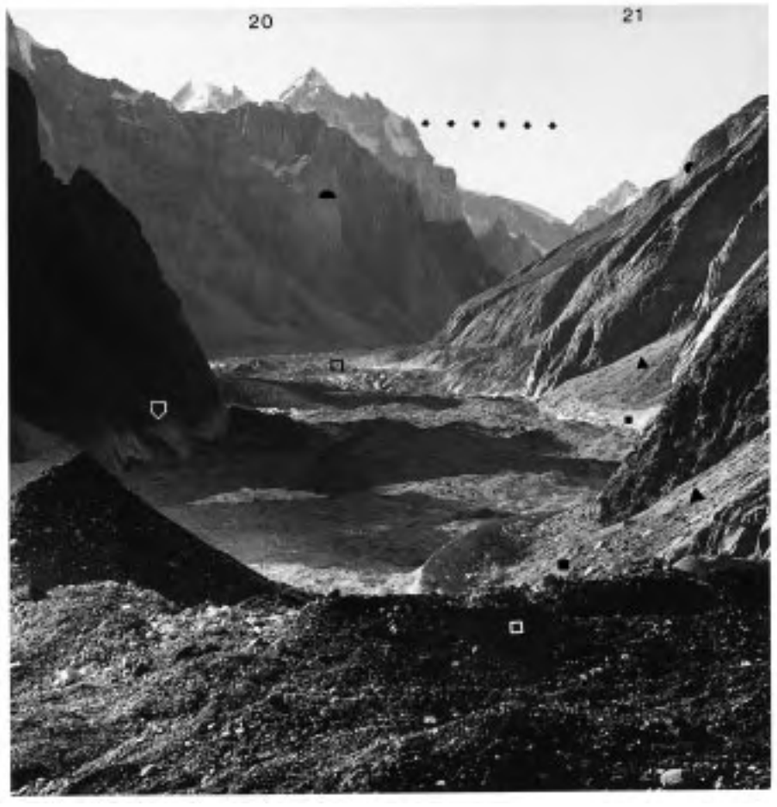
← *Photo 38.* From the S-margin of the Baltoro glacier (orographic left margin) at 3870 m, looking up the Liligo tributary glacier. No. 28 is a fore-summit of the 6251 m-high Liligo Peak, which stands exactly in the S. (■) shows the orographic right ground- and lateral moraine, released from the Liligo glacier a few years before. (□ large) is its tongue covered with surface moraine, which was advancing at the time when the photo was taken. (○) marks the present-day meltwater discharge of the Liligo glacier, accumulating a gravel floor (a small sander). (□ small) is the surface moraine of the Baltoro glacier margin, rich in coarse boulders. (▼▼) indicate moraines with cone-like accumulations of debris on the orographic left side of the Liligo glacier. (◓) are trough valley flanks of phyllitic gneiss bedrock (left) and granite (right) rounded by the glacigenic flank abrasion. (↓) mark the lower slopes, undercut by glacigenic lateral erosion of the postglacial Liligo glacier, which through the resulting fresh crumblings were steepened. These young, still light, lower slopes gradually waste away the glacigenic roundings of the dark-coloured upper slopes (◓). Photo M.Kuhle, 18.9.1997.

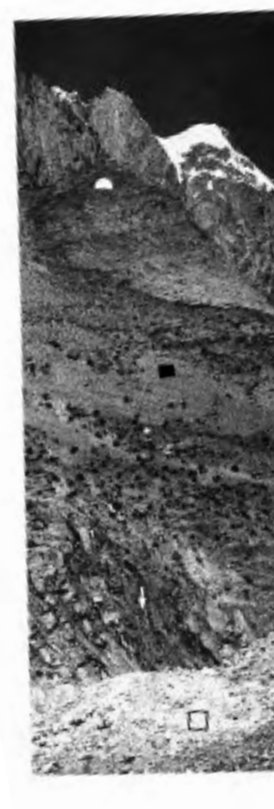
→ *Photo 40.* Looking up the Trango glacier valley facing NNE. The inflow of the Trango tributary glacier (□ black) into the Baltoro parent glacier (□ white) is at 3670 m asl (35°43′ 30″ N/76°11′ 20″ E). No.20 are the glaciated, unnamed summits of an over 6000 m-high, uninvestigated mountain group N of the Uli Biaho- and W of the Sarpo Laggo massif. No.21 marks a western, c. 6000 m-high satellite peak of the 6225 m-high Sarpo Laggo. (– –) indicates the Ice Age (LGM) glacier level, reconstructed according to the glacigenic abrasions and roundings of the valley flanks (◓). (■) are older historic to neoglacial lateral moraines (Younger Dhaulagiri Stage VIII and VII up to Nauri Stage V, i.e. c. 300-5,500 YBP after Kuhle 1982-1999) at the orographic left margin of the Trango glacier. Holocene to present-day debris cones are adjusted to them (▶). At the same time older, i.e. High- to Late Glacial deposits of ground moraine have been preserved under their cone-mantles up to approximately the roots of the debris cones. The light rock stripe above the orographic right glacier margin (⇩) provides evidence of the latest drop of the glacier level since c. 1850 (since Stage X, ibid.). Photo M.Kuhle, 21.8.1997.

→ *Photo 39.* Panorama from the orographic left flank of the Baltoro glacier valley at 3850 m asl, taken 150 m above the glacier surface (□) between the Liligo glacier and the Liligo locality (35°42′ 20″ N/76°11′ 55″ E) facing W via the tongue of the Baltoro glacier and the inflow of the Uli Biaho glacier below the Paiju Peak (No.11, c. 6600 m), via N with the inflow of the Trango glacier into the Baltoro glacier, up to NE, the Baltoro glacier diagonally upwards in the direction of the 7273 m-high Muztagh Tower Group (with hanging glaciers near to the summit). No.26 is the 6417 m-high glacial granite-horn of the Uli Biaho. It towered above the LGM-glacier surface (– –) by c. 250-400 m. (◓) mark the glacigenically rounded and abraded trough valley flanks, developed in the granitic rock on the opposite, northern side of the Baltoro glacier. (■) are ground moraine remnants preserved up to 150 m above the present-day glacier surface. (◇) shows a glacier stream, flowing down in the orographic left ablation gorge of the Baltoro glacier. It undercuts the 30-60 m-high ice margin, so that the glacier ice continuously breaks down and falls into the ablation gorge (⇩). Photo M.Kuhle, 21.8.1997.



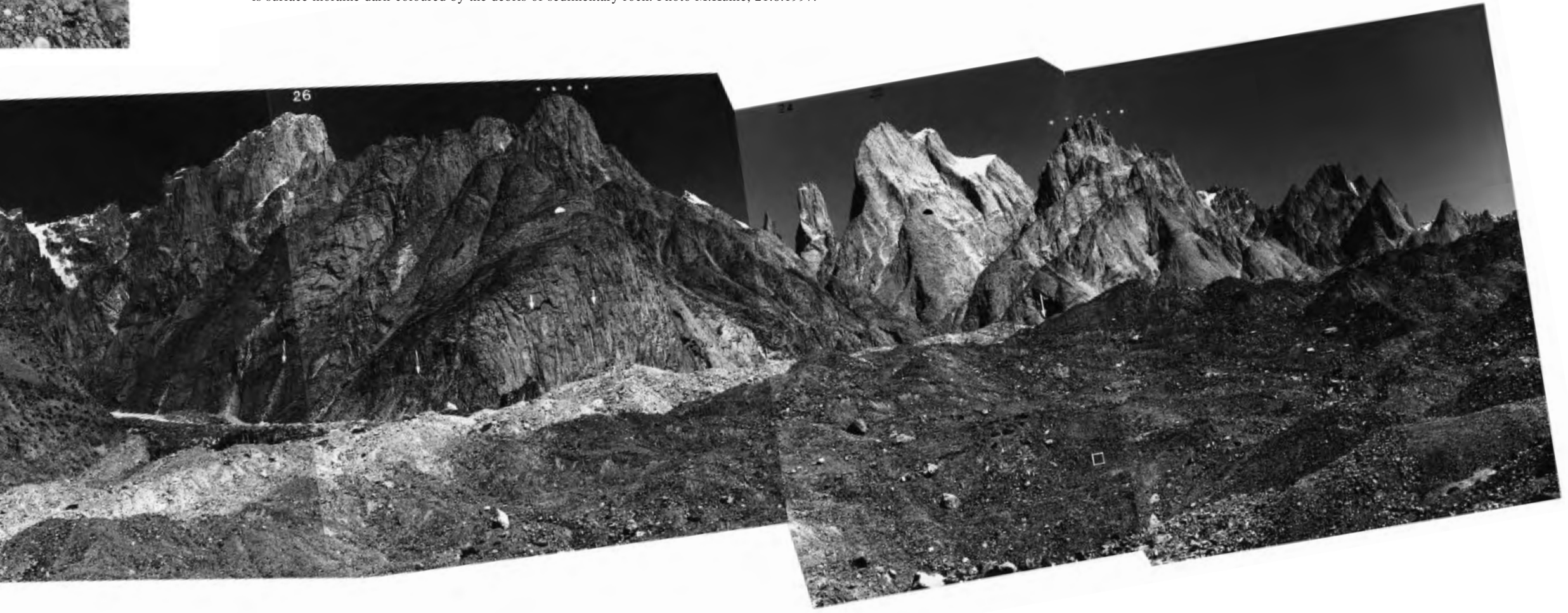
↓ *Photo 41.* Panorama taken from the Liligo locality on the subrecent (= recent) orographic left lateral moraine ledge (■ white) at 3650 m asl (35°42′ 20″ N/76°12′ E) across the Baltoro glacier (□) facing W to the Paiju Peak (No.11, c. 6600 m), NW to the Uli Biaho (No.26, 6417 m) and N to the Trango Cathedral (= Trango I, No.23, 6286 m). The right margin of the photo lies in an E-direction and shows the orographic left Baltoro flank with its large-scale glacigenic rock abrasions (◖ right). (■ black) marks the up to 45 m-thick ground moraine layer, attached to the slope foot of this rock flank. (○ black) is a exemplarily facetted large moraine boulder of granite with an extension of the longitudinal axis of 220 cm. (○ white) are ice blocks the size up to a house, broken down (⇓) from the 30-50 m-high glacier edge (□) which have fallen into the ablation gorge between the subrecent (= recent) lateral moraine (■ white) and the glacier body. The glacigenic rock abrasions and -roundings (◓) document an LGM-glacier level (– –) about 5800-6100 m. Photo M.Kuhle, 9.9.1997.

↑ *Photo 42.* This panorama was taken at 3600 m from the middle of the Baltoro glacier, 2.8 km away from (upwards of) its tongue end (35°41′ 35″ N/76°09′ 25″ E). At this viewpoint the Baltoro glacier is completely covered with surface moraine containing polymict boulders (□). The photo section reaches from down-valley with the orographic left, glacigenically abraded valley flank (◓ on the very left) facing SW, via the orographic right valley flank with the Uli Biaho (No.26, 6417 m) in the NNW and the Trango Tower (No.24, 6239 m) right in the N, up to the ENE, the Baltoro glacier upwards with the glaciated 6000 m-summits of the Biange massif, situated 20 km away (near the right margin of the panorama). (◓ on the very right) is also the abraded, orographic left Baltoro flank (see above), but 15 km up-valley. No.30 marks the unnamed 5800 m-Peak E of the mouth of the Chingkang valley. (▲) are undisturbed, i.e. primarily deposited ground moraine slopes (▲ on the orographic left) and ground moraine material broken away and slid down by fluvial undercutting of the Baltoro meltwater river (▶ on the orographic right). (○) is the broad, wild meltwater bed of the Baltoro glacier river; (■) show the ground moraine sheets in situ on the orographic right valley flank. (⇩) indicates rock crumblings - due to lateral erosion by the Baltoro glacier margin - on the lower slope of the same valley flank. (▽) is the orographic right influx of the not quite 10 km-long Uli Biaho glacier. (◓) signify the glacigenic abrasions, smoothing and rounding the rocks of the valley flanks. They led to the characteristic phenomena of glacigenically triangular-shaped slopes on the back-polished mountain spurs between the inflows of the tributary glaciers. (– –) is the LGM-ice level at 5800-6100 m asl, reconstructed according to these large-scale features. Photo M.Kuhle, 11.9.1997.

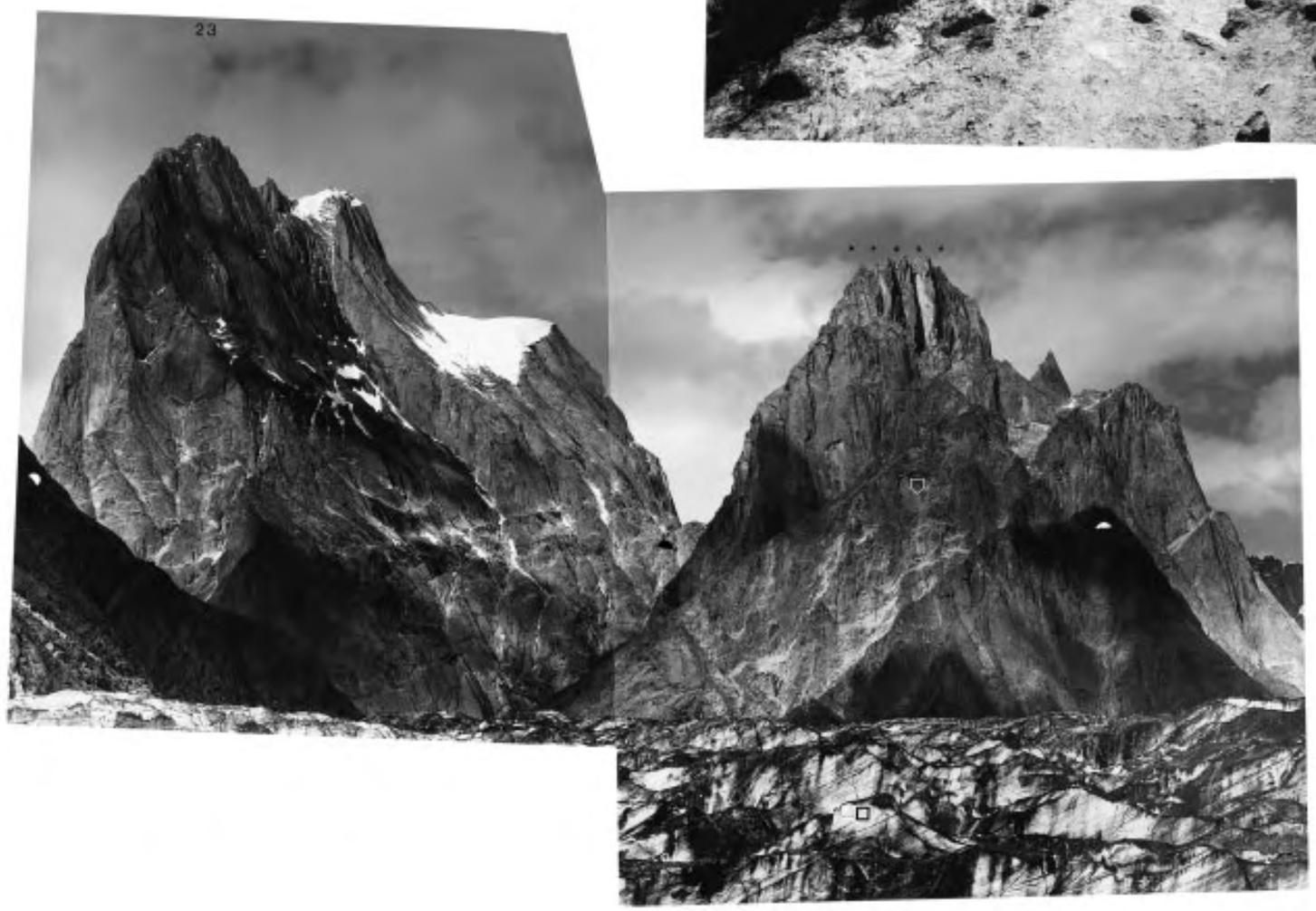


→ *Photo 43.* View from the Uli Biaho glacier at c. 3600 m facing NW, looking steeply up into the valley head of the Uli Biaho valley. No.22 marks the over 6000 m-high unnamed cathedrals and towers of the NE-Choricho Group (for orientation cf. Photo 36 and 44). They are made up of coarse-bedded granite. This valley head lies above today's orographic snow-line (ELA), i.e. at over 5000 m asl. Snow- and ice avalanches coming down out of the walls, accumulate on the still steep avalanche cones (○). From here the regenerated and newly created ice moves down towards the true body of the valley glacier (⇩). These avalanche cones, above all, supply the Uli Biaho. The primary snow precipitation plays only a subordinate role for the feeding. (– –) are minimum heights of the level of the Ice Age glacier filling in this tributary valley. They could be evidenced by glacigenic flank abrasions, i.e. roundings up to an altitude of 5900 m asl. Since the interglacial drop of the glacier level to its present-day altitude, the above-mentioned ice avalanches have eroded fresh, steep rock gullies and wall gorges (⇩) into the granite, so that it has been roughened. Photo M.Kuhle, 11.9.1997.

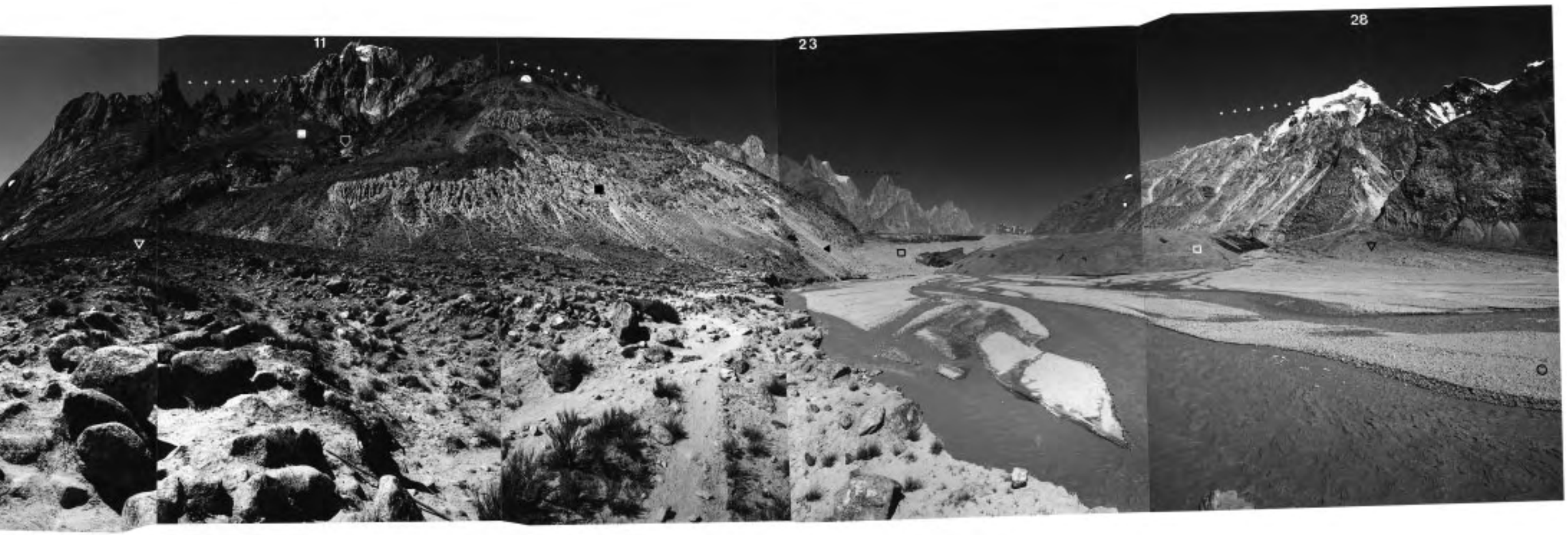
↓ *Photo 45.* From the over 1 m-thick surface moraine (□) of the Baltoro glacier (35°41′ N/76°08′ 50″ E, 3530 m asl), c. 1.4 km away from the tongue end, seen towards the NNW (left margin of the panorama) via approx. N (No.24, Trango Tower, 6239 m) to the NE, upwards of the glacier (right margin). No.26 is the 6417 m-high Uli Biaho and No.23 the 6286 m-high Trango Cathedral (Trango I). The Uli Biaho SSW-face, visible here, falls steeply away (2700 m) from the summit (No.26) down to the surface of the Uli Biaho glacier (vertically below No.26). As far as c. 5800-5900 m glacigenic rock roundings (◓) have been formed and preserved. Accordingly, the glacier level ran at c. 5900-6000 m asl during the LGM. At some places ground moraine can be met up to several 100 meters above the present-day glacier level (■) on the orographic right rock slopes of the Baltoro glacier valley. (↓) mark Late-Late Glacial to present-day undercuttings and breakages in the bedrock granite of the valley flanks. Three phases must be distinguished: 1) glacigenic flank abrasion with the steepening of a 200-300 m-high lower rock slope during the Late Late Glacial (Sirkung Stage IV, older than 12,870 YBP after Kuhle 1997, Tab 1) (↓ ↓ short, below ◓ centre). 2) lower rock slope, 80-90 m-high, smoothed by lateral abrasion of the Uli Biaho glacier during the Neoglacial (c. 5,500-1,700 YBP: Nauri V- to Middle Dhaulagiri Stage 'VII, ibid.) (↓ long, on the left below ◓ centre). This rock polishing is younger than that of 1), because it forms against the latter a working edge which has been sharpened by the lateral erosion of the Uli Biaho glacier. 3) the remaining three arrows (↓ short, below ■) and (↓ long, vertically below No.26 and diagonally to the right below No.23) are very fresh breakings. (□ black) marks the light, granitic surface moraine. (□ white) is surface moraine dark-coloured by the debris of sedimentary rock. Photo M.Kuhle, 21.8.1997.



← *Photo 44.* Looking from the debris-covered Baltoro glacier (□) at 3660 m asl (35°42′ N/76°11′ E) to the c. 6600 m-high Paiju Peak, nearly standing in the W, and to the 6756 m-high Choricho (No.22) in the WNW. The Uli Biaho glacier joins the Baltoro parent glacier from the NW. (– –) is the c. 5900 m-high LGM glacier level, documented by glacigenic flank abrasions resulting in typical rock roundings (◓). The glacigenic lateral erosion of the Holocene, historic and modern glaciers (since the Neoglacial Nauri Stage V up to the recent Stage XII about 1950-1980 with all - more or less pronounced - interglacial level positions of Stages VI to XI; Kuhle 1997, Tab 1) the surfaces of which have more and more melted down since the LGM, has undercut these Ice Age flank abrasions. Owing to this, the lower slopes of the valley flanks break away from below (↓), developing a distinct working edge (above ↓ on the right) against the glacigenic roundings (◓ white) preserved above. These breakages are orientated according to the steep- to vertically-layered structure of the bedrock granite (↓ on the right). The Paiju Peak, rising above the ice level by 600-800 m during the LGM (left of No.22) must have shown this vertical column-structure, characteristic of the crystalline compact rock, during the entire LGM. Photo M.Kuhle, 18.9.1997.



→ *Photo 46.* At 3540 m asl, looking from the tongue of the Baltoro glacier (35°41′ 40″ N/76°10′ E) across the ice of the Uli Biaho glacier (□) which joins the parent glacier from the NW, seen towards the NNE to the Trango Cathedral (No.23: Trango I, behind: 6286 m and II, in front: 6237 m). Measured from today's glacier surface its S-face is c. 2500 m-high. In front of the Trango Cathedral (behind ◥, on the left) the Trango glacier flows into the Baltoro parent glacier from the NW. (◓) shows glacigenic flank abrasions in the bedrock granite, which in many places have been wasted by postglacial breakages (⇩). Especially the 5753 m-satellite of the Trango Cathedral (below – –) has been roughened by typical processes of detraction. Due to the heavy resistance of the jagged crest of its summit, the glacier ice wrapping the whole mountain during the LGM, was able to attack on both sides. Owing to this, the ice has broken large monolithic granite scales out of the vertical structure of the bedrock and then pulled them along. The c. 4500 m-high transfluence pass (◓ black) situated between the Trango Cathedral and the 5753 m-satellite provides evidence of the Ice Age glacier flow between these two mountains. The pass leads from the present-day Trango glacier in a NE-direction to the Dunge glacier. Photo M.Kuhle, 10.9.1997.



↑ *Photo 48.* 330°-panorama from the first orographic right mudflow cone (▽ white) in the Biaho Lungpa (valley) (also Blaldo valley) down the tongue of the Baltoro glacier (□) at 3430 m asl (35°40′ 25″ N/76°07′ 20″ E). (○) is the recent and present-day gravel floor of the Biaho Lungpa and - genetically - the gravel floor of the Baltoro glacier. The glacier tongue (□) lies up-valley towards the ENE. There stands the Trango Cathedral (No.23, 6286 m). The 5800 m-Peak (No.30) is situated in a SW-direction down-valley. The orographic left valley flank has been smoothed and rounded by glacigenic flank abrasion up to the immediate summit-superstructure of the Liligo Peak (No.28, 6251 m) and - further down-valley - up to the 5800 m-Peak (No.30), i.e. as far as 5800-6000 m (◓ on the very left and right). At these altitudes the Ice Age (LGM) glacier level (– –) has run. (▽ black) is a fresh mudflow cone which has been (and still is) accumulated from dislocated moraine material from the orographic left, currently glaciated side valley (⇩ on the right) during the last decades. A steep side valley (⇩ on the left) also leads down from the SSE-flank of the Paiju Peak (No.11, c. 6600 m), showing a present-day hanging glacier. Out of its notch (⇩ on the left) the orographic right mudflow cone (▽ white), also consisting of moraine material (granite boulders in the foreground), has been deposited within the last 180 years (since Stage X after Kuhle 1982a Tabs. in Vol.I (text): pp 150-168 and 1998a Tab 1). (■) are High Glacial (LGM) to Late Glacial remnants of ground moraine on the glacigenically abraded (◓) and polished (◓ second from the left) valley flanks. (■ black) are ground moraine remnants of that type, the surfaces of which have been disintegrated into fine gullies and earth pyramids due to the down-flowing water. (▼ white) are thicker ground moraine remnants reshaped to steep cone forms since the deglaciation. (▼ black) is fresh debris of slope crumblings, formerly undercut glacigenically and today fluvially. Photo M.Kuhle, 20.8.1997.

← *Photo 47.* The Trango Tower (No.24, 6239 m) seen from its SSW- side. The mountain rises c. 1100 m above the present-day orographic snow-line (ELA). However, firn deposits with cores of ice covered with fresh snow can only be observed on the very narrow, flat-inclined rock ledges of this granite tower. The vertical (dominant) and the horizontal (subordinate) cleft-structures of its rocks determine the edged surface of the horn. Nevertheless, genetically it is a glacial horn, the slender form of which is due to the abrasion caused by the complete enclosure of its shaft by the High- to Late Glacial glacier. The LGM-ice-level lay c. 200-250 m below the summit whilst the Late Late Glacial ice level dropped to approx. the base level below the snow patch which is only just visible here. Photo M.Kuhle, 11.9.1997.

← *Photo 49.* From the orographic right flank of the Biaho Lungpa (35°39′ 30″ N/76°06′ E; 3350 m asl) up-valley to the Baltoro glacier end (□) facing ENE. The 8617 m-high K2 (Tschogori, No.1, in the background) towers above the granite pinnacles of the Trango Group. It stands 43 km away from the viewpoint. No.13 is the summit crest of the 1257 m lower Skilbrum (7360 m) - Savoia Kangri (7263 m) massif. (◓) indicates the glacigenically abraded and polished valley flanks of the Biaho Lungpa trough. Especially (◥ left) marks a polish face on vertical layers of crystalline schist (phyllites), the smoothings of which weather very fast subaerially, i.e. these rock faces were still recently as well as subrecently covered. (■) is a metres-thick ground moraine sheet on parts of these polished rock faces. At the slope foot this ground moraine cover is undercut by the Biaho Lungpa-river, the meltwater river of the Baltoro glacier. (○) is the approx. 1 km-wide present-day gravel floor of the braided streamlet-bed of this river. It is an accumulation which, genetically speaking, is a glacier mouth gravel floor (sander). (△) are young mudflow cones being in the process of development, which are made up of the ground moraine material from the valley flanks and steep side valleys. Photo M.Kuhle, 19.9.1997.

↓ *Photo 51.* From the foot of the Paiju-S-flank, i.e. from the orographic right slope of the Biaho Lungpa (Blaldo valley) (35°39′ 10″ N/76°05′ 30″ E; 3330 m asl) facing S looking into the N-flank of the 5800 m-Peak (No.30). The point of view is on one of the two kilometres-wide mudflow fans of dislocated ground moraine rich in granite boulders (▽). (■) are ground moraine deposits on the rock faces of the opposite valley flank, abraded and polished by the prehistoric valley glacier body (◓). The rock faces have been formed in edges of the banking and the stratum, so that a classic band polishing of outcropping edges of the stratum was created (◓ below). (◓ above) shows the remnants of this glacigenic abrasion damaged by crumblings. Naturally, the postglacial roughening of the rocks above took place earlier and, correspondingly, lasted longer than below, where the glacier polishing and -cover was more persistent. (– –) is the minimum altitude of the prehistoric glacier level documented by these local glacigenic rock roundings. However, the real level lay higher. (○) is the braided network of water channels of the Biaho river with the meltwater of the Baltoro glacier which undercuts the prehistoric ground moraine (■ white) exposing it as far as 150 m above the talweg. The exposure has been chiselled with microfluviatile gullies (fine, rill-like cuts created by the down-flowing water). (■ black) marks steep accumulative parts of the slope where the ground moraine cover thins out in an upward direction and snuggles against the polished rock faces. Photo M.Kuhle, 19.9.1997.

← *Photo 50.* From the orographic right, recently accumulated mudflow cone below the Paiju-S-hanging glacier with large granite boulders (□ black) (35°39′ 25″ N/76°05′ 40″ E; 3340 m asl) looking up the Biaho Lungpa, facing ENE. The K2 (No.1, 8617 m) with the upper section of its W- and SW-slopes can be seen 45 km away. The Skilbrum-Savoia Kangri-massif is situated in front of it on the right (No.13, 7360 m). (□ white) is the Baltoro glacier end covered with metres-thick surface moraine. (○) indicates the continuing glacier mouth gravel floor which makes up the valley bottom on a several hundred metres-thick body of loose rocks (moraine and glacifluvial gravel). The valley ground of bedrock in the underlying area is to be imagined in the downward continuation of the abraded wall of the trough valley (◜). The profile line of this valley slope (light-dark line at ◜) decribes the sinusoidal curve typical of a glacigenic flank abrasion: the upper slope is soft-convex (◜), the middle slope forms the long, but nowhere stretched transition to a concave course mediating to the trough floor. (■) is ground moraine of the prehistoric main valley glacier, which today is gradually being washed down from the glacigenically polished rock faces (below ■). Photo M.Kuhle, 19.9.1997.

↑ *Photo 52.* Panorama at 3375 m asl (35°37′ 50″ N/76°02′ 30″ E), taken from the foot of the orographic right flank up the Biaho Lungpa valley towards the NNE (left margin) via ENE directly up-valley (No.28, Liligo Peak, 6251 m) as far as SSE (right margin). (○) is the gravel floor of the Biaho Lungpa, i.e. the glacier mouth gravel floor of the Baltoro glacier. (■) mark ground moraine deposits on both valley flanks up to a relative height of 300-400 m, undercut by the gravel bed (○). In many places the undisturbed ground moraine (■) has broken away and slid down, re-accumulated into debris cones- and slopes (▽ white) and, by way of mudflows, has been synchronically re-deposited into comparably flat mudflow cones (▽ black); a process, which still continues every year. (The two porters cross the surface of a mudflow cone which had come down a few days before). The ground moraine sheets are decametres-thick; dark and light layers of material occur alternately (■ on the left). This is an indication of rock falls of different parent rocks which got under the prehistoric Baltoro ice stream and have been triturated into ground moraine. (◓) are glacigenic flank abrasions which have rounded the metamorphic bedrock. (– –) marks the LGM-glacier level lying at 5800 m asl, i.e. c. 2400 m above the gravel floor. Photo M.Kuhle, 19.8.1997.

→ *Photo 53.* At 3350 m asl, upwards of the locality of Bardumal, looking down-valley into the orographic left flank of the Biaho Lungpa (35°37′ 40″ N/76°01′ 45″ E) facing WSW. No.35 is the 5810 m-high Bakhor Das. The maximum glacier level (– –) has reached up to at least its summit. (◓) indicates the glacigenic flank polishing. Below (◓ white) is a crumbling area with a rough surface, created by the fluvial erosion at the mouth of the Chingkang River. (■) is the ground moraine overlay, reaching as far as several hundred metres above the gravel floor (○ = glacier mouth gravel floor) in many places. Photo M.Kuhle, 19.8.1997.

← *Photo 54.* Looking from the locality of Bardumal at 3330 m asl (35°37′ 30″ N/76°00′ 20″ E) facing SE, up the Chingkang valley towards the Double Peak I (No.34, c. 6700 m). Here, a glacigenic V-shaped valley is concerned, the glacial forming of which is evidenced by the orographic left flank abrasion (◜). (– –) marks a prehistoric glacier level, which can still be recognized by the orographic right glacigenic flank abrasions, naturally thinning out in an upward direction. Accordingly, the actual maximum prehistoric glacier level might have run c. 200-400 m higher during the LGM, namely at an altitude of 5800-6000 m. (■ left) points to ground moraine on the orographic left flank of the Biaho Lungpa, i.e. the main valley; (■ right) is a ground moraine complex of the side valley (Chingkang valley) situated close to the valley bottom. (⇩) marks a ravine, cut into the valley ground by sub- to postglacial fluvial meltwater erosion of the Chinkang river, i.e. across the ground moraine (⇩ on the right) as far down as into the bedrock (⇩ on the left). The Chingkang river is adjusted to the gravel floor of the Biaho Lungpa (valley) (○). Photo M.Kuhle, 19.8.1997.

↓ *Photo 55.* Panorama at 3230 m asl, c. 1 km down-valley of the locality of Bardumal (35°38′ N/75°59′ E) looking from the orographic right flank of the Biaho Lungpa (upper Braldo or Blaldo valley) facing SE (No.34, Double Peak, c. 6700 m) via S up the Hurlang Lungma (valley), as far as WNW down the main valley (Biaho Lungpa) with the Shinlep Brakk-mountain ridge (No.37, 5517 m). This was fringed by the LGM glacier ice (glacier level = – – on the very right) almost up to its culmination. (– – middle and on the very left) indicates the simultaneous prehistoric glacier level above the ribs and crests of the orographic left valley flank, showing glacigenic flank abrasions (◓). On vertical phyllites and banded gneisses, they currently break away (□). (– – below No.34) marks the LGM glacier level about 5800 m asl. Emerging from the ravine in the Hurlang Lungma mouth (⇩), a Holocene to present-day mudflow cone (▽) is accumulated. It presses the gravel floor (○) against the right valley flank and at the same time is fluvially undercut (▼). The mudflow cone consists of displaced moraine material from the Hurlang Lungma. (■) is a decametres-thick ground moraine on the glacigenic flank abrasion in the rock, extending up to at least 500 m above the valley bottom (○). Photo M.Kuhle, 19.8.1997.

← *Photo 56.* Looking down from the orographic right valley side of the Biaho Lungpa (35°39′ N/75°07′ 30″ E, 3160 m asl) towards the NW. (■) is Ice Age ground moraine on the valley flanks as far as c. 600 m (■ black, in the background) above the gravel floor (○). (◓) mark the glacigenic abrasions which can be evidenced on the Shinlep Brakk-mountain ridge (No.37, 5517 m) up to a height of 5500 m asl (– – middle). (◓ on the right) is band polishing of edges of the strata on bedrock phyllites (see also Photo 58). On this SE-spur of the Bullah (No.36, 6294 m), small-scale remnants of the glacigenic abrasion reach as far as approx. 5800 m; with this an LGM-glacier level is proved up to this height (– –). (■ black, foreground) indicates ground moraine in situ, undercut by the high-water-bed of the Biaho Lungpa river (○). Photo M.Kuhle, 19.8.1997.

← *Photo 57.* From the orographic right side of the Dumordo (or Panmah) valley between the localities of Laskam and Jora (Zora) at 3250 m asl (35°41′ 30″ N/75°58′ E) looking across the junction with the Biaho Lungpa. Taken from via SSE (left margin) up the Biaho Lungpa (main valley), via SSW to the 5810 m-high Bakhor Das (No.35) as far as SW (right margin) slightly down the main valley. The Bakhor Lungma leads down on the left of No.35. (○) is the 800 m-wide, braided streamlet-network of the Panmah glacier meltwater, 110 m below the viewpoint. (◓) are the rock slopes of the main valley which have been abraded into perfect glacigenic trough valley flanks. During the LGM the glacier level (– –) ran at least at 5700 m. (■) show the ground moraine overlays (middle) on the valley flanks which occur up to at least 800 m above the gravel floor (○). In other places they have been decomposed into classic earth pyramids (■ on the right). Photo M.Kuhle, 18.8.1997.

↑ *Photo 58.* From the orographic right flank of the Dumordo (or Panmah) valley near the locality of Jora (or Zora) looking from c. 220 m above the Dumordo river (○) (3360 m asl, 35°41′ 50″ N/ 75°57′ 30″ E) up the main valley towards the S. This is the Biaho Lungpa, the orographic left valley flank of which, abraded by the prehistoric glacier ice up to the top, is clearly visible (◜ background). Also the rock flank in the foreground has been polished by the glacier (◓ foreground). The very resistant bedrock quartzite has only been slightly splintered and roughened by the postglacial weathering for c. 13,000 years (Sirkung Stage IV, older than 12,780 YBP after Kuhle 1982a, 1989, 1994b, 1997). Merely the fine polish is lacking, whilst the abrasive rounding has been preserved (◓ in the foreground; climber for scale). The corresponding valley flank, however, has already been weathered and broken away more heavily (left margin). The crumblings have built up an active debris cone (▽) (see also Photo 59) which is undercut by the glacier gravel floor of the current Panmah glacier (○). Photo M.Kuhle, 18.8.1997.

→ *Photo 59.* From the orographic left margin of the gravel floor (○) of the Dumordo river (Panmah valley) (35°41′ 50″ N/75°59′ E; 3140 m asl) looking across the confluence area of this valley into the Biaho Lungpa (also Braldo or Blaldo valley) towards the SW (left half of the photo). The valley flanks depicted here, have been completely glacigenically abraded. (◜) marks a classic band polishing of outcropping edges of the strata. Since the last contact with the glacier ice during the Late Glacial Sirkung Stage (IV), the edges of the strata of the metamorphic sedimentary bedrocks are splintered off by weathering. (■) is a prehistoric ground moraine remnant which could accumulate decametres-thick in a concave niche-form on the glacier edge and persisted during the Holocene. (▼) shows a quartzite boulder the size of c. 4.5x3.1x1.8 m. This is one of several large boulders which, during the rain on the day when the picture was taken, fell out of the wall in the line of dip and then rolled, i.e. sprang across a 35°-steep debris cone. It has torn up the c. 2 m-deep bomb crater. In the crater stands a 170 cm-tall person. (The wall is depicted in Photo 58 and the debris cone is marked half-right below (▽)). Photo M.Kuhle, 22.9.1997.

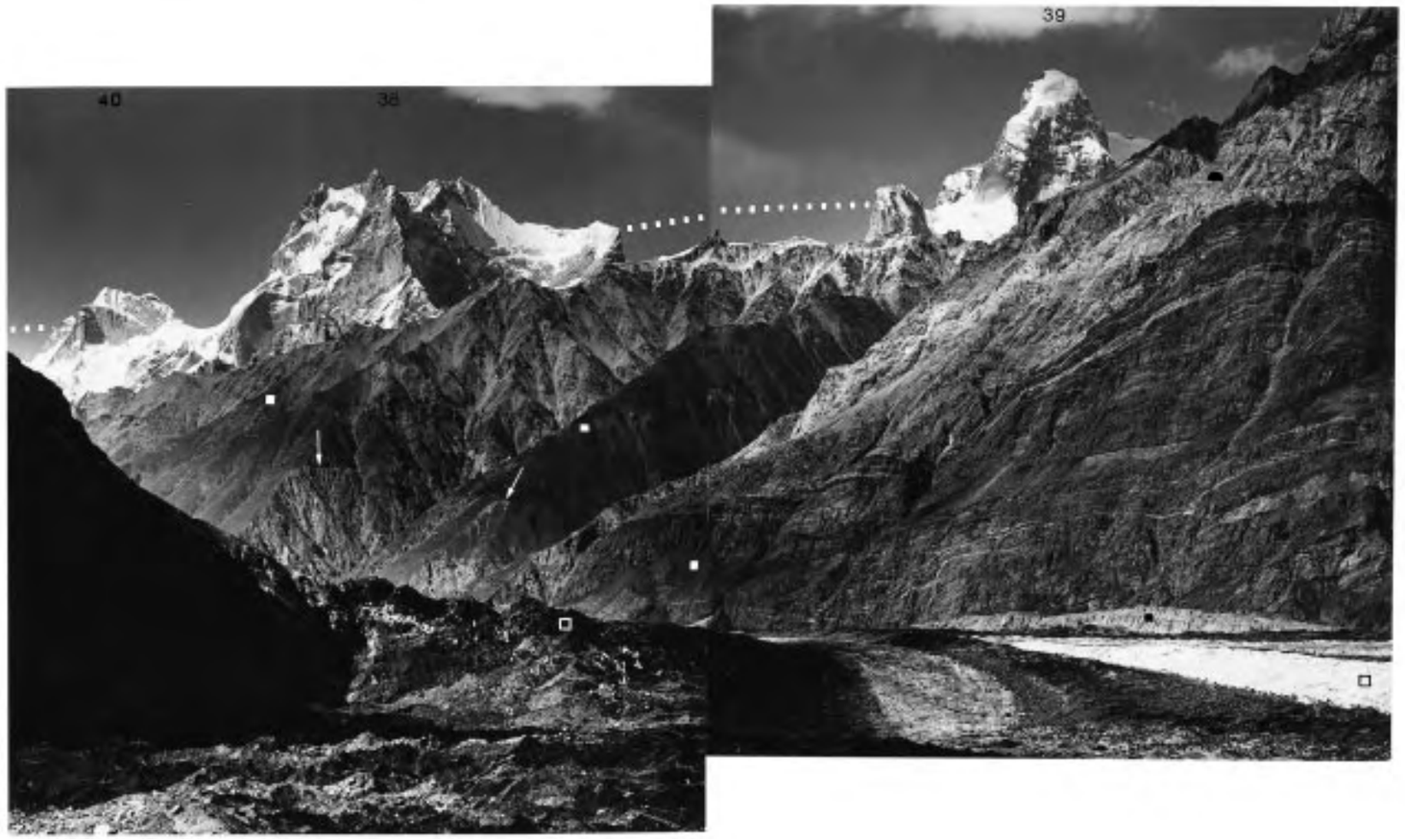
← *Photo 61.* From the orographic right flank of the Dumordo (or Panmah) valley near the locality Jora (or Zora), c. 220 m above the Dumordo river (○) (3360 m asl, 35°41′ 50″ N/75°57′ 30″ E), facing NNE, looking up the side valley. The glacigenic flank polishings (◓) reach as far as 900 m above the valley bottom (◓ black, background). A local prehistoric glacier level about 4100 m asl (– –) can be deduced from them. Since the Late Glacial (Sirkung Stage IV) deglaciation, crumblings in boulder-dimensions have collapsed and still break away (□) from the glacigenically abraded (◥ black and white on the left) vertical edges of the strata of the quartzite-bearing bedrock phyllites (metamorphic sedimentary rocks) over which two porters are climbing down. Ground moraine (■) has been preserved up to 450 m above the valley bottom (○). Mudflow fans (▽), made up from dislocated ground moraine, occur on the lower slope. They are undercut by the high water bed (○). (↓ ↓) mark a large cleavage fissure along which the material of the mudflow fan (▽) slips down from the ground moraine preserved in situ (■ black). Photo M.Kuhle, 18.8.1997.

↑ *Photo 62.* The Choricho-W-valley and the Choricho-W-glacier seen facing N up the Dumordo valley towards the 6756 m-high Choricho main summit (No.22). The striking subrecent terminal moraine (■) of the c. 7 km-long side valley glacier is situated at 35°42′ 50″ N/76°00′ 20″ E at c. 4200 m asl. Owing to the steepness of the fringing walls of the glacier (below No.22) and the resulting supremacy of avalanche-nourishment, its lowest tongue-section is covered with surface moraine (□). (▽) mark two orographic right side valleys in S-expositions, which are glaciated as well. Only the back one of the two tributary glaciers reaches the main glacier, i.e. tributary glacier of a higher order (▽ black). (◓) are prehistoric (High-(LGM) to Late Glacial = Stage 0-IV) roundings and polishings of the glacigenic abrasion preserved on both sides, formed up to a minimum height at 5500 m asl (– –). Photo M.Kuhle, 2.10.1997.

← *Photo 60.* Panorama of the Dumordo valley (Panmah valley), taken 3 km upwards from its inflow into the Biaho Lungpa (35°42′ 50″ N/ 75°57′ 10″ E; 3170 m), looking up-valley from facing N (left), via E into the W-slope of the 6756 m-high Choricho-massif (No.22) up to the S down-valley to the cross-running main valley (on the right). The coarseness of the polymict boulders building up the gravel floor of the Dumordo river (○) points to the proximity of the Panmah glacier end at a distance of only 10 km. For scale: porters with their loads and the pillar of the rope-bridge across the river. The meltwater river undercuts moraine deposits (e.g. ▽), the boulder fractions of which are already rounded at the edges or rounded (○ on the right) over a distance of a few kilometres. The glacigenic flank abrasions (◓), which are in a good state of preservation, can be observed as far as 800 m up the rock slopes (◓ white). The minimum height (– –) about 5000 m asl of the Ice Age glacier level can be inferred from all abraded roundings, including those which are less intact. Cf. Photo 62 showing the higher level of the Choricho-W-slope with the Choricho-W-glacier and up to 5500 m-high flank abrasions which are not visible here. (⇩) are two cuts into the gorge deriving from the meltwater erosion of the Choricho-S-glacier. (■) indicate deposits of ground moraines preserved on the slopes as far as 400 m (■ on the right) above the valley bottom (○). Photo M.Kuhle, 22.9.1997.

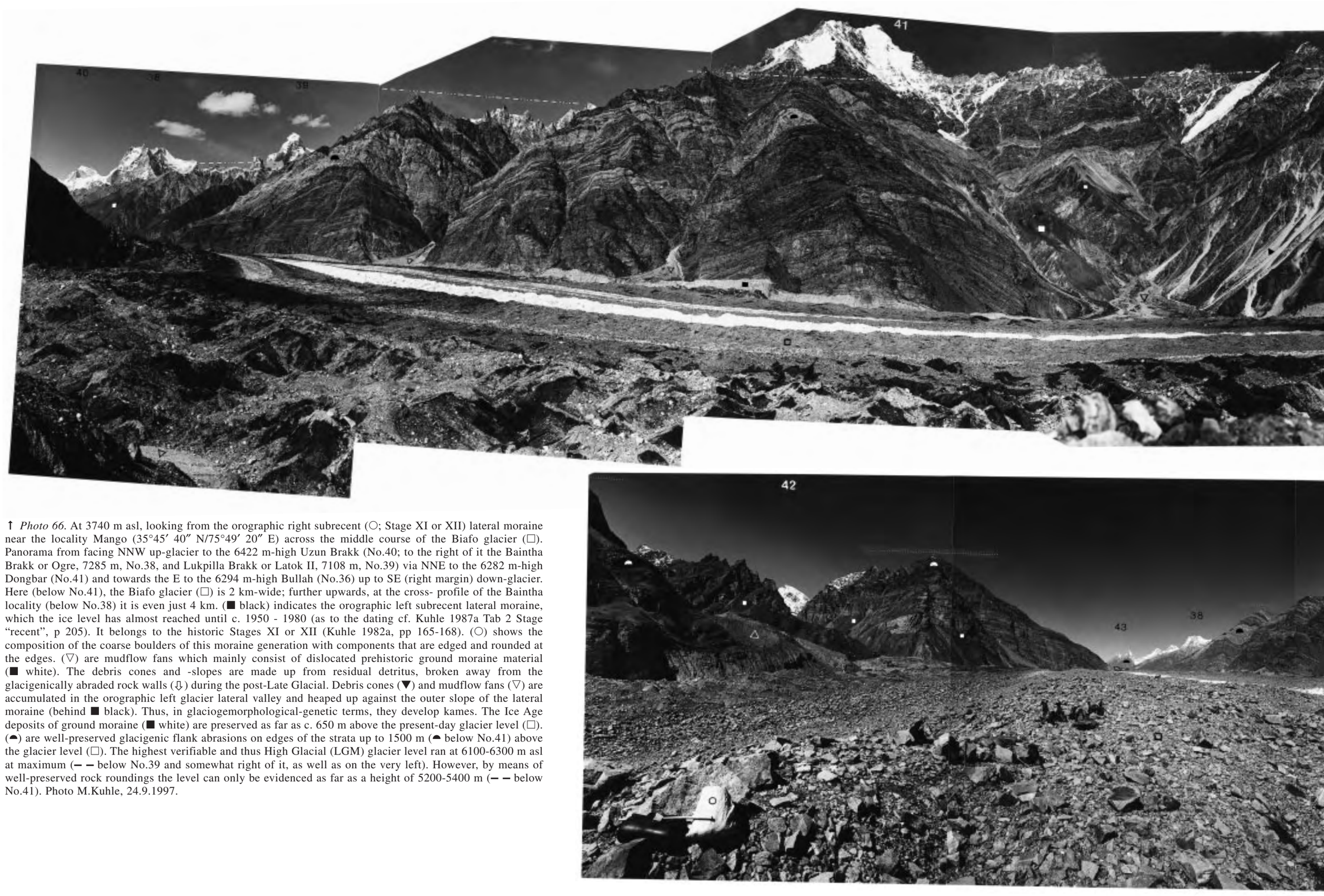
← *Photo 63.* From the orographic left (E) side of the Dumordo river (Panmah glacier meltwater river) (35°42′ 50″ N/75°57′ 11″ E; 3170 m) looking up-valley to the N across the subrecent 3.5 m-high gravel floor terrace (○). (■) is a ground moraine deposit of High- (LGM) to Late Glacial genesis. (▼) shows a block debris cone which is still active. Its edged components prove a genesis by rock crumblings. The lower cone edge (△) is syngenetically undercut by the river. The crumblings are a result of the glacigenic flank steepening. As this photo perspective shows, numerous valley cross-profiles have been formed into a trough-shape and preserved up to the present-day glacier terminal of the Panmah glacier situated c. 10 km up-valley. Within the altitude interval of the lower 100-150 m, a small cross-profile is set into the trough ground which clearly contrasts with the trough profile (below ▽). It is set off against the concave bow of the trough ground (◓) by convex profile lines (▽▽). (◓) shows an upper edge of the trough rounded by glacier abrasion. Accordingly, the LGM ice level (– –) has run higher. Photo M.Kuhle, 18.8.1997.

→ *Photo 64.* C. 1.5 km up-valley from its inflow into the Biaho Lungpa main valley, the main branch of the Dumordo river develops an undercut slope (3140 m asl, 35°41′ 50″ N/75°57′ 30″ E). At 10 o'clock in the morning, the river is 70 cm-deep (see persons for scale). (⇩) marks the high water line on the bedrock which is 4 m higher. At high water the gravel bank (○) is completely overflowed and its material becomes rearranged. (– –) is the prehistoric glacier level at c. 4100 m asl, evidenced for this section of the valley flanks by way of the glacigenically abraded roundings (◓). (■) indicates the secondarily redeposited ground moraine material laid down to form a mudflow fan (△) at the slope foot. Photo M.Kuhle, 22.9.1997.

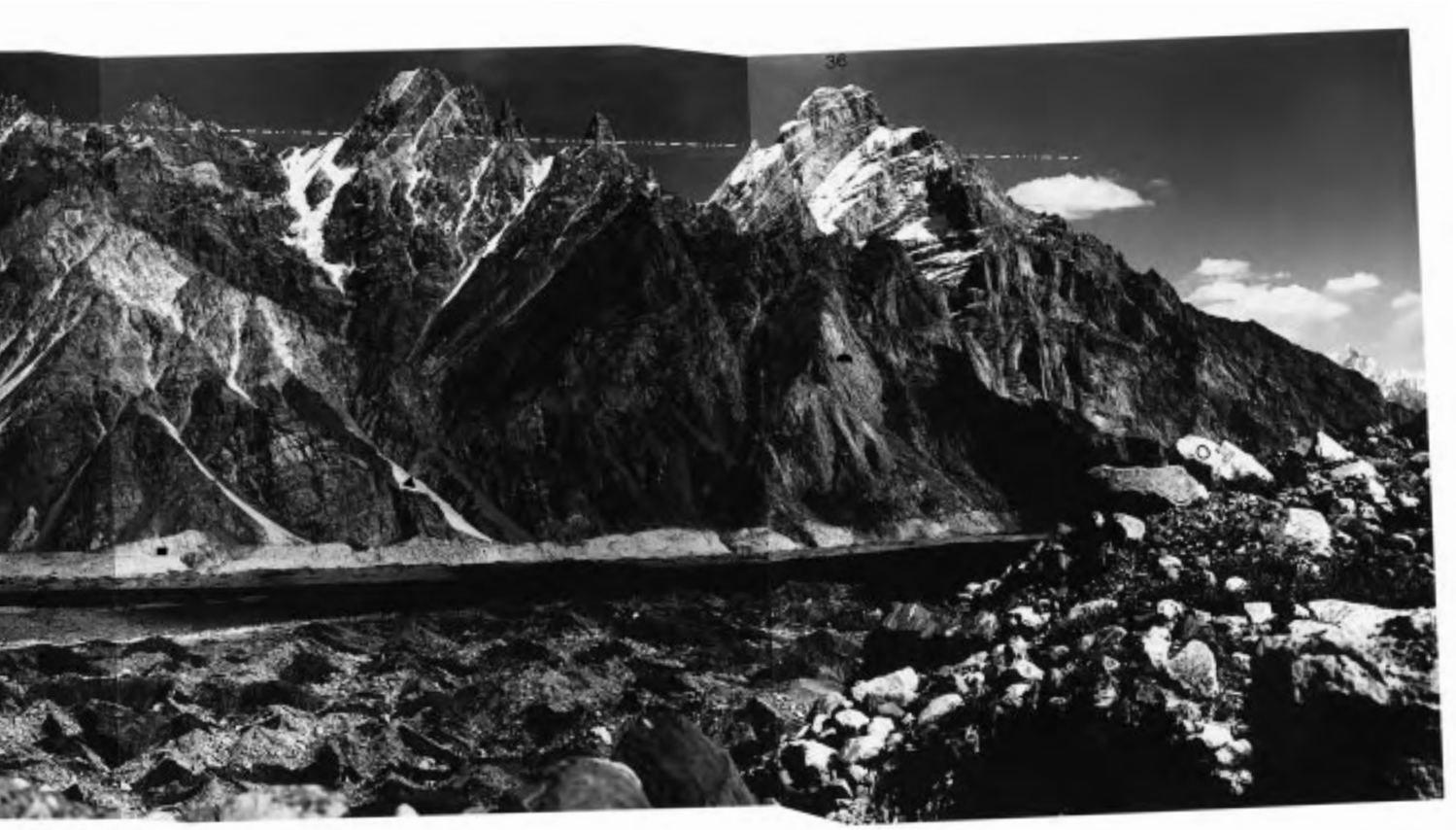


→ *Photo 65.* From the orographic right side of the Biafo glacier (□) facing up-valley towards the NW (left margin) up to the N (right margin) into the orographic left flank of the Biafo valley and onto the summits of Baintha Brakk or Ogre (7285 m; No.38), its W-satellite, the Uzun Brakk (6422 m; No.40) and the Latok II or Lukpilla Brakk (7108 m; No.39). (□ white) marks glacier ice covered with surface moraine; (□ black) is sheer ice. (■ black) indicates the orographic left lateral moraine, which rises c. 50 m above the glacier surface and belongs to the subrecent Stage XI or XII 1950, i.e. 1950-1980. It provides evidence of a subrecent ELA-depression of only 10-20 m (Kuhle 1994b, p 260 Tab 3 ; also most recent Dhaulaghiri Stages XI or XII after Kuhle 1982a, pp 165-168; 1983a; 1986a; 1987a; 1997 Tab 3 p 114). (■ white) are Late Glacial (Stages I to IV; ibid.) deposits of ground moraine up to approx. 650 m above the ice surface (□). (↓ ↙) are ripped fissures along which this ground moraine is exposed in a metres- to decametres-thickness. (◓) marks glacigenic flank abrasions developed on the valley wall up to at least 1200 m above the present-day Biafo glacier. They thus reach a minimum altitude of 5000 m asl. Here, the easily weathering and splintering-off edges of the strata of horizontally layered metamorphic sedimentary rocks and phyllites are concerned, interspersed by swarms of quartz dikes. (– –) is the LGM glacier level which has run here about 6100-6300 m asl. It has glacigenically undercut the summits (No.38-40) built-up of monolithic granite, so that they have been steepened and shaped into glacial horns. The summit which corresponds the most with the form of a horn is the Lukpilla Brakk (Latok II). Photo M.Kuhle, 24.9.1997.

← *Photo 67.* The 360°-panorama was taken from the locality of Mango on the orographic right subrecent lateral moraine (○) of the Biafo glacier (Stage XI or XII: developed c. 1950-1980) (35°45′ 40″ N/75°49′ 20″ E; 3740 m). (– –) indicates the prehistoric (LGM) glacier level, verifiable by the glacigenic flank abrasions and roundings of rock heads (◓). It can be continuously evidenced up to approx. 5200-5400 m asl (– – on the very left and right as well as below No.41), in some places even up to 6100-6300 m asl (– – on the right of No.39 and below No.36). (■ white; ■ black on the very right) are High-(LGM) to Late Glacial deposits of ground moraine on both flanks of the Biafo valley. (▼) show rock fall- and mudflow cones. The latter consist of substrate of ground moraine which has been transported down-slopes (▼ on the very right). (▽) are mudflow fans and alluvial soils heaped up in the subrecent lateral valleys, i.e. lateral depressions of the Biafo glacier against its subrecent lateral moraines (■ on the very left). (■ large) is a subrecent frontal moraine of the Mano glacier, of hardly over 30-40 years of age (Stage X ?, cf. Kuhle 1980 p 246, section 3; 1987a, Tab 2, p 205) (◇). At the time when the photo was taken (see Photo 68), the glacier advanced. No.37 is the 5517 m-high Shinlep Brakk. Photo M.Kuhle, 24.9.1997.



↑ *Photo 66.* At 3740 m asl, looking from the orographic right subrecent (○; Stage XI or XII) lateral moraine near the locality Mango (35°45′ 40″ N/75°49′ 20″ E) across the middle course of the Biafo glacier (□). Panorama from facing NNW up-glacier to the 6422 m-high Uzun Brakk (No.40; to the right of it the Baintha Brakk or Ogre, 7285 m, No.38, and Lukpilla Brakk or Latok II, 7108 m, No.39) via NNE to the 6282 m-high Dongbar (No.41) and towards the E to the 6294 m-high Bullah (No.36) up to SE (right margin) down-glacier. Here (below No.41), the Biafo glacier (□) is 2 km-wide; further upwards, at the cross- profile of the Baintha locality (below No.38) it is even just 4 km. (■ black) indicates the orographic left subrecent lateral moraine, which the ice level has almost reached until c. 1950 - 1980 (as to the dating cf. Kuhle 1987a Tab 2 Stage "recent", p 205). It belongs to the historic Stages XI or XII (Kuhle 1982a, pp 165-168). (○) shows the composition of the coarse boulders of this moraine generation with components that are edged and rounded at the edges. (▽) are mudflow fans which mainly consist of dislocated prehistoric ground moraine material (■ white). The debris cones and -slopes are made up from residual detritus, broken away from the glacigenically abraded rock walls (⇩) during the post-Late Glacial. Debris cones (▼) and mudflow fans (▽) are accumulated in the orographic left glacier lateral valley and heaped up against the outer slope of the lateral moraine (behind ■ black). Thus, in glaciogemorphological-genetic terms, they develop kames. The Ice Age deposits of ground moraine (■ white) are preserved as far as c. 650 m above the present-day glacier level (□). (◓) are well-preserved glacigenic flank abrasions on edges of the strata up to 1500 m (◓ below No.41) above the glacier level (□). The highest verifiable and thus High Glacial (LGM) glacier level ran at 6100-6300 m asl at maximum (– – below No.39 and somewhat right of it, as well as on the very left). However, by means of well-preserved rock roundings the level can only be evidenced as far as a height of 5200-5400 m (– – below No.41). Photo M.Kuhle, 24.9.1997.

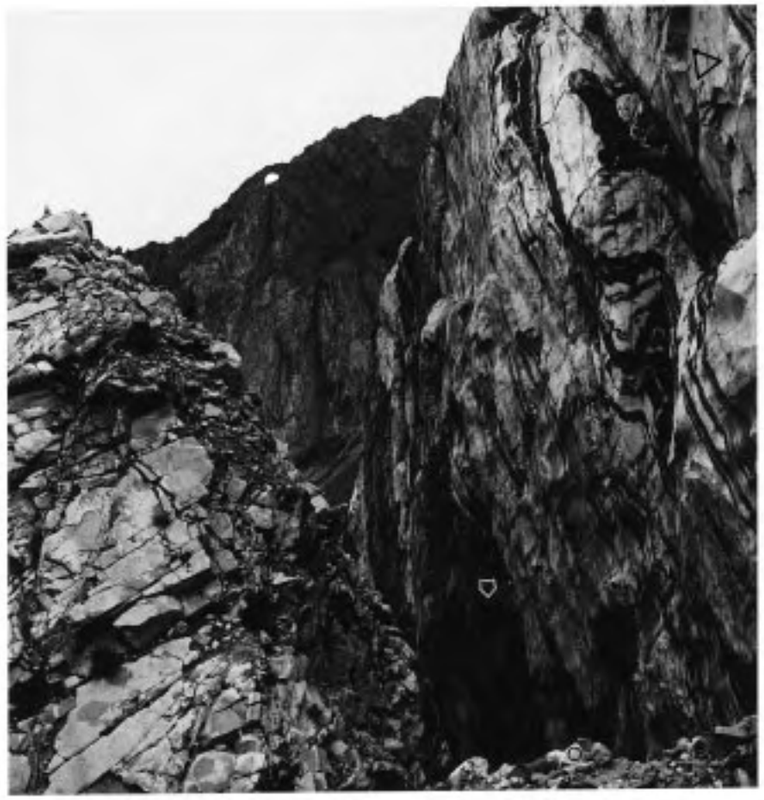


↓ *Photo 69.* 360°-panorama at c. 3630 m asl, 1 km down-valley of the locality Brangsa (△ white) (35°45′ 20″ N/75°51′ 10″ E), from a large medial moraine string of the Biafo glacier (□). This glacier is not only one of the most extended Karakorum-ice- streams, and thus one of the largest extra-arctic glaciers on earth at all. It is a classic, 60 km-long parent glacier as well, made up of numerous components with (□) and without a cover of surface moraine (string of sheer ice in the middle ground). The surface moraine (□) consists of edged boulders up to head- high (for scale: 14 expedition participants and porters with their loads). Right in the W stands the 6282 m-high Gama Sokha Lumbu (No.42); up-glacier in the NW, the unnamed 5989 m-Peak can be recognized, a 36 km-distant glacial horn (No.43); the 6282 m-high Dongbar (No.41) stands approximately in the N (at 12°). To the right of No.36 the Biafo glacier extends down to the SE, reaching there the Braldu main valley (also Blaldo valley or Biaho Lungpa). (■ black on the left and white on the right) are the orographic left and right lateral moraine inner slopes of the historic Stages XI and XII, which had been covered with ice until 20-50 years ago (1950-1980). (▽ black) are mudflow cones and -fans filling up the lateral valleys; therefore, in glacio-genetic terms, they can be addressed as lateral kames. (△ white) indicates the orographic right lateral moraine of the Shinlep Brakk NNE-tributary glacier, accumulated during Stages XI and XII. (■ white on the left) are prehistoric remnants of ground moraine which occur on the glacigenically formed lower slopes up to c. 650 m above the Biafo glacier. (◓) show glacigenic abrasions and roundings. (– –) are the limits of Ice Age polishing, i.e. abrasion, verifiable as far as c. 6100 m asl. Photo M.Kuhle, 24.9.1997.

← *Photo 68.* Detail of Photo 67: the Mango hanging glacier in a NE-exposition. Its tongue comes to an end at 4200 m, the mean altitude of the catchment area (height of the crest in the background) is c. 5600 m, so that an orographic snow-line (ELA) about 4900 m can be estimated. The end of the glacier tongue is steep and heavily disrupted, thus indicating an advance. Especially the disruption of the ice points to a very brittle, i.e. cold glacier ice. Cold glacier ice at the tongue end suggests semi-arid climate conditions. For comparison: the glacier ice- and air temperature measurements on the K2-N-glacier during September/October, 1986, yielded mean annual temperatures between -10.1 and -12.3°C at an ELA-level at 5000 m asl, corresponding to ice temperatures of -9.1 to -11.3°C in a glacier depth of over 10 m at the snow-line-level (Kuhle 1988d, pp 413/414; 1990a, pp 320/321). At a gradient of 0.65°C per 100 m the ice has still a temperature of merely -4.55 to -6.75°C at the 700 m-lower glacier terminal (ELA=4900 m; glacier terminal 4200 m). (■ in the foreground) is ground moraine, left behind by the penultimate glacier advance, which is dissected by a strikingly small meltwater thread. (■ on the left) shows Late Glacial to historic ground moraine (Sirkung Stage IV to Stage IX: Kuhle 1980 p 246, section 3), undercut, i.e. laterally eroded by the orographic right margin of the advancing glacier. Photo M.Kuhle, 24.9.1997.

↓ *Photo 70.* 360°-panorama at 3400 m asl from the Biafo glacier (□), 300 m away from its orographic left margin (35°42′ 30″ N/75°54′ E) and at a distance of 4 km from its lowest tongue end at the Korophon locality (No.35). Here the glacier is extensively covered with surface moraine. The 5810 m-high Bakhor Das (No.35) stands in the SSE, W of it the Stokpa Lungma trough valley leads upwards to the S to the 6288 m-high Mango Gusor (No.44); in the NNW, 38 km further up the Biafo glacier towards the Hispar pass, the 5989 m-Peak (No.43) is situated. The surface moraine (□) is significantly richer in matrix than 10 km up-glacier (Photo 69); besides polymict edged boulders (○ small) boulders do also occur, which are rounded at the edges, i.e. facetted, most of them of granite (○ large) (for scale: porters with their loads). (■ black) is ground moraine of the subrecent Stages XI and XII, passing upwards into an orographic right lateral moraine crest. (■ white) are older remnants of ground moraine in wall gorges and -gullies (on the left) as well as slope niches (centre) up to 950 m above the talweg of the main valley (Braldu valley). (◓) mark glacigenic flank abrasions and glacier polishings (◓ black large) which to a great extent are continuously preserved in the massive-crystalline rock (◓ left and right), but in the metamorphic sedimentary rock they are only little extended (◓ half right). (▼) are Late Glacial ground moraine deposits on which rock debris has been piled up. (– –) indicate the High (LGM)- to Late Glacial glacier levels (Stages I,II,III,IV after Kuhle 1980 p 246) which can be evidenced on the spot by the highest occurrence of glacigenic flank abrasions. These traces reach up to a height of 5650 m at No.35 (– –), in the area of the Stokpa Lungma (No.44) c. 6000 m (– –) and on the Shinlep Brakk (– – between No.43 and 44) c. 5500 m asl; (– – to the right of No.43) also attains 6000 m. (▽) marks a spillway between a bar mountain (“riegel”) and a valley flank through which the meltwater discharge of the Biafo glacier has still recently taken place (see Photo 71). Photo M.Kuhle, 23.9.97.

← *Photo 71.* From c. 3120 m asl looking N into a notch (⇩) through which an insignificant discharge of the Biafo glacier has taken place until a few decades ago, so that a spillway has been developed (locality: Photo 70 ▽)(35°41′ N/75°53′ E). Between the Bullah (No.36) and the notch the lower part of the Biafo glacier is situated. Beyond the notch (⇩) the glacier tongue still clings to the rock. During Stages XI or XII, when the level of the glacier tongue has towered above the level of the notch by several metres to decametres, material of ground- and end moraines has been washed out by the overflowing meltwater and partly removed, so that the steep mudfow- and alluvial fan (▽) was piled up with it. Before, at a still higher ice level, a specific glacier tongue flowed through the notch and has widened it into a trough-shape (between the two ◓). (◓) are 110-130 m-high glacigenically abraded rocks of banded metamorphites (phyllites, banded gneisses). The outcropping edges of the strata (◓ on the right) have already been roughened by splintering and breaking away. Photo M.Kuhle, 26.9.1997.



↑ *Photo 72.* Taken facing W, locality (35°41′ N/75°53′ E; 3110 m asl), looking to the back of the round-polished barrier mountain (“riegel”) in Photo 70 on the left of (▽). From near the present-day Biafo glacier mouth view down through a ravine (⇩). The rocks of the barrier mountain (“riegel”) of vertical, banded metamorphites (phyllites) have been steeply dissected by the subglacial meltwater of the Biafo glacier (⇩). This happened during the neoglacial up to early historical stages (c. 5,500-400 YBP) during Stages V to VII (more precisely: Nauri Stage V to younger Dhaulagiri Stage VII after the nomenclature Kuhle 1980; 1998a Tab 1 p 82) and suggests an ELA-depression of 60-80 m at minimum. From the next younger Stage VIII, the ELA-depression amounted to only just 50 m and the Biafo glacier margin could no longer overthrust the area on the lee side of this rock-barrier (“riegel”). On the rock face in the proximity of (⇩), small concave half-caves and bowl-shaped remnants of potholes are preserved, thus providing evidence of the subglacial cavitation corrasion. Under the control of the clefts a partial reworking of the wall has already taken place by breakages leaving behind edged, roughened areas (△). (○) are younger glaciofluvial gravels as remainders of the subaerial glacier meltwater of the last centuries to decades. (◓) indicate rock roundings as traces of an Ice Age abrasion on the orographic right, 600-800 m above the bottom of the Braldu valley. Photo M.Kuhle, 27.9.1997.

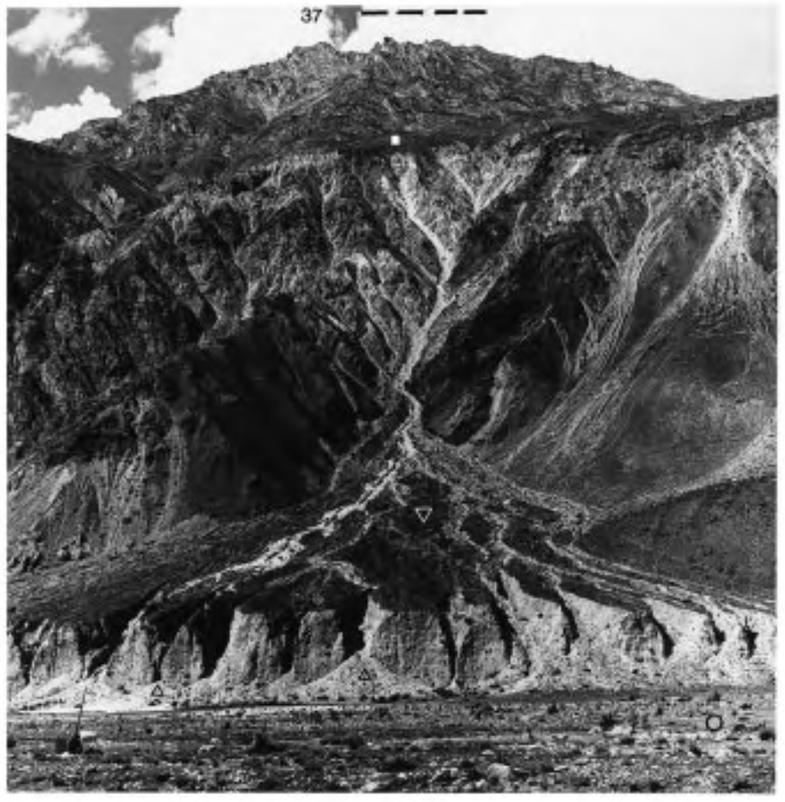
← *Photo 73.* N above the locality of Korophon, on the orographic right side of the Braldu river (○), looking from the E margin of the Biafo glacier terminal (■ black) at 3200 m (35°41′ 20″ N/ 75°55′ 30″ E) facing SSW to the valley exit of the Stokpa Lungma. (□) is a large, edged moraine block the size of 6.1x4.2x3.5 m (porter for scale) which has been dislocated in a clayey lateral- and end moraine matrix on to a mudflow fan situated on the orographic left side of the Biafo glacier tongue. (▽) marks a very shallow mudflow fan accumulated from the very short and steep side valley on the orographic left (between the shady und sunny rock in the left half of the picture) on to the gravel floor of the Braldu valley bottom (○). (◥) are horizontal glacigenic abrasions and polishings preserved between 700 m (◥ on the left) and 1700 m (◥ right) above the valley bottom on comparatively easily splintering, i.e. weathering, clay schists. Even later, during the Late Glacial Stage IV, (◥ on the right) has still been polished by a hanging glacier parallel to the line of dip. (■ white) are remnants of ground moraine in more (■ white on the left) or less (■ white on the right) exposed slope positions up to 950 m above the Braldu valley bottom. (– –) indicates the Ice Age glacier surface which can be evidenced by the remnants of an abrasion line at 5650 m asl. Photo M.Kuhle, 26.9.1997.

↓ *Photo 74.* 360°-panorama at 4300 m asl from a rock head on the ESE-spur of the 5517 m-high Shinlep Brakk (No.37, main peak is not visible), 1200 m to the W above the Biafo glacier tongue (□ on the very left and right), i.e. 1300 m above the gravel floor of the Braldu valley (○) (35°42′ 10″ N/75°52′ 10″ E): the mountain ridge No. 37 lies in the WNW, the 6282 m-high Dongbar (No.41) in the N, the 6294 m-high Bullah (No.36) in the NE, the 6756 m-high Choricho (No.22) in the E, the 5810 m high Bakhor Das (No.35) in the SSE and the 6288 m-high Mango Gusor (No.44) in the S. On the very left and very right one also looks up the Braldu trough (Blaldu valley or Biaho Lungpa) towards the ESE. To the right (below No.35) a steep valley leads down from the Bakhor Das (cf. left half of Photo 73). Below No.35 up to 44 the Stokpa Lungma joins the Braldu valley. (▽ white) marks the debris cone shape of its prehistoric ground moraine remnants. (■) are ground moraine remnants on the valley flanks. The ground moraine (■ on the very left) is shown in Photo 75 (■) in detail. (◇) are erratic granite boulders the size of several metres (person for scale in the middleground; in the foreground rucksack and mountain stick); partly they are integrated into the ground moraine matrix (■ on the slope below No.37). The metamorphic sedimentary bedrocks in the underlying bed have been abraded to roches moutonnées (◓ white on the left). (– –) are the locally verifiable highest Ice Age glacier levels reaching altitudes of 5650 m (– – below No.35) up to approx. 6000 m asl at maximum (– – left of No.35 in the background; below No.44 and 41). (◓) show glacigenic rock abrasions which from above to below are of High-(LGM) to Late Glacial age. (↙) is a well-preserved lateral moraine ramp of the Late Glacial Stage I to III (Kuhle 1998a Tab 1 p 82). At that time mountain ridge No.37 was already free of ice and the Biafo ice stream net component, joining a Braldu parent glacier, was 1300 m thicker than at present. Photo M.Kuhle, 28.9.1997.

← *Photo 75.* From the lowest ice margin of the Biafo glacier at the Korophon locality facing NE into the orographic right flank of the Braldu valley (35°41′ 30″ N/75°57′ E) looking towards the Choricho massif (No.22, 6756 m). (■) is a metres- to decametres-thick ground moraine cover which continuously extends between 3200 and 4000 m asl (cf. Photo 74 (■) on the very left). It is exposed along a c. 300 m-long rock crumbling (⇧) and can be diagnosed as an erratic ground moraine rich in matrix with separate coarse boulders. The rock pedestal below consists of metamorphic sedimentary rock. As outer bank of the Braldu river it has been - and still is - undercut. (▽) marks a debris cone of bedrock that has broken away and hanging ground moraine. (– –) indicates the Ice Age glacier level in the Choricho W-valley with glacigenic rock abrasions (◜) reaching up to 5500 m asl at minimum. Photo M.Kuhle, 19.8.1997.

→ *Photo 76.* Taken at 4270 m asl looking across the ground moraine cover (■) of the mountain ridge ESE of the Shinlep Brakk (35°42′ 10″ N/75°52′ 10″ E) up-slope towards the NE to the Bullah (No.36). The moraine surface shows a periglacial patterned ground structure (Kuhle 1985a). In the clayey moraine matrix (■) numerous erratic granite boulders are embedded, several metres in length (person for scale); (○), for example, indicates a facetted granite boulder the size of 2.8x1.6x1.1 m. (◓) is a classic roche moutonnée with "whale-back"-form, the abrasion surface of which has been roughened by frost weathering. Its longitudinal axis runs from E (right) to W (left). Photo M.Kuhle, 28.9.1997.

← *Photo 77.* At 4000 m asl, on the orographic right flank of the Braldu valley (35°41′ 10″ N/75°53′ E), c. 1000 m above its present- day valley bottom (○), a Late Glacial lateral moraine (■ black) is shown with a classic small lateral valley in which alluvial soils are developed (□). A hardly older lateral moraine remnant is on the right (□ right). This lateral moraine belongs to the Last (youngest) Late Glacial glacier position, the Sirkung Stage IV. It is c. 13,500 to 13,000 years of age and underwent an ELA-depression of c. 700 m against the current course of the snow line (after Kuhle 1980; 1998a Tab 1 p 82). (■ white) is ground moraine at the same level up-valley (cf. Photo 75). From Askole the area is intensively grazed and trodden on, so that cattle tracks have been developed between the dwarf scrub. No.22 is the Choricho massif (6756 m) with its W-glacier situated in the ENE, No.35 the Bakhor Das (5810 m). Here, the glacigenic abrasion forms (◓) enable the Ice Age glacier levels (– –) to be reconstructed between 5600 and 6000 m asl. Photo M.Kuhle, 28.9.1997.

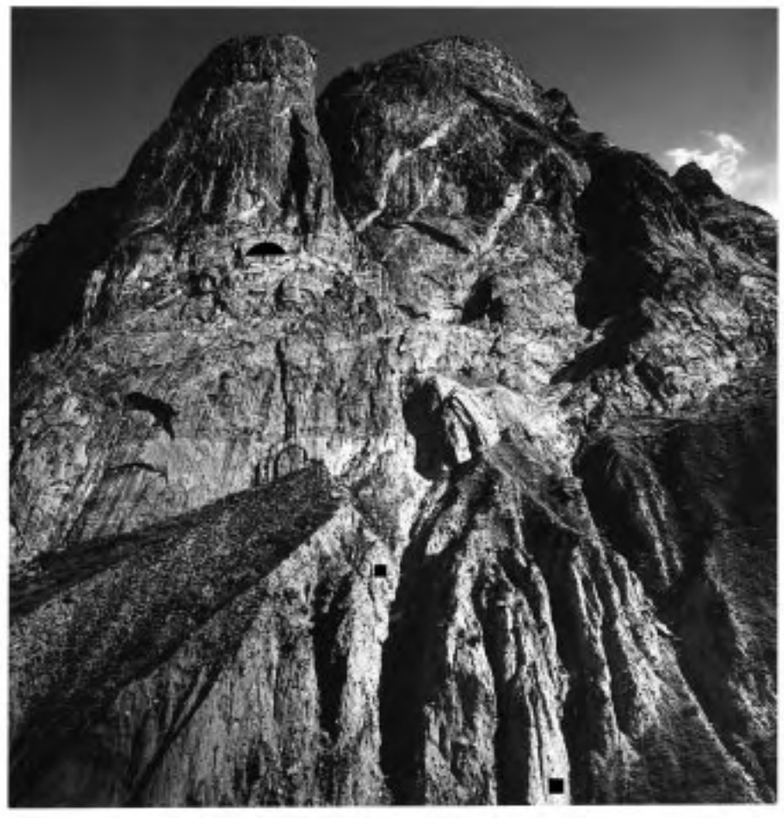


← *Photo 78.* At 3090 m asl (35°39′ 55″ N/75°52′ 50″ E) between the Braldu- and Biafo river from the bottom of the Braldu valley, consisting of loose rock - here, a glaciofluvial glacier mouth gravel floor (○) -, facing NNW seen towards the Shinlep Brakk mountain ridge (No.37, main summit is not visible). (▽ white) is a post-Late Glacial (post-Sirkung Stage IV) mudflow fan, which for an important part has been - and still is - built-up from dislocated glacial ground moraine material, as is evidenced by the fresh mudflow paths. Only after the deglaciation of this valley cross section and the corresponding flank could it be built-up. The mudflow fan is distally undercut by the meltwater river of the Biafo glacier, so that a 45 m-high exposure has been developed (above △ black). (△ black) are specific debris cones which break through the wall of the exposure and are adjusted to the river. (■) is the undisturbed High- (LGM) to Late Glacial ground moraine at the level of the lateral moraine preserved somewhat further to the right (E) (see Photo 77), i.e. 1000 m above the valley bottom. The rills (below ■) have undercut the ground moraine and, at the same time, supply the mudflow cone (▽ white) with debris of the weathered and eroded sedimentary bedrock. Though the bedrock phyllites have already been roughened postglacially as far as the culmination about 5000 m asl, the glacigenic abrasion is still recognizable. (– –) indicates the LGM glacier level. Photo M.Kuhle, 26.9.1997.

→ *Photo 79.* At 4300 m asl, from the orographic left flank of the Teste valley in the proximity of its exit (35°38′ N/75°49′ 30″ E; viewpoint in Photo 84 ⇩), 500 altitude metres above the pasture of Thal Brok looking towards the NE to the bottom of the Braldu valley (○) at c. 3000 m asl with the fields of the Ste Ste settlement. No. 37 is the Shinlep Brakk (5517 m), No.36 the Bullah (6294 m). (□) indicates the Biafo glacier tongue covered with surface moraine; (◓ black on the left) is the polish band with ground moraine overlay and Late Glacial lateral moraines (■) at the Shinlep Brakk ESE-ridge (cf. Photo 74 and 77); (◓ black on the left) is at the same time the viewpoint of Photo 84. (▽) mark postglacial rock crumblings and (▲) the corresponding debris cones. (◓ white) is the gneiss pillar rounded by glacigenic abrasion on the orographic right side of the junction threshold at the exit of the Teste valley. (◇) is local moraine and residual detritus in a mudflow- and avalanche ravine. (– –) is the LGM glacier level about 5600 (– – black) up to 6100 m asl (– – white). Photo M. Kuhle, 3.10.1997.

↑ *Photo 80.* At the head of the Teste valley between the Darso Brok pasture and the Skoro La (pass) at 4550 m asl, looking from the orographic left (35°35′ 30″ N/75°49′ 10″ E) over the Alpine valley- and hanging glacier system (□) of the Skoro La Gans (or Teste glacier): from facing NNE down the Teste valley (◓ left margin) via its right flank up to the highest summit (nameless) of the Skoro massif (No.46, c. 6000 m) in the uppermost catchment area of the Skoro La glacier, via the c. 5500 m-high summits at the head of the Teste valley (half-right), as far as the abraded rock ribs (◓ on the very right) in the area of the Skoro La (5070 m). (– –) marks the glaciogeomorphologically verifiable, i.e. the minimum level of the LGM-ice infilling of the valley. (⇩) indicates exemplarily the numerous fresh and Holocene rock crumblings which, under the control of the clefts (orientated according to ac- and bc-clefts), have remoulded the Ice Age flank abrasions. (△) are the corresponding debris cones- and slopes underlain by High- to Late Glacial ground moraine (cf. Tab 1: Stage 0 = LGM and Stage I to IV). (■ white) is the historical orographic right lateral moraine of Stage X or XI (for dating see Tab 1). (■ black) shows a lateral- or end moraine inset, laid down by two adjacent hanging glacier tongues on to an older neoglacial (Holocene) to historical (Stages V to IX; Tab 1) pedestal moraine (below and on the left below of ■ black). This has also taken place during Stages X or XI. (○) indicates edged quartzite moraine boulders between different dark components the size of blocks. This polymict historical lateral moraine on the orographic left is still poor in vegetation and belongs to Stage IX or X (Tab 1). Here, lateral moraine ramps are concerned which are attached to each other (see person on one of the moraine ledges for scale). The hanging glacier tongues of Stages V to VII with ELA-depressions of 150-60 m against the present-day real glacial snow-line limit about 4900 (4800-5000) m asl had merged to a joint tongue reaching the main glacier (□ = its surface moraines). Photo M.Kuhle, 2.10.1997.

← *Photo 81.* Taken at c. 4300 m asl, 500 m above the Thal Brok pasture, from the orographic left flank of the Teste valley near the valley exit (35°38′ N/75°49′ 30″ E; viewpoint in Photo 84⇩), i.e. the inflow of the valley over a c. 800 m-high confluence step (Photo 84 on the left below ⇩) into the Braldu valley (○) from facing NNE (left) up to E (right) looking into the right flank of the Teste valley (⇩). The mountains in the background are the Bullah (No.36, 6294 m) and the Choricho (No.22, 6756 m). (○) is the glacier mouth gravel floor of the Biafo glacier which covers the valley bottom of the glacigenic Braldu trough and serves as farmland and fields of the settlement of Ste Ste (2950 m). Slopes of active debris crumblings (△) are adjusted to the main valley bottom (○) and the side valley bottom (□). (■ white large on the right) marks late Late Glacial ground moraine (Stage IV; Tab 1) mantling a glacigenically abraded rock hill; (■ white small on the left) is the ground moraine in Photo 82. (◇) indicates a present-day avalanche ravine with temporary mudflow activities. (■ black) are ground moraine sheets with erratic boulders on the orographic right side, 1000-1200 m above the valley bottom of the Braldu trough. (◓) show LGM- to Late Glacial glacigenic flank abrasions and -polishings, the upper margins and polish lines of which document the prehistoric glacier level (– –). (– – white below No.36) runs at c. 6100 m asl, i.e. approx. 3000 m above the bottom of the Braldu trough valley. (⇩) points to postglacial wall gorges in the talwegs of which the debris of crumblings is transported; their development is dependent on ac- and bc-clefts. Photo M.Kuhle, 3.10.1997.



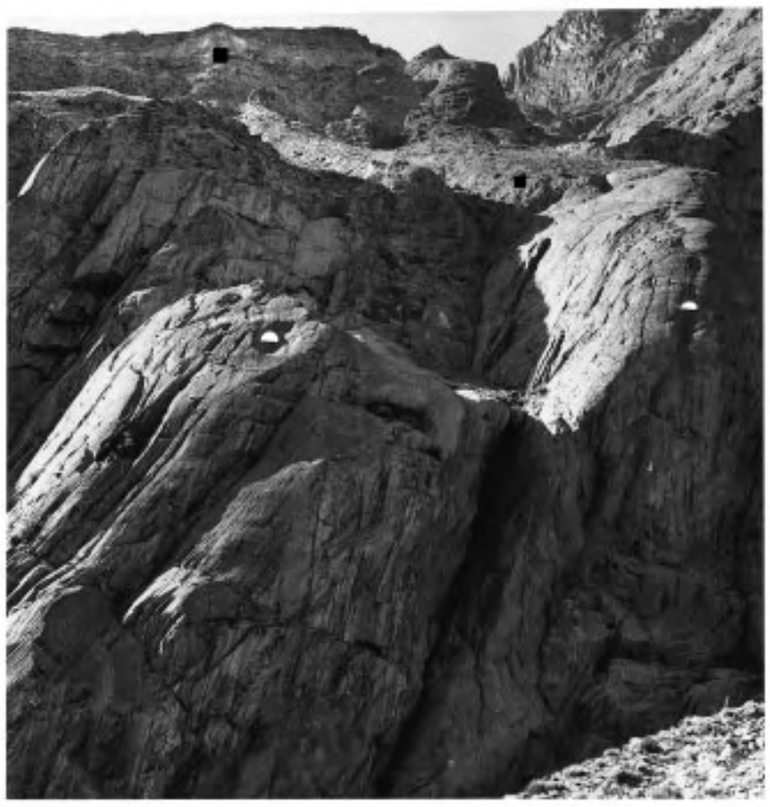
← *Photo 82.* From 3680 m asl, looking into the orographic right flank of the Teste valley (35°39′ N/75°50′ 20″ E) in the area of its confluence step leading down to the Braldu valley bottom. In Photo 81 the position of the ground moraine, dispersed into rills and earth pyramids (■), is located in a greater topographic connection (■ white small on the left). During the Sirkung Stage (IV: ELA-depression against today c. 700 m; see Tab 1) the ground moraine, fluvially furrowed since the deglaciation in the post-Late Glacial, has been stuck onto the glacially abraded rock wall (◓) by the Teste glacier tributary stream. From the lighter rock faces of the lower half of the wall (from ◓ on downwards) the ground moraine overlay has only relatively recently slipped down and been flushed out (during the last centuries), so that the dark coloration of the rock face deriving from water-stripes with the development of algae and lichens has still not reached the degree and climax which above (at ◓) has already been attained. The sharp line of the rock coloration (at ◓) provides evidence of the upper margin of the prehistoric ground moraine cover. The bedrock consists of strongly metamorphic, anatectic rock with light aplite-pegmatite- and quartz veins which break diagonally through the horizontal banking structure. The glacigenically rounded pillar forms of the gneiss-like rock immediately remind one of a Norwegian trough-valley- or fjord flank. Photo M.Kuhle, 3.10.1997.

↑ *Photo 83.* Panorama taken at 3350 m asl from the orographic right flank of the Braldu valley and the root of the mudflow fan (the two white ▽ in the middle) N above the settlement of Askoli (35°41′ 20″ N/75°49′ E); from facing SSE with the exit of the hanging Teste trough (background above ◓ black), via the Cherichor (6030 m; No.45) and via SW with the c. 6400 m-high Koser Gunge (No.47) behind the valley head of the Cherichor trough (▽), upwards of the settlement of Sino and then down the Braldu valley as far as into its orographic right flank (◓ white on the right) and side valley flank (◓ black on the very right). The mudflow fans (▽ white) consist of redeposited Ice Age ground moraine material (■ white) which in some places is also covered with dislocated moraine material (second ■ black from the left). Apart from these mudflow fans (▽ white) the glacial ground moraine material is also removed by debris cones and -slopes (▽ black) and covered by them at other places (▽ on the very left is the settlement of Kurpe). Several ground moraine sheets on the slopes of the Braldu valley (■) have been preserved on a large scale at 750-850 m above the valley bottom (the three ■ on the left); further down-valley even at an altitude of 1000 (the second white ■ from the right) up to 1400 m (■ white on the very right) above the valley bottom. The highest verifiable prehistoric ice level (– –) is substantiated by partially very well (i.e. genetically unambiguous) preserved glacigenic abrasion forms (◓) on the bedrocks of the trough flanks. The LGM glacier level (– –) runs about 5600 m asl in this valley chamber. Photo M.Kuhle, 4.10.1997.

← *Photo 84.* Taken at 4240 m asl from the pasture settlement of Askole (summer-settlement) in the orographic right flank of the Braldu trough (35°41′ N/75°51′ E) from facing SSE (left margin) via S with the Skoro massif (No.46, c. 6000 m-high) and SSW to the 6030 m-high Cherichor (No.45) up to WSW to the c. 6400 m-high Koser Gunge (No.47). The 1400 m lower bottom of the Braldu valley, which is not visible here, is shown in Photo 83. (⇩) is the viewpoint of Photo 81. (▽ white) marks the glacigenic trough of the Teste valley, a hanging side valley, situated c. 800 m above the main valley bottom on the orographic left side. (▽) are postglacial debris- i.e. mudflow fans and -cones of dislocated and buried ground moraine. The present-day Skoro Gans (glacier) lies in the catchment area of the Teste valley (below ◠). (○) are Late Glacial cirques with bottoms between 4600 (○ on the right) and 5400 m asl (○ on the left). (▽ black) indicates a trough-shaped saddle polished out by the Ice Age (LGM to Late Glacial; Stage 0 to III) Braldu main glacier between a roche moutonnée (◓ white large) and the valley flank which continues towards the Shinlep Brakk. (◓ small) show the highest preserved abrasions and rock roundings shaped by this main valley glacier and the connected LGM-ice stream network. (– –) is the highest LGM level evidenced by these abrasions up to c. 5600 m. (□) marks the lateral depression at the back of an orographic right lateral moraine ramp (■ black below) of the Late Glacial Stage III or II (II); (↓) are metres-high erratic granite boulders contained in this lateral moraine. (■ white and black above) indicate High- (LGM) to Late Glacial ground moraines. (▼) are meltwater gullies cut into the Ice Age ground moraine; here they attain the dimensions of steep small valleys. (◠) is the transfluence of the LGM-ice stream network over the 5070 m-high Skoro La (pass) into the Skoro Lungma which beyond leads down to the Shigar valley. Photo M.Kuhle, 28.9.1997.

↑ *Photo 85.* At 2800 m asl, 4 km down-valley from Askole near the settlement of Tonga, from the orographic right historic glacier mouth gravel floor terrace (○) of the Braldu river (35°41′10″ N/ 75°55′ 50″ E) from facing ENE to the Shinlep Brakk (5517 m, on the left margin; Figure 2/1 No.37) and E looking up-valley to the Bakhor Das (No.35, 5810 m). In the centre of the photo the Cherichor-N-valley (cf. Photo 83 ▭) with its glacier creek joins the Braldu main valley (▽ black, centre) from the S. (▼) are six glaciofluvial gravel floor terraces of the main- and side valley (period of origin: neoglacial Stage V to historic Stage XI, i.e. 5500-80 or 50 YBP; see Tab 1) which have been preserved on the inner bank of the Braldu river. Today they are the farmland of the settlement of Sino. (▽ black on the left) is the mudflow fan of the settlement of Surungo. (□) mark exposures of mudflow fans which consist of dislocated ground moraine material and are coarsely stratified. (■) show High- (LGM) to Late Glacial remnants of ground moraine cover on the valley flanks. (▽ white) is a mudflow cone which - in the same way as the mudflow fan (▽ black on the left) - contains a moraine core overlain by the cone form. (◓) are the glacigenic flank abrasions which are proof of the prehistoric ice level (– –) and the verifiable Ice Age (LGM (= Stage 0) to Stage I; Tab 1) glacier thickness. Photo M.Kuhle, 16.8.1997.

← *Photo 86.* From the fields 1.5 km down-valley of the settlement of Tonga, which lies on the most extended gravel floor terrace on the bottom of the Braldu valley (35°40′ 50″ N/75°45′ 10″ E), 2820 m asl, looking in an NE direction onto the S-flank of the Shinlep Brakk (No.37; 5517 m). This is the orographic right flank of the Braldu valley, which during the LGM has been completely glacigenically shaped as far as the then level of the glacier surface (– –). (◓) are glacigenic abrasion forms. Here their characteristic roundings are difficult to preserve, so that they have only remained on the vertical bedrock phyllites in some places. In part large-scale remnants of ground moraine (■) overlie the prehistoric glacier polishings as far as a height of 4200 m. (⇩) is a ravine which has already been created subglacially and cuts the round-polished rock heads (◓ black). Today it is flowed through by a glacier creek of a hanging glacier in the S flank of the Gama Sokha Lumbu (6282 m; Photo 69 No.42). Its development has taken place during Stages II to IV (Tab 1) when the ELA had already increased to an ELA depression of just 1000 to 700 m (against an ELA-depression of 1300 m during the LGM = Stage 0). During the development of the ravine the ELA ran about 3800 to 4100 m asl. (△) are terraces in the mudflow fan which has been built up of the detritus transported through the ravine (⇩). Photo M.Kuhle, 16.8.1997.



↖ *Photo 87.* Taken at 2700 m asl, 2 km down-valley of the settlement of Hoto (or Pakore), from the talweg of the Braldu (or Blaldu) valley (4 m above the Braldu river) (35°42′ 20″ N/75°42′ 50″ E) facing NNE looking into the SSW-flank of the Gama Sokha Lumbu (6282 m; Photo 69 and 91, No.42). (– –) indicates the LGM-glacier level (Stage 0), i.e. the maximum prehistoric ice level which can be evidenced empirically. (■) are the Ice Age (Stages 0 to IV) ground- and lateral moraine accumulations on the orographic right slopes of the Braldu valley. This slope, being at the extreme 3500 m and in the average 2500 m-high, is undercut by the very intensive erosion of the Braldu river (▲). The undercutting destabilizes the moraine slope (■) and causes staggered segment slides of the moraine covers ("Staffelrutschungen"; cf. Kuhle 1982a p 107; 1983a p 305 f). This down-slope movement is accelerated by spring erosion on the middle- and lower slope and the soaking of the clay-containing material, resulting in saturation flows (▽). The snow-meltwater which infiltrates on the upper slope (background on the left) contributes to this. But in consequence of snow melting and heavy summer rains (as e.g. monsoon incidences on August 25th and 28th, 1997) mudflows also take part in the dislocation and denudation of the moraine covers (▽). Photo M.Kuhle, 16.8.1997.

← *Photo 88.* Glacier striae and glacigenic rock polishings at 2900- 3000 m asl on the orographic left flank of the Braldu valley (35°42′ 20″ N/75°41′ 55″ E) c. 5.5 km up-valley of the valley chamber with the settlements of Gomboro and Tosha. Between c. 200 and 300 m above the talweg the vertical bedrock gneiss has been rounded, polished and scratched (◓) by the High- to Late Glacial Braldu parent glacier (LGM = Stage 0 to Stage IV). The last polishing took place during Stage IV (Tab 1). Ground moraine (■) which rests on the rock shoulders and -ledges is up to decametres-thick (■ large). In places where the moraine has been flushed out only a few decades or years ago and has slid down or been blown away, the rock polishing has not yet been weathered and roughened by splintering (below ■ small). Further down, where the rock surface falls away more steeply and, owing to this, has been left without any cover of ground moraine for a long time, the vertical banding of the rock penetrates the roughening of the surface (at ◓). Frost weatherings lasting a few centuries can be sufficient for a roughening of the glacier polishing like this. Photo M.Kuhle, 5.10.1997.

↗ *Photo 89.* Late Glacial rock polishings with glacier striae at 2950-3020 m asl between 250 and 320 m above the talweg on the orographic left flank of the Braldu valley (35°42′ 20″ N/ 75°41′ 50″ E) c. 5 km up-valley of the valley chamber with the settlements of Gomboro and Tosha. For the last time they have been treated by the Braldu glacier of Stage IV (Sirkung Stage) (see also Photo 88). (↓ and ◓) mark well-preserved glacigenic rock polishings on bedrock gneiss with an approximately horizontal rock lineation showing almost parallel glacier striae. (■) are remnants of ground moraine which remained on flattened areas. The pelitic ground mass of these moraine remnants, i.e. the clay, silt and fine sand, have been flushed out of the moraine matrix and have developed overlays ("wallpapers") up to several mm in thickness dried onto the glacigenically polished rock faces. They show a vertically-striped texture with which they are also attached to the vertical to slightly overhanging rock areas. This can clearly be seen in the shadow below (◓). Photo M.Kuhle, 5.10.1997.

↑ *Photo 90.* At 2830 m asl from the Braldu valley cross-profile between Gama Sokha Lumbu (Photo 91 No.42) in the NNE and Koser Gunge (Photo 84 No.47) in the SSW (35°42′ 30″ N/75°41′ 45″ E) looking to the WNW down the Braldu trough. Both the flanks are mantled by ground moraine from the valley ground up to a great height (■); this is also true of the slopes below the Hoh Lungma (■ below – – on the left) which joins from the orographic right side (from the N). Above the settlement of Gomboro, in the area where the ground moraine attains a greatest height of 4300 m, i.e. 1600 m above the talweg (■ white), it is exposed in the form of huge, decametres-high classic earth pyramids. The corresponding exposure walls are over 100 m-high (below ■ white). On the classically preserved glacigenic triangle-slope (■ below – – on the left) on the mountain ridge named Shana Sir (below – – on the left; c. 4700 m-high) the ground moraine covers reach similar high up. (◓) are sporadically preserved glacigenic abrasion roundings, which are proof of the LGM-ice level (– –) covering the entire relief visible here. Only in places where the mountain cupolas tower above 4700-4900 m, have cirques, which still contained small glaciers (○) during the neoglacial period and the historical glacier stages (during Stage V to Stage VII; for the corresponding ELA-depressions see Tab 1), sharpened the mountain ridge, roughening and fraying it into a crest of rock pillars and -precipices. On the SE fore-summit of the 5199 m-high Zarn Peak a perennial snow ledge is still attached to the back of the cirque (above ○ on the right), thus providing evidence of a present-day orographic ELA in an ESE-exposition about 4900 m asl. This corresponds quite well to the snow line value about 4800 m suggested by v. Wissmann (1959 Abb.14, p 144-145). (▽ black) are fresh mudflow cones and -fans consisting of ground moraine transported down-slope. Every year, i.e. after every intensive rainfall, they are getting more and more heaped up. (□) is a covering layer - close to the surface - of the 50 to 70 m-thick ground moraine on the valley bottom (■ on the left below □). It ought to be addressed as an ablation moraine being comparatively poor in clay. Processes of flushing, too, have slightly remoulded the ablation moraine since deglaciation. (▽ white) are post-Late Glacial rock crumblings on rock ribs which have been glacially abraded before. Photo M.Kuhle, 5.10.1997.

→ *Photo 91.* Panorama from 2700 m asl, c. 40 m above the Braldu river on the orographic left side, taken up-valley (35°42′ 40″ N/75°41′ E) of the valley chamber of the settlements of Tosha (visible on the left margin of the photo) and Gomboro, from facing NW diagonally down-valley via N to the 5499 m-summit (No.48) up to NE into the S-flank of the 6282 m-high Gama Sokha Lumbu (No.42) looking diagonally up the Braldu valley. Ground moraines (the three white ■ on top) are verifiable up to c. 4300 m asl, i.e. 1600 m above the present-day talweg (Braldu river). (■ black and ■ white on the right below) mark deposits of ground moraine in lower slope- to valley bottom positions. The 50-70 m-thick ground moraine complex on the valley bottom (■ black and white below) was a ground moraine pedestal of the Late Glacial Braldu glacier, which for the last time was glacier-covered during Sirkung Stage (IV) (cf. Tab 1). Since the post-Late Glacial deglaciation it has been dissected by the Braldu river. (△) are still active areas of crumblings (△ on the right) and dislocations of moraines (△ on the left). (○) shows a present-day mudflow fan supplying the Braldu river with substrate of moraine. (◓) is a glacigenic rock rounding 600-700 m above the talweg. (– –) indicates the reconstructed LGM-glacier level about 5000 m. Photo M.Kuhle, 16.8.1997.

↘ *Photo 92.* Panorama from 2530 m asl on the level of the Braldu river in the 90°-bend between the settlements Biano and Gohe (35°41′ 50″ N/75°35′ 30″ E) in the valley chamber of the settlement of Goyungo below the Koser Gunge NW-flank, looking from facing NNE Braldu up-valley as far as into the orographic right side valley Hoh Lungma with the 5584 m-Peak (No.49), up to E to the debris-covered avalanche snow which is hard like concrete (×) in the middleground. The avalanche snow which reaches far down here and persists long into the summer (×) comes from the mountain flank of the Koser Gunge rising up to c. 6400 m, which is approximately 4000 m-high and in the average 27°-steep. The steep, c. 4 km-long Koser Gunge NW-glacier hangs below this summit. (▽) marks a fresh mudflow fan over which the debris of the melting avalanche cone reaches the river in the form of a viscous saturation flow. (■) are High-(LGM=Stage 0) to Late Glacial (Stage I to IV) ground moraines on both valley sides (for ■ black see Photo 93); (↓) is exposed ground moraine material, dispersed into earth pyramids. (■ white) is a secondary cone form moulded out of the ground moraine by fluvial flushing as well as modified by the crumbling material which has been piled up on it (cf. Iturrizaga 1999). (◓) show glacigenic abrasions reaching up to 4650 m (■ on the right below No.49). (⇩) is a rock crumbling of the type which resolves the prehistoric flank abrasions on steep slopes. The highest geomorphologically verifiable ice level (– –) ran at c. 5000 m asl. Photo M.Kuhle, 16.8.1997.

← *Photo 93.* Taken at 2540 m asl from the bottom of the Braldu valley at the locality of Biano (35°42′ 20″ N/75°35′ 40″ E) up-valley to the NNE and beyond the sharp E-bend of the main valley (below ■ on the top) looking up the inflowing Hoh Lungma side valley. There the 5585 m-Peak (No.49) stands. (○) are coarse boulders of phyllite and granite deriving from the ground moraine on the valley bottom (■ below) between which the Braldu river has washed out the moraine matrix. The hut-sized boulder behind (○) originates from a rock fall caused by crumblings from the orographic right valley flank. (■ below) is a 50-75 m-thick ground moraine remnant in situ. Beneath the glacier ground a ground moraine pedestal of this type (■ below) has been built-up in the entire valley course of this trough valley section. First it has been partly cleared out along a subglacial meltwater tunnel during the late Late Glacial (Stage IV at ELA-depression 700 m; Tab 1) and then subaerially by the Braldu river in postglacial times. (■ above) is a ground moraine sheet covering the glacially abraded valley flanks (◓) over large parts. Its metres- to decametres-thickness is documented by over 10 m-deep rills (↙) which eat backward into this cover of loose material up the slope. (– –) indicates the 5500 m-high LGM-glacier level in the cross-profile of the Hoh Lungma at the tongue end of the present-day Sosbun glacier. Photo M.Kuhle, 5.10.1997.

↑ *Photo 94.* At 2535 m looking into the orographic right flank of the Braldu valley immediately above its bend from a SSW to a WNW course (35°41′ 50″ N/75°35′ 30″ E). (○) are bowls and half-caves of subglacial pothole walls in the granite, situated 25-60 m above the present-day level of the Braldu river. Further up the bedrock is overlain by ground moraine which has been washed in some places (■). (▲) is a debris cone of collapsed moraine which is in the process of being built-up at the wall foot. Photo M.Kuhle, 16.8.1997.

→ *Photo 95.* Viewpoint at 2530 m asl; here, the Braldu bend turns from a SSW to a WNW valley course (35°41′ 50″ N/75°35′ 30″ E) and the bedrock granite falls steeply away (50°) to the river. The rocks in the foreground (◓) have been glacigenically abraded. Owing to the construction of the jeep-road, the rocks have been blasted off in the area of the lower 4-6 m above the level of the Braldu river (for scale: jeep and three persons in the foreground on the right). (◓ in the background) are remnants of flank abrasions on the orographic left side, isolated from each other by multifarious crumblings. These were orientated by the approximately slope-parallel banking structure and have produced rock overhangs (shady areas between ◓ black and white in the background). (▽ above) is a Holocene wall gorge developed since deglaciation, i.e. after Stage IV, which bundles the rock fall and releases mudflows. (△ below) indicates the corresponding accumulation feature, i.e. the mudflow fan, lying on a Late Glacial ground moraine core (■). Photo M.Kuhle, 16.8.1997.

→ *Photo 96.* At 2540 m asl, 1 km up the Braldu valley from the wasteland of Gohe (35°41′ 50″ N/75°35′ 20″ E) looking down facing W from a ground moraine ridge (foreground) on the valley bottom c. 10 m above the river. The 'Dasso-Peak' (No.50) is an at least 5500 m-high, glaciated summit. (◓ white) are glacigenic abrasion forms of the orographic left Braldu valley flank, (◓ black) are those of the right flank. (◓ white, large) shows the steep lee-flank of a roche moutonnée-like granite ridge. This steepening of the lee-side has been developed by extraction of the rock frozen to the glacier bottom and, owing to this, is the result of regelation. The glacier abrasion can be verified by the rounding of the edges of rock crumblings (↑). (■ white) is moraine material with coarse, round-edged boulders on the granite ridge. (■ black) mark High- (LGM) to Late Glacial ground moraines on both valley flanks, which on the right side above the settlement of Niyel reach up to at least 900 m above the valley bottom (■ on the left below No.50). (◓ below – –) is a classic, glacigenically abraded triangle-shaped slope, the upper crest of which rises 1300 m above the valley bottom. (– –) indicates the glaciogemorphologically documented prehistoric surface level of the ice stream network about 4900 m asl. Photo M.Kuhle, 5.10.1997.

→ *Photo 97.* Looking from the valley chamber of Dasso at 2510 m asl (35°42′ 40″ N/75°31′ 20″ E) upwards across the gravel floor (○ black) with the Braldu river, facing ESE. The settlement on the ground moraine terrace (■ black on the left) is Niyel; No.47 is the c. 6400 m-high Koser Gunge massif, the highest one of the Mango Range, with the middle Koser Gunge NW-glacier (□) above the avalanche gully shown in Photo 92. (○ white) is a short trough, i.e. an over 4000 m-high hanging side valley on the orographic left which then breaks off, with the present-day front moraine of the easternmost Koser Gunge NW-glacier. (■) are High-(LGM) to Late Glacial ground moraine remains of this Braldu trough section; the ground moraine pedestal (■ white on the right) has been subrecently undercut by the Braldu river. In the meantime, the ground moraine pedestal (■ white on the right) has come in the position of an inner bank so that towards the river a mudflow fan (▽) could be built-up from the material of its rills. (■ white on the left) marks a ground moraine remnant at c. 3150 m asl, 600 m above the gravel floor. (◓) are rock roundings as a result of glacigenic abrasion. (– –) is the prehistoric ice level (LGM to Late Glacial, i.e. Stage 0 to IV; Tab 1), verifiable by the abrasion features. Photo M.Kuhle, 5.10.1997.

↓ *Photo 99.* Panorama taken at 2380 m asl (aneroid measurement: 2430 m) from the bridge-settlement named Haidarbad "Bollah" near the settlement of Mungo, from the bottom of the Shigar valley at the point, where the Braldu valley (right half of the panorama) and the Basna valley (left half) flow together creating by this confluence the Shigar valley (35°39′ 30″ N/ 75°29′ 30″ E): from facing SW to the 5552 or 5610 m-high Munbluk massif (No.51) via NW with the exit of the Basna valley (middle of the panorama) leading down from the Chogolungma glacier out of the northern Haramosh Range N-side, up to N with the 5046-5778 m-high southern fore-summits (No.50) of the Ganchen massif N of the lower Braldu valley. Both the massifs (No.50 and 51) show a current high valley- and compound cirque-glaciation of the Alpine type (▽). (■ black) are the ground moraines on the valley flanks deposited as far as c. 3800 m, i.e. 1300 m above the Basna valley bottom (■ black somewhat left of the middle of the panorama); (■ white) are the over 100 m-thick ground moraine layers in the foot bend of the slopes. They are reshaped by mudflow fans. Here are the irrigation oases of the settlements of Tisar and Molto. (○) is the valley bottom plain, built-up of edged boulders of rock avalanches (□ megaclasts of tonalite the size of a hut (Zanettin 1964)) (see Ghoro Choh rock avalanche according to Hewitt 1999:230-233) and glacier mouth gravel floors accumulated upon it. On its surface are meadow loams heaped up by historical high waters and - in some places in the middleground above - only metres-thick covers of current wind-blown sands. (○) are the meadow loams used as fields; they contain morainic clays and the minerally still fresher (completely unweathered) clays and silts of the historical glacier meltwaters of the Braldu- and Basna river (glacier milk). They are therefore extremely fertile. As one can conclude from the plunging of the ground moraine covers under the surficially sediments of the valley bottom (□ and ○) on both valley flanks (■ on the very left and right), High (LGM)- to Late Glacial (Stage 0 to IV; Tab 1) ground moraines basally also exist below the rock avalanche and above the rock bottom. (◓) mark the classically formed and in many places well-preserved glacigenic abrasions. They reach as far as a good 4600 m asl. The present-day hanging glaciers (▽) destroy the flank abrasions of the LGM-glaciation (Stage 0) by their small-scale down-slope erosion transversely to the horizontal direction of the down-flowing prehistoric ice stream network (from No.50 from the right to the left). Photo M.Kuhle, 16.8.1997.

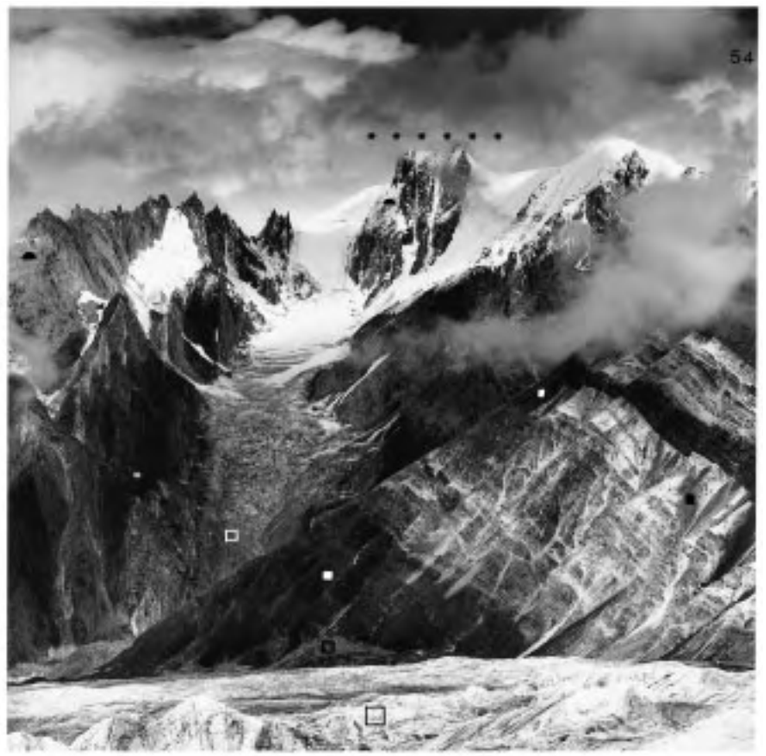
↑ *Photo 98.* At 2460 m asl from the orographic left side of the Braldu valley opposite the settlement of Tigstun, from a mudflow fan with a current cover of wind-blown sand (○ foreground) held by bushes of myricariae and junipers, looking across the present-day river gravel floor (○ middleground) (35°42′ N/ 75°29′ 10″ E) facing W diagonally down-valley on to the right valley slopes. (◓) are strikingly fresh-preserved glacigenic flank polishings on granite bedrocks. The rock ridge above has also been polished round and divided into separate roche moutonnée-like 'glacial knobs'. (■) are ground moraine remnants overlying the glacier polishings; these sloping ground moraine areas are patterned by the present-day flushing rills developed by the down-flowing rain water. (▽) show fresh crumblings on the fluvially undercut outer bank of the Braldu river. (No.51) is the c. 5550 m-high Munbluk massif in the SE Haramosh Range with its hanging glaciation and the autumnnal cover of freshly fallen snow. Photo M.Kuhle, 5.10.1997.

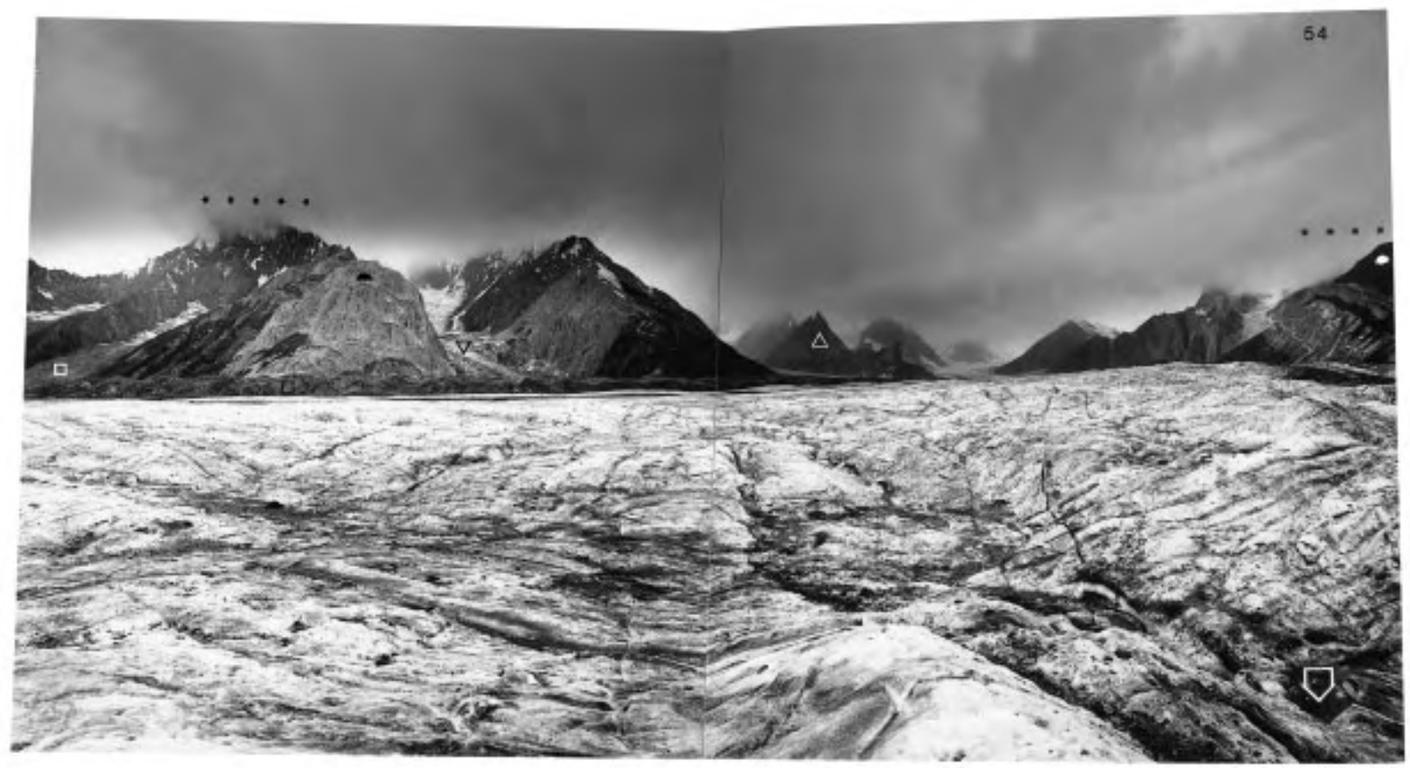
→ *Photo 102.* No.55 is the 6986 m-high Laila Peak. (□) indicates a central surface moraine string on the Chogolungma glacier at 3920 m (35°58′ 40″ N/75°04′ 20″ E), flanked by flat strings of sheer ice which melt down more heavily; in the background (below the two ▲ on the right) the Chogolungma parent glacier (its main component), flowing down from the Polan La. (▲) are glacigenically triangular-shaped faces, undercut so intensively through lateral erosion of the present-day glacier, that, owing to the resulting breakages, they have been strongly roughened. This is especially true from the ELA up the glacier. Below the snow-line the valley flanks with their triangular-shaped faces are protected against the current lateral erosion by lateral moraines and small lateral valleys, so that the trough flanks have preserved their prehistoric glacigenic abrasion forms (◓ black). In places they even show remnants of ground moraines (■). Perennial snow sticks on side valley flanks rising up to over 5000 m asl (⇓). It forces the frost weathering by water supply and the effect of increasing freezing and thawing on the snow- and rock margins, i.e. on the black/white limit (cf. Ampferer 1928). From this result roughening breakages. The vertical structure of the crystalline and metamorphic bedrocks preforms the dip-orientated development of wall cuttings, -rills and -gorges (e.g. on both sides of ▲ in the middle). (◜ white) is the polishing of edges of the strata on phyllites with light quartzite banks on the orographic left side. (– –) indicates the LGM glacier level about 5900 m asl, running on the avalanche-sprayed mountain flanks of this NE-exposed Chogolungma valley flank c. 1000 m above the current snow-line. Photo M.Kuhle, 18.7.2000.

→ *Photo 100.* At 3900 m asl (35°58′ 35″ N/76°06′ 20″ E) from the orographic left lateral moraine (historical Stage X; cf. Tab 1) towards the W up the Chogolungma glacier looking at the Malubiting (No.52; 7458 m). The summit at the back is the main summit. It is the highest and easternmost mountain of the Puparash Group. The summits in front are the 7260 m-high eastern Malubiting fore-summit (on the right of No.52) and the 6970 m-high Malubiting E-peak (left of No.52). Here, the Chogolungma parent glacier branches into three 2 to 7 km-long source arms supplying it with ice masses of the Malubiting NE-slope from above the snow-line (ELA) (on both sides of the two ⇩). Behind the glacigenically rounded rock spur (◜), i.e. the extended middle Spantik SW-crest, the parent glacier continues as far as the 5840 m-high Polan La, where it has its source (cf. in Photo 123 the glacier pass between No.52 and 54). At c. 4700-4800 m the grey glacier ice beneath the old snow becomes exposed. At this altitude the highest-lying boulders of the surface moraine set in, indicating the orographic ELA (present-day glacial snow-line). (□) marks a 20 m-high glacier ice ridge covered by a string of medial moraine. Protected against ablation, it was capable of rising so high over the surrounding area of sheer ice. Despite the vertical strata series of the bedrock, the rock ridge of the Spantik crest shows a glacial rounding (◜), whilst, due to the undercutting lateral erosion of the present-day glacier margin, the glacigenically triangular-shaped faces (⇩) are broken away very craggily in the form of sharp-edged wall gorges (⇩). (– –) is the verifiable LGM glacier surface about 5900 m, indicated by the abrasion and rounding of rock heads and -ridges (– – below No.52) as well as remnants of wall pedestals preserved in the shape of pillar-heads (– – on the right). Photo M.Kuhle, 23.7.2000.

← *Photo 101.* Taken in the E-flank of the 6986 m-high Laila Peak (No.55). (□) marks the Haramosh glacier covered by a thin "veil" of surface moraine (35°58′15″ N/75°01′ 50″ E), 1 km upwards of its junction with the Chogolungma glacier. The Ice Age glacier level (– –) ran about 5900 m asl sloping opposite to the current surface of the Haramosh glacier (□), namely towards the SW, up the Haramosh valley. There, the 4800 m-high Haramosh La is situated, over which the LGM glacier was connected to the Indus valley with its parent glacier (via the Mani- and Phuparash Gah) running at a height of only just 1500 m. (■) are ground moraine overlays on the very steep (32-45°) valley flanks, the glacigenic rock roundings of which (◓) are preserved only sporadically. (⇩) are Late (Stage IV, Tab 1) to post-Late Glacial breakages on the rock pinnacles (here of granite), which have been polished during the LGM (Stage 0) and undercut through glacigenic lateral erosion during the Late Glacial (Stages III and IV). As today, so too the Laila E-glacier (below No.55) existed in the form of a hanging glacier in a comparable thickness of 100 m at maximum during the Ice Age. However, already at the level of its ice-fall it was adjusted to the Ice Age level of the Haramosh glacier (– – directly below No.55). This High- and interglacial hanging glacier was able to scour an extended cirque, i.e. a "Wannen-Kar" (after Maull 1958, p 383, Photo 40). Photo M.Kuhle, 23.7.2000.

→ *Photo 103.* Taken from the middle of the Chogolungma glacier (35°58′ N/75°05′ 30″ E, 3810 m asl) from the central, completely surface-moraine-free string of sheer ice (□ large), facing NW up the parent glacier towards a steep valley glacier (□ white), which, parallel to the Basin glacier, flows down from the Spantik massif (No.54, 7027 m) in a SE direction, joining the Moraine glacier behind the spur (■). The sheer ice becomes exposed about 5000 m asl. The Moraine glacier is the most extended orographic left tributary stream of the Chogolungma glacier. (■) are separate deposits of ground moraine on the orographic left valley flank. They are superimposed upon large-scale edges of the strata of metamorphic sedimentary rocks. (□ black, small) shows a mudflow fan below the exit of a gully; here, dislocated material of ground moraine is accumulated. It contains far-travelled erratic coarse-crystalline boulders. (◓) are highest glacigenic features of abrasion and rounding deriving from the High Glacial ice stream network. They can be observed on the granite rocks of the Spantik (No.54) up to approximately 6100 m and provide evidence of an LGM ice level somewhat above this height (– –). Photo M.Kuhle, 25.7.2000.





→ *Photo 104.* Panorama at 3840 m (35°58′ 25″ N/75°05′ 35″ E) from the NNE margin of the most extended string of sheer ice of the Chogolungma glacier from facing S (left margin) - where the 5787 m (or 5610 m)-high spur peak with its short side glacier (□ white is its surface moraine) flanks the inflow of the Second East Haramosh glacier on the orographic left side, via the First East Haramosh glacier (▽ black) in the SW, up the main glacier in a W-direction (△ white) with the junction of the Haramosh glacier from the SW (from the left), as far as the SE spur of the Spantik massif (No.54). (□ black) marks the present-day surface moraine of the orographic right medial moraine string of the Chogolungma glacier. The sheer ice in the fore- and middleground is free of crevasses and provides a surface for supraglacial meltwater creeks (⇩). (◓) shows glacigenic abrasion roundings in the massif-crystalline rock (here granite: ◓ black) as well as on the edges of the strata of metamorphic sedimentary rocks (here phyllites as e.g. quartzites: ◓ white). (– –) is the minimum height of the LGM ice surface, geomorphologically verifiable between 5900 and 6100 m asl (the clouds are lower). (△ white) indicates a small glacial horn, which has no longer been overflowed by the ice only since the late Late Glacial and Neoglacial (Stage IV and V; see Tab 1). From then on it has been sharpened by flank polishing on both sides in the confluence area of the Haramosh glacier and Chogolungma parent glacier. Photo M.Kuhle, 23.7.2000.

↑ *Photo 105*. 360°-panorama at 3810 m asl from the middle of the Chogolungma glacier (35°58′ N/75°05′ 30″ E) - here 2.4 to 2.6 km-wide - and the central, completely surface-moraine-free string of sheer ice (fore- to middle-ground). The left and right margin of the panorama are exactly in a S-direction. Here, two short hanging valley glaciers join the Chogolungma glacier (□ black) from the NE flank of the 5787 m (or 5610 m)-high spur peak (in the clouds) of the 8 km-long Mani Peak NNE-crest. This takes place over two confluence steps (in the area of ▲). The ESE hanging glacier is about to develop a moraine pedestal, i.e. a dam moraine (▲), on which its tongue flows down at an increasing height over the rock bottom of the hanging valley. Towards the tongue terminus, which reaches the main glacier (Chogolungma glacier □ black), this ground moraine pedestal becomes thicker and thicker. The middle of the panorama in the NE shows the orographic left flank of the Chogolungma valley with the 5328 m-high spur peak (in the clouds) between the Sgari Byen Gang valley (half right) and the Boluche valley (below No.71). This is a large, glacigenically triangular-shaped slope (◓ black on the left below No.71) with a nearly 3 km-wide basis, which has been abraded by the Ice Age Chogolungma parent glacier. Concomitant with the lowering of the glacier level from the Late Glacial (17 Ka) up to the present, this large triangular-shaped face - which during the High Glacial was connected - has been cut and dissected by rills and avalanche gullies (▽) through backward erosion of the edges of the strata of the sedimentary bedrocks. (■ white on the left) is a ground moraine remnant with metres-high erratic boulders, which is still superimposed upon the valley flank 400 m above the present-day glacier level. (■ white on the right) marks also ground moraine, overlying the orographic left main valley flank as far as at least 4400 m, i.e. 700 m above the present-day Chogolungma glacier level. Below No.71 there is a 5571 (or 5405)m-high glaciated mountain named Aren Cho; below No.59 the 6005 m (or 5937)m-high unnamed main peak of the Bukpun massif and on the orographic right side of the Chogolungma valley, below No.61, there is the Kapaltang Kun (c. 6220 m). Between No.59 and 61 the Chogolungma glacier flows down to the ESE; up the main glacier (between the two black ◓ on the left) one looks toward the WNW. (□) are strings of surface moraine. (□ white) are those of the Second East Haramosh glacier, joining from the ororogaphic right, from SSW. Its inflow is S of the viewpoint. (□ black) are the areas of the Chogolungma main glacier, where the surface-moraine-covered ice has been raised up to over 10 m-high above the surrounding ice level. (■X) shows the orographic left lateral moraine with a 80 m-high inner slope. It has been built-up as far as its crest for the final time during the last historic glacier maximum in Stage X (Tab 1). (◓) are clearly verifiable glacigenic abrasion forms reaching a height of 5100 m (second ◓ from the left on the top of a huge glacigenically triangle-shaped face) which by the ground moraine deposits on the valley flanks (■ white) provide evidence of an LGM glacier level between 6100 and 5900 m asl. Photo M.Kuhle, 25.7.2000.

↓ *Photo 106.* Looking from the tongue of the Sgari Byen Gang glacier at 4400 m asl (36°00′ 18″ N/75°06′ 40″ N) up-glacier (left third of the panorama □ large) toward the NNE (No.69) over the orographic left valley flank (centre) facing WSW up to SSW down-valley (No.56) to the Chogolungma main glacier (□ white). No.56 is the clouded 6253 m-summit in the NNE crest of the Haramosh II with the First East Haramosh glacier; (□ white) marks its surface-moraine-covered inflow into the Chogolungma main glacier. No.69 is the c. 5500 m-high ESE-crest of the 6193 m-massif S of the Gandes Chhish (6445 m). The surface moraine of the Sgari Byen Gang glacier (black, large □) consists of an up to over 100 cm-thick layer of coarse debris with a 90%-predominance of edged boulders (foreground) of sedimentary rocks and a clay-, silt-, sand- and pebble-bearing matrix. (▲) shows the entrance of a meltwater tunnel beneath the hanging solid glacier ice. (black □ small) are remnants of avalanche snow of the winter and spring. On their edges occur fresh mudflows of the last weeks and days, which can be diagnosed by their still humid, laminar accumulations (on the right of □ small on the left). The avalanche- and mudflow tracks follow the permanently flowed-through meltwater rills in the valley slopes (left of △ on the right). They are cut into Late Glacial ground moraine (■ black, centre) and neoglacial to historic lateral moraine (■X). Owing to this, the meltwater creeks as well as the summertime mudflow- and wintertime avalanche discharges dislocate this prehistoric moraine material, removing it into the surface moraine of the Sgari Byen Gang glacier (□ black). (■X) is the slightly layered lateral moraine generation of Stage X from c. 180-80 years before present (cf. Tab 1). Its accumulation was dependent on a snow-line depression of 30-40 m against the present-day ELA. (○) is the glacier creek. In this position (4150 m asl) the lowest remains of dead ice are situated marginally (recognizable by the humid slope debris on the left of ○), 500 m down-valley of the current glacier terminus at 4200 m. (↓) is the locality of the erratic quartzite boulder shown in Photo 108. (△ left) marks a debris cone with ground moraine core; (△ on the right) is a fluvially re-worked ground moraine, on which a hanging glacier tongue still lay in the neoglacial period (Stage V-'VII). (■ white) are the highest Late Glacial ground moraine remnants preserved here; (◓) shows the highest verifiable glacigenic abrasion roundings; (– –) is the geomorphologically verifiable Ice Age glacier level (Stage 0=LGM) about 5900 m asl. Photo M.Kuhle, 22.7.2000.

↑ *Photo 107.* 360°-panorama from the junction area of the Sgari Byen Gang side-valley (No.69) into the Chogolungma valley (□ white) (35°59′17″ N/75°05′35″ E; 3920 m asl) from the moraine- (○) and gravel accumulations of the historic glacier stages from the Younger Dhaulagiri-Stage VII up to Stage IX with the corresponding gravel fields or sanders (outwash) No.-4 to No. -7 (see Tab.1): the left and right margins are situated in a SE direction looking down the Chogolungma valley; No.56 is the 6253 m-Peak in the SW, covered by clouds, from the NE-flank of which the First East Haramosh glacier joins the Chogolungma glacier (□ white). On the right of No.56 the Chogolungma glacier flows down out of the W-flank of the Malubiting massif, which at 7453 m is the highest catchment area. In the NW lies No.69, the catchment area of the Sgari Byen Gang glacier (□ black), which reaches the 6193 m-Peak. The moraine-covered current glacier surface has been lowered about 150 m against its lateral moraines (■X), which belong to Stage X (Tab 1) (cf. Photo 106). (⇩) marks the ruins (remnants of stone-huts and wind-shields) of a temporary settlement of mineral prospectors, abandoned several years ago. Somewhat above, at 4120 m asl, there lies the front moraine of Stage X of the Sgari Byen Gang glacier. (■ black and ■ VII-IX) indicate the lateral moraines upthrust by the glacier ice during the historical Stages VII-IX, i.e. c. 1700-180 years ago (Tab 1). At that time there was the last ice contact between this orographic left side-glacier (□ black) and the main glacier (□ white). Meanwhile sporadic flowers have settled (in the area of ○). The moraine debris contains polymict boulders of sedimentary- (○ large) and massif-crystalline (○ small) rock the size of several metres. They are edged, partly rounded at the edges (○ large) and rounded at the edges (○ small), i.e. facetted. (△) mark debris cones and -slopes as well as -surfaces which have been developed by the down-slope transport of their material on Late Glacial cores of ground moraine and historic lateral moraine ledges. (▲) is the basis of the pedestal moraine of an orographic right hanging glacier upwards of the inflow of the Second East Haramosh glacier, which is in the process of being built-up. (■ white) mark ground moraine remnants on the outcropping edges of the strata at 4600-4700 m asl; (◓) are glacigenic abrasions and flank polishings on glacigenically triangle-shaped faces and "truncated spurs". In parts the work of mineral prospectors has abraded and roughened the outcropping edges of the strata (◓ on the left and right below No.69). (– –) is the glaciogeomorphologically verifiable minimum height of the LGM glacier surface. The classic trough form all over the valley below No.69 has been polished out during the LGM. Photo M.Kuhle, 20.7.2000.

→ *Photo 108.* Taken in situ, a longish, rounded erratic quartzite boulder of 1.39 m in length with glacier striations, embedded into a clayey, loamy ground moraine matrix (■) next to edged fragments of phyllites. The striations are up to 40 cm-long; they are inset in the form of sharp, thin to medium-wide scratches up to furrows, as wide as a finger (for scale: the head of the moraine pickaxe is 19 cm-long). They are rectilinear and run at an acute angle to each other in five main directions. The boulder consists of the altogether best rock material for the development and preservation of striations and glacier scratches: fine-grained, highly metamorphic quartzite on the base of coarse silt up to fine sand (grain-sizes about 0.05-0.08 mm). Rock of this type is a glaciogeomorphological rarity. Locality: Photo 106 ↓; 35°59′ 35″ N/76°05′ 40″ E, 4135 m asl. Photo M.Kuhle, 22.7.2000.

↓ *Photo 109.* From the outer slope of the orographic left recent (Stage X, Tab 1) lateral moraine of the Chogolungma glacier (■ white on the very right) (35°58′ 25″ N/75°06′ 20″ E; 3810 m asl) looking down towards the SSE into the left valley flank (⇩) and the lateral valley of the glacier (○). The left margin of the panorama with the large mudflow cone (△ large) is in a N-direction. No.57 is the Kupulting Kung-massif (6321 m), situated in the SSW beyond the Chogolungma glacier. The lateral valley is at most of neoglacial age, i.e. it has come into being between the Nauri Stage (V) and the middle Dhaulagiri Stage (‘VII) and - since c. 1,700 years ago - has been furnished further by the development of lakes with lake sediments (□), fillings of alluvial debris (○) and mudflow fans (△) during the historical stages. The mudflow- (△), as well as the alluvial material (○) has been and is still heaped up against the outer slope of the lateral moraine (■ large), building-up a kames in the shape of a paraglacial bank formation with a lateral sander. The left mudflow cone (△ large) pours out of a valley flank gorge (⇩ on the left) which sets in 1300 m further up. This cuts as an obsequent talweg into the metamorphic sediment series (32/10) dipping with 32° to the N (cf. Photo 105 ▽ on the left). (⇩ on the right) is a subordinated erosion rill. In the catchment area of the larger gorge, at the 5126 m-peak, snowfall also occurs in summer (see Photo 111 below ▬ ▬). Perennial avalanche snow (◇) lies on top of and clings to the cone at the exit of the gorge (△ large). In the proximal section of the cone mantle it is covered by debris which has thawed-out and has then been dragged away (△ large). The melting snow produces the creeks of this lateral valley section (left of the person). In winter the discharge of avalanches takes place, in summer that of mudflows. A corresponding polygenesis applies to the much smaller avalanche- and mudflow cone (▷ on the right) (see also Photo 105 ▽ centre). Before an overspill over, i.e. through the lateral moraine (■ white on the very left; the lateral moraine break-through is above ○ in the background), has taken place, a lateral valley lake has been developed, into which 8 m-thick lake sediments (□) were deposited: thinly-layered silts, sands and pebbles. (◓) are High- to Late Glacial (Stage 0 = LGM to IV) abrasions of bands of edges of the strata preserved in remnants. (■ white, middle) marks Ice Age remains of ground moraine. The larger part of them has already been removed from this mountain flank, which has developed an extended, glacigenically triangle-shaped face. Photo M.Kuhle, 20.7.2000.

↑ *Photo 110.* At 3730 m asl from the Chogolungma glacier surface or, more exactly, from the orographic left surface moraine string (□) (35°57′ 40″ N/75°06′ 30″ E) towards the NE into the Bolocho valley with the debris-covered Bolocho glacier (cf. Photo 112 □) looking onto the mountains at the valley head rising up to 5755 m, in the area of the Bolocho La (5450 m). No.71 is the Aren Cho (5402 or 5577 m), covered by hanging glaciers. Here, the orographic left surface moraine string (□) is 0.8 km-wide and covered by polymict boulders of phyllites (dark) and white granite (○), which are edged or rounded. The boulders attain a length of up to 4.5 m (for scale: the three persons in the middleground on the right). (IX) shows a 60-70 m-high lateral moraine ledge of the historical Stage IX (see Tab 1) which has been sedimented at a time when the Bolocho glacier was still a tributary stream of the Chogolungma glacier, i.e. when it joined the main valley and lay down with its tongue parallel to the main glacier. (■) are High- to Late Glacial remnants of ground moraine (Stage 0 to IV, Tab 1); (■ on the right) is a typical spur position, where the ground moraine has been left behind in the confluence of the side- and main glacier on a glacially triangular-shaped slope, here at 4380 m asl, i.e. 500 m above the present-day glacier surface. (◓) the preserved flank abrasions document an LGM glacier level at a minimum height of 5300 m (– –). Photo M.Kuhle, 25.7.2000.

→ *Photo 112.* Panorama taken at 4150 m asl from an orographic left subrecent lateral moraine slope (■ on the right) of the Bolocho glacier (□) (35°59′ 10″ N/75°09′ 20″ E) from facing SSW (left margin) down-valley, via WNW (centre) into the orographic right valley flank of the Bolocho valley, via NNE (No.70) up-valley, as far as NE into the orographic left slope (right margin). No.56 is the 6253 m-peak at the northern end of the crest. The Chogolungma glacier, to which the pedestal moraine (▲ black) of one of the two hanging glaciers is adjusted, crosses below. No.70 is the "Bolocho crest" culminating at 5755 m asl, over which the Bolocho La (5450 m) leads into the Kero Lungma valley with the Kero Lungma glacier, situated towards the ENE. The glacier is covered by a surface moraine, which in the tongue area is over 1 m-thick (□ black). (□ white) shows a dead ice body, already separated from the thrusting Bolocho glacier, which is still connected to the catchment area. (▼ white) marks the outlet of a meltwater tunnel with ice in the meltwater creek, which has freshly broken away. However, this does not concern the actual glacier mouth, because some decametres down-valley the meltwater vanishes again beneath the glacier. The current glacier terminus (with the glacier mouth) is situated at 4040 m asl (on the right behind □ white). (○ black) is the Bolocho glacier creek, flowing sub-aerially over c. 3 km and then draining in or under the Chogolungma glacier, i.e. interglacially or subglacially. (■X) is the orographic right lateral moraine of Stage X (see Tab 1); (■ on the right) marks the corresponding orographic left lateral moraine; (○ white) is a 1.5 m-long moraine boulder of dark crystalline schist, rounded at the edges; the adjacent light boulders, similar in size, consist of white granite. Since Stage X, the glacier surface (□ black) has melted down at a maximum by 80 m (below ■X). Syngenetically the development of sand pipes and earth pyramids has set in (on the right and left of ■X). (△) are polygenetic debris bodies deposited in the lateral valley. (■ centre of the panorama) shows a glacigenically triangle-shaped face with a Late Glacial (Stage I-IV) ground moraine overlay. (◓) are glacigenic abrasion features, which mediate to the High Glacial (LGM = Stage 0) glacier level (– – and – – 0). (– – 0) runs about 5500 m, (– – middle) about 5300 m and (– – on the left) is evidenced by the local geomorphology as running at 5600-5800 m. Naturally, there was at the same time only one connected glacier level, which, accordingly, lay about 5600-5800 m at minimum. Photo M.Kuhle, 19.7.2000.

→ *Photo 113.* Panorama taken from the orographic left flank of the Chogolungma valley c. 200 m above the glacier surface (35°57′10″ N/75°08′25″ E; 3850 m) down-valley of the locality of Aren Cho (Arinchu) (a yak pasture) from facing S (No.58) via WSW (No.56) and WNW (No.52) as far as NE (No.54). No.58 is the 5770 m-peak (in the clouds) with its northern fore-summits from which the western Marpho glacier - as an orographic right tributary stream - flows into the Chogolungma parent glacier. No.56 is the 6253 m-peak, the two eastern hanging glaciers of which (left below No.56) join the Second East Haramosh glacier, which flows into the Chogolungma glacier (□). (▼) are the pedestal and lateral moraines of two relatively small hanging glaciers running down to the NE. No.52 marks the 7453 m-high Malubiting massif with the highest catchment area of the entire dendritic Chogolungma glacier system. Its 6843 m-high N-summit (on the right below No.52) is cloudless; its N-crest falls away to the right towards the 5840 m-high Polan La. This pass is a High Glacial (LGM = Stage 0) transfluence pass; (– – on the right below No.52) shows the corresponding glacier level of the LGM ice stream network with its culmination and decline in altitude beyond the ice divide toward the NW to the Barphu-, Hispar- and finally Hunza-glacier-system. There, and further to the N in the area of the Spantik-massif (No.54, 7027 m), the LGM-glacier surface (– – between No.52 and 54) reached an altitude of 6200-6400 m. (□) marks exemplarily one of the numerous medial moraines, which below the glacier confluences are put together by two lateral moraines each, building-up the surface moraine cover which increases down-valley. (▽) are rock fall- and mudflow cones, made up of crumblings (⇩ black) as well as dislocated Late Glacial ground moraine (■). They are distally cut by the glacier (△ white) and integrated into the lateral moraines. (X) is a lateral moraine of Stage X (see Tab 1). The highest prehistoric deposits of ground moraine visible here (■), are preserved 400 m above the present-day glacier surface (■ white). (■ on the very right) are decametres-thick ground moraine covers with erratic rounded quartzite- and facetted granite boulders; bedrock schist is in the underground. In many places glacigenic abrasion features (◓) are preserved on metamorphic sedimentary rocks as well as on massif-crystalline rocks; the highest ones can be observed at c. 700 m above the glacier (◜ on the very right). (⇩) mark postglacial rock crumblings, which in dependence on the rock have been shaped differently. Photo M.Kuhle, 25.7.2000.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← *Photo 111.* View from the central sheer ice string of the Chogolungma glacier at 3810 m asl (35°58′ N/75°05′ 30″ E) into the orographic left valley flank facing NNE to the 5126 (left) and 5328 m (right) double-peak. Due to the protection against ablation by a complete cover of surface moraine, the glacier ice (□) has thawed-out residually up to 10 m beyond the level of the sheer ice (foreground). (■X) is the left inner slope of the lateral moraine which the glacier has last formed by the accumulation and attachment of moraine up to its highest point during Stage X (see Tab.1). The valley flank consists of crystalline schist series dipping to the N (see also Photo 109). It is overlain by ground moraine, which covers the glacigenically abraded edges of the strata (◓) in the form of large residual surfaces up to an altitude about 4450 m (■). In between, wall gorges (▽ white) have been cut by linear erosion of the meltwater, widened by avalanches, or cleft-controlled crumblings (⇩) have taken place (along the ac- and bc-clefts). In their areas the wintry scouring effect of the snow and rock fall is especially active. All these postglacial mass movements, which in the first place have transported away the Ice Age hanging ground moraine, led - and still lead - to the build-up of debris bodies in the neoglacial to historic lateral valley (△ black). The LGM glacier level (– –) is confirmed by very high abrasion features (outside this photo-perspective). On this summit, overflowed by the LGM-ice stream, the crumblings resulting from cleft-controlled frost weathering within c. 20 Ka, have created a form which was dictated by the rock structure (stratification). Photo M.Kuhle, 25.7.2000.

↓ *Photo 114.* At 3855 m asl from approximately the same viewpoint as in Photo 113, taken from a rock spur of bedrock schist (left margin of the panorama) facing ESE toward the 6005 m-Peak (or 5937 m; No.59) above the locality of Shing Kuru, looking down the Chogolungma glacier. In the middleground the pasture Aren Cho (○) is situated in the orographic left lateral valley. The 6246 m-high Karaltang Kun (No.61) lies directly in the S. No.57 is the 6321 m-high Kupultung Kung massif in a SW direction (the summit is in the clouds). Toward the WSW lies the 6253 m-Peak (No.56, in the clouds), the two eastern hanging glaciers of which join the Second East Haramosh glacier. Up-valley, toward the WNW, the Chogolungma glacier can be seen; the right margin of the panorama shows the northern main valley flank. No.60 is the 5861 m-high (or 5846 or 5820 m) Berginsho Church (or Sensho); No.58 indicates the 5770 m-Peak with its northern fore-summits from which the E-components of the West Marpho glacier flow down. The West Marpho glacier itself joins the Chogolungma parent glacier (□) as an orographic right tributary stream. (X) is the striking subrecent (Tab.1) lateral moraine of the Chogolungma glacier. It contains an older neoglacial to historic (Stage V to IX) lateral moraine core. The pseudomorphotic moraine tongue (⇦) provides evidence of a local break-through of the ice through this lateral moraine during Stage IX. (▽) are debris bodies of interglacial, dislocated moraine material, building-up the surfaces of up to very large (▽ centre) mudflow fans; (▽ on the left) is a current mudflow track. (○) marks sandy alluvial debris sedimentated by the creek in the lateral valley. (■) are High- to Late Glacial ground moraine deposits in situ, preserved up to an altitude of 600 m (■ on the very left and right) above the present-day glacier surface (□). On the mountain ridge below No.60 the ground moraine even attains 800 m (■); (↑ ↑) are erratic granite boulders of this ground moraine, the size of up to 1.5 m. They lie on bedrock schists. The clayey matrix of this ground moraine is visible in the right corner at the bottom. (◓) are glacigenic flank abrasions indicating a highest prehistoric ice level (LGM = Stage 0) at altitudes between 5800 (– – half-right and centre) and 5600 m (half-left). Photo M.Kuhle, 18.7.2000.

↑ *Photo 116.* At 3550 m asl, looking down the orographic left lateral valley (▼) of the Chogolungma glacier (35°56′ 10″ N/ 75°10′ 05″ E) facing ESE toward the 6005 m-Peak (No.59; or 5937 m). The left margin of the panorama points N into the left valley flank showing a ground moraine cover, being several metres - over 10 m at maximum - in thickness (■ left) with up to 4 m-long boulders; there are also erratic quartzite boulders. The bedrock in the underlying is granite. Following the valley receptacle, the glacier, running down from the left to the right (→), has horizontally scratched these granite rocks (◓ white and → left). However, the rock with its glacigenic flank polishing, set free of the ground moraine, has only been preserved in the form of relatively narrow rock bridges. On the right and left postglacial crumblings have occurred; (□) shows one of the broken-out granite boulders. (◓ black) is a mountain spur, glacigenically abraded up to an altitude of at least 4650 m, at the confluence of the Kilwari Nala (valley) into the main valley. (– –) are the glacier surfaces between c. 5000 (– – left and centre) and 5600 m asl (– – right), reconstructed by means of the local glacigenic roundings and polish cavettos (– – on the right below No.59). The highest one belongs to the LGM. (■ on the right) is the subrecent outer slope of the lateral moraine (Stage X; Tab 1) with (○) granite boulders of 1 to 3 m in length, rounded at the edges and facetted; in front two seated persons with their loads. Photo M.Kuhle, 26.7.2000.

← *Photo 115.* At 3500 m asl from the orographic left side of the Chogolungma valley (35°55′ 40″ N/75°11′ E), from the western margin of the pasture of Khurumal facing WSW, looking on to the 7409 m-high Haramosh (No.53), which bears a thick overlay of firn ice up to its summit. (□) is the surface moraine string of the West Marpho glacier in the junction area with the Chogolungma glacier, the central sheer ice string of which is divided into ice pyramid forms (foreground). (■) are Late Glacial ground moraine remnants on the orographic right flank of the Chogolungma valley; their relatively great resistance and superficial durability is to be diagnosed by its Alpine grass cover, which benefits from the grazing of ibex herds. (△) is a representative mudflow cone, in the centre of which runs a snow-meltwater creek (left of △). The debris cone has been - and continues to be - built-up by displaced ground moraine (■ on the left) and the rock fall debris. The latter derives from crumblings (⇩) and is delivered through ravines. This rock flank, strongly preformed by the structure of the metamorphic bedrock, the layers of which dip steeply to the N (38/05), shows only verifiable glacigenic roundings of abrasion on the edges of the strata (◓). During the LGM the jagged structure of the flat rock crest was overflowed by a glacier ice overlay which was many hundreds of metres thick (– –). Photo M.Kuhle, 26.7.2000.


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← *Photo 117.* 330°-panorama from the confluence of the Kilwari Nala (side-valley) (35°56′03″N/75°10′ 50″E, 3650 m asl) into the Chogolungma main valley, 175 m above the Chogolungma glacier (□ white). Toward the ENE the front of the glacier tongue of the Kilwari Gans (glacier) (□ black) is situated and one looks up the side valley (left margin); down the side valley one views the main valley in a SW direction, looking on to the 6246 m-high Kapaltang Kun (No.61; in the clouds). No.59 is the position of the 6005 (or 5937) m-Peak, No.60 is the Berginsho Church massif (or Sencho; 5820 or 5846 or 5861 m). (■X) marks the orographic right ground moraine of the Kilwari Gans (glacier) of the historical Stage X (Tab 1). From that time until c. 1920, the tributary glacier has permanently reached the main glacier (Chogolungma glacier) - for a short time perhaps even during Stage XI, i.e. 1920-1950. The sharp, narrow glacier tongue end (below □ black) testifies to a further glacier retreat. (○) is one of the rounded polymict boulders on the corresponding orographic right lateral moraine crest of Stage X. (■ on the right) can be approached as the next older lateral moraine, sedimentated into the triangular section formed by the side- and main glacier, and belonging to the historic Stages VII to IX. (■ on the right) is the sampling locality 16.7.2000/1 (Figure 6 No.2; Figure 8). Its heavy trituration classifies the material as being ground moraine, developed under a very thick ice. (■ white) is the corresponding ground moraine beyond this side valley incision. (◓) are glacigenic roundings of abrasion on bedrock of varying resistance and intensity of reshaping since the deglaciation. (– –) are the prehistoric (Late to High Glacial: Stages 0 to IV; Tab 1) glacier levels reconstructed according to the abrasion forms between 5000 m (– – left half of the panorama) and 5300-5600 m (– – right half). Photo M.Kuhle, 16.7.2000.

← *Photo 118.* From the subrecent orographic left lateral moraine (■X) of the Chogolungma glacier (□ below) at 3550 m asl in the area of the pasture of Khurumal, west below the 6005 (or 5937) m-Peak (No.59) (35°55′ 10″ N/75°11′ 30″ E), panorama taken facing NW (left margin), looking up the orographic left lateral valley, toward the E (No.59) into the W-flank of the 6005 m-Peak, toward the SE down the glacier, seen on to the Berginsho Church massif (i.e. Sencho: 5820 or 5846 or 5861 m, No.60) up to the SE into the right main valley flank with the 6246 m-high Kapaltang Kun (No.61) and its 5770 m-high SW satellite peak (No.58). Due to thawing-down, the current glacier surface (□ below) has been lowered by 50 m against the subrecent moraine crest (■X). (■ white, left margin) shows the gullying and development of sand pipes on the 50 to 60°-steep inner slope of the moraine within a maximum of 80 years, which is the pre-stage of earth pyramids. (□ above) is the central Marpho glacier covered by surface moraine, running down from the Kapaltang Kun and reaching the Chogolungma glacier. (▲) marks a debris cone, made up of sharp-edged rock fragments, transported by avalanches, up to 3 m-long boulder fractions; it is situated in the track of the small and steep flank valley above which functions every winter as an avalanche ravine. (▽) are current mudflow cones with down-flowing snow meltwater, adjusted to the lateral valley. At the time of day (16 to 17°°) when this photo was taken, a series of mudflows of older moraine material from higher slope positions (see below) came down on to the right mudflow cone (▽ on the right), raising the spill-over of the lake. (↓ ↓) is the front of the water which, due to this fact, has been dammed-up. Two hours later, the three tents on the sandy gravel floor (○) have been reached by the water of this rapidly growing but only 1.5 m-deep lake. (⇧) is a moraine remnant, undercut by the creek of the lateral valley. According to the geomorphological chronology, this is ground moraine which has been sedimented in the course of the Late Glacial to neoglacial Stages IV (Sirkung Stage) to 'VII (middle Dhaulagiri Stage) (cf.Tab 1). (■ black and white above) mark ground moraine covers in higher slope positions which, accordingly, are of the older Late Glacial Stages III (Dhampu Stage), II (Taglung Stage) and I (Ghasa Stage), with material portions of a reshaped High Glacial ground moraine, i.e. of Stage 0 (LGM). (◓) are glacigenic flank abrasions in the shape of classic glacigenic triangular faces, developed from the back-polished mountain spurs (◓ from below No.60 up to below 58), as well as unambiguous glacier polishings with smooth rock flanks (◥ on the left of No.60). (– –) show the highest prehistoric glacier levels, which can be evidenced glaciogeomorphologically between 5000 (– – on the left of No.59) and 5500-5700 m asl (on the very left and right of No.59). Photo M.Kuhle, 15.7.2000.

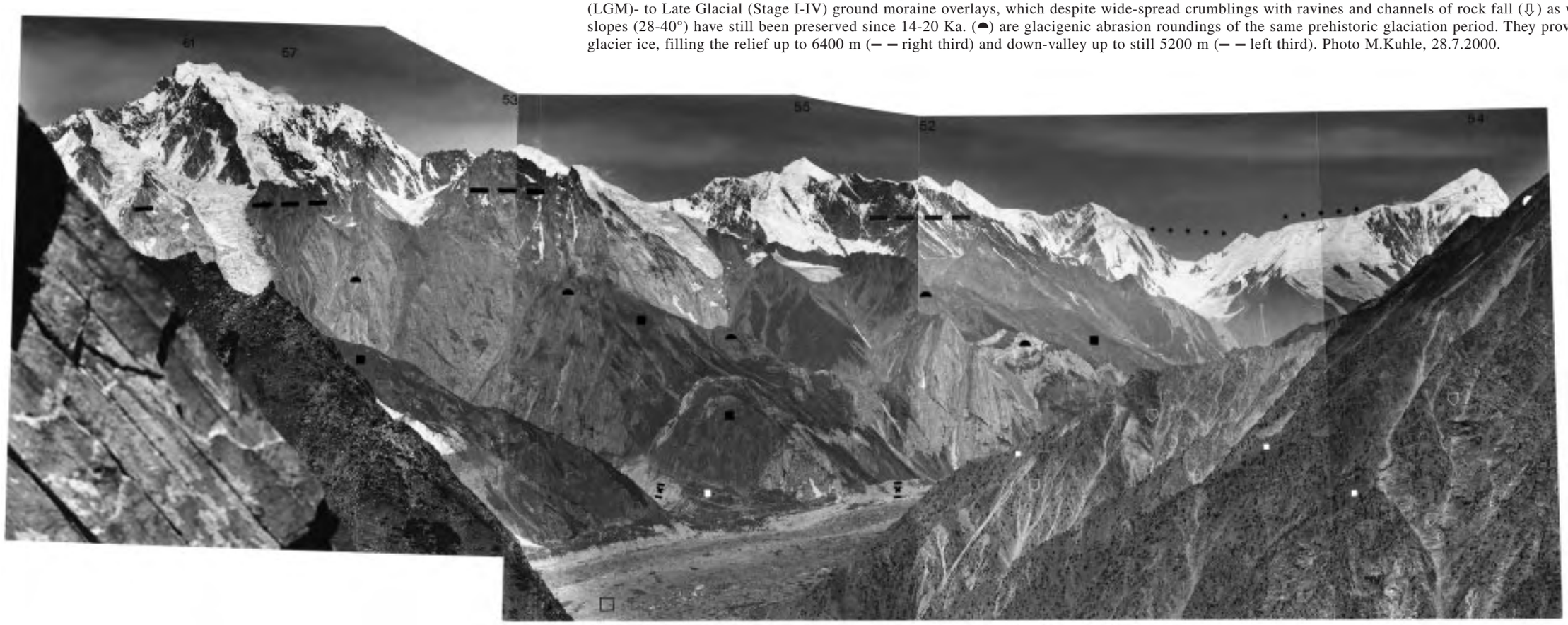
↑ *Photo 119.* At 3470 m asl, in the orographic left flank of the Chogolungma valley (35°53′ 10″ N/75°13′ 17″ E), from 200 m above the current glacier surface, looking up-slope in a N-direction. The following 100 altitude-metres consist of late Late Glacial ground- and lateral moraine (■ black) of the Sirkung Stage IV (see Tab 1). Here, erratic boulders of gneiss and quartzite can be found, fist-sized up to the size of 1.5 m and even 2.2 m at maximum (longitudinal axis) (○ person for scale), facetted and also relatively well-rounded, embedded in a pelitic matrix with a high content of clay (see also Figure 6, sample No.1; Figure 7). Metamorphic sedimentary bedrocks outcrop in the underlying bed. They also form the rocks which have been abraded by the prehistoric glacier ice (◓) above the noticeably over 10 m-thick ground moraine cover (■ black). As far as an altitude of 3700 m asl, a somewhat older, late Late Glacial ground moraine (but still Sirkung Stage IV) (■ white) lies on these rocks at a thickness of 1 to 3 m. (– –) is the highest verifiable glacier level about 5600 m asl, probably belonging to the LGM (Stage 0). Photo M.Kuhle, 14.7.2000.

← *Photo 120.* Up-valley of the pasture of Chohob Langsa at 3185 m asl, from the outer slope of the subrecent moraine of the Chogolungma glacier (35°52′ 10″ N/75°14′ 35″ E), looking into the orographic left valley flank toward the NNW. (■) mark ground- and lateral moraine accumulations of the Sirkung Stage IV (cf. Tab 1), over 100 m-thick at maximum, left behind by the late Late Glacial glacier, which has "smeared" it along and pressed it against the valley flank. Meanwhile, reshapings through incisions of the downflow of water due to sheet floods etc., have occurred on its surface. (▼) is a fresh, still active fault over a distance of 420 m, along which this moraine complex (■) has slid down und continues to do so. It is a downthrow running exactly along the upper edge of this moraine accumulation at c. 690 m above the viewpoint, i.e. at about 3900 m. This process can regularly be observed at places, where - due to the thawing-off of a valley glacier - the abutment of the ice is lacking, so that the moraine material is not supported. Glacigenic abrasions above this fault (above ▼) provide evidence of a minimum prehistoric ice level at 5200 m asl (– –). Photo M.Kuhle, 26.7.2000.

↓ *Photo 121.* Panorama at 3175 m asl from the subrecent (historical Stage X, see Tab.1) orographic left lateral moraine (X) of the Chogolungma glacier, down-valley of the pasture settlement of Chohob Langsa (on the right above X) (35°52′ 05″ N/75°14′ 55″ E). (▽) is the trough-shaped, right tributary valley Niamul (or Niamur) Nala, situated in the SSE (left margin), which at present is no longer glaciated as far down as the Chogolungma glacier. No.61 is the position of the 6246 (or 6222) m-high Kapaltang Kun massif, situated in the W; the orographic left valley flank of the Chogolungma is in the NW (right margin of the panorama). (□) marks the undulating surface of the Chogolungma glacier, nearly completely covered by surface moraine and locally (□ right) torn up by glacier crevasses. (⇩) indicates a marginal ice spalling into the ablation gorge, which has been developed in a radiation- and thermally-intensive SW-exposition between the outer slope of the glacier and the subrecent inner slope of the moraine (X), according to Visser (1935; 1938), discharging meltwater. During Stage X, 180 to 80 years ago, the glacier margin (X) lay c. 20 m below the pasture settlement of Chohob Langsa. Debris cones and alluvial fans (▽) have been accumulated in the lateral valleys behind the lateral moraines of this striking historic glacier position. The core of the lateral moraine of Stage X has been made up of the material of older, also Holocene, glacier stages. This concerned neoglacial advances, connected to ELA-depressions of c. 100 m against today (older Dhaulagiri Stage VI; Tab 1). (■) are obviously older, i.e. Late Glacial deposits of ground moraine on the slopes, in places preserved in a thickness of decametres (e.g. ■ on the very left and the second and third from the right). The highest moraine deposits of this type (■ white) are situated 450-1000 m above the current glacier (□). (▼) is a present-day end moraine, sedimented at the same altitude at the exit of a still-glaciated hanging side valley. There, the almost 3 km-long Palchas-N-glacier is situated. (◓) are glacigenic abrasion features. (– –) indicates the LGM ice level at at least 5100-5500 m asl, extracted locally and differentiated by the glaciogemorphological arrangement of the positions. Photo M.Kuhle, 26.7.2000.

← *Photo 122.* At 3120 m asl, view from the orographic left side of the Chogolungma valley (35°51′ 53″ N/75°16′ 15″ E) toward the SSE into the Sencho Nala (valley) with the Sencho Gans (glacier) (□ on top) and on to the Berginsho massif (No.60) with its 5681 m-high fore-summit, the Sencho. (□ below) marks the Chogolungma glacier with its complete cover of surface moraine - here almost 2000 m below the present-day ELA. The meltwater creek of the Sencho Gans runs in a V-shaped narrow passage (between □ above and ▽ middle), left behind by the steeply hanging, and thus narrow, tongue of the subrecent tributary glacier (□ above). (⇩) is a wall gorge in the process of being built-up, dug out by the avalanches, which break away from the ice balcony (above ⇩). (▽ above) is a kame heaped up against the subrecent Sencho Gans glacier body, which was thicker at that time. (▽ centre) is an active debris cone of dislocated moraine material, which has been transported here through the ravine (diagonally on the right above ▽ middle). (△ below) is a further kame, originally accumulated against the lateral moraine (×) and thus against the Chogolungma glacier of Stage X, which for several decades has become dissected. Today, the dissecting glacier creek of the Sencho Gans is adjusted to the lowered surface of the present-day Chogolungma glacier (□ below). (■) are High- to Late Glacial ground moraine covers on glacigenic abrasion faces in the bedrock. (– –) is a prehistoric glacier level (Late Glacial Stage I) about 5000 m asl, extracted from the completely abraded 4841 m-high mountain, constructed by edges of the strata of sedimentary rock. Photo M.Kuhle, 26.7.2000.

↓ *Photo 123.* Panorama at 4050 m asl from the orographic right flank of the Basna valley in the valley chamber of Arandu (35°50′ 40″ N/75°18′ 40″ E) above the Chogolungma glacier (□), looking up-glacier. No.61 is the 6246 m-high Kapaltang Kun, situated in the W; No.57 the 6321 m-high Kupultung (or Kupulting) Kung, just visible behind it; No.43 is the 7409 m-high Haramosh; No.55 the 6986 m-high Laila Peak and No.52 marks the Malubiting, which, with 7453 m, is the highest summit of the entire mountain group in the WNW; No.54 is the 7027 m-high Spantik in the NW. In the left corner at the bottom of the panorama, sedimentary bedrocks occur in the form of very steeply dipping layers of quartzite. In the section of the lower third of the Chogolungma glacier depicted here, the ice is completely covered with surface moraine. (X) are the subrecent inner slopes of the lateral moraine of Stage X (cf. Tab 1), undercut by the current ice margins. (■ white between X and X) is a series of lateral moraine ramparts, belonging to the historical Stage X. It proves, that c. 180-80 years ago, the orographic right side valley glacier, the Remendok (Rong Kushun or Rong Shun Gans) glacier, which at present has melted back from the confluence c. 1 km, still joined the Chogolungma glacier. (■) are remnants of High (LGM)- to Late Glacial (Stage I-IV) ground moraine overlays, which despite wide-spread crumblings with ravines and channels of rock fall (⇩) as well as very steep slopes (28-40°) have still been preserved since 14-20 Ka. (◓) are glacigenic abrasion roundings of the same prehistoric glaciation period. They provide evidence of a glacier ice, filling the relief up to 6400 m (– – right third) and down-valley up to still 5200 m (– – left third). Photo M.Kuhle, 28.7.2000.



← *Photo 124.* At 3730 m asl from the orographic right flank of the Basna valley above the pasture of Guma (next to ■ below) in the valley chamber of Arandu (35°51′ N/75°18′ 20″ E) facing N across the Chogolungma glacier (□), looking into the orographic left side valley, the Shu u Chen (or Kero) Lungma (ᑌ). Near to its end, the glacier tongue, covered with thick surface moraine (□), has dropped the most - namely up to 100 metres in altitude - against the subrecent upper edge of the lateral moraine (X). (■ large) are the Late Glacial ground- and lateral moraine remnants of Stage IV (Sirkung-Stage, Tab 1), lying 730 m above the glacier surface on both sides of the glacier (□); thus, the buildings and cattle kraals of the pasture of Guma are situated in the corresponding remains of an orographic right, small lateral valley of Stage IV (■ below). The analyses of sample 27.7.00/1 (cf. Figure 6 No.10; Figure 16) and the Photos 125-127 (foreground) describe the moraine material of this locality in detail. In higher slope positions remnants of ground moraines (■) in decreasing thicknesses reach localities at 4500 m asl (■ on the very right), i.e. 1620 m above the valley bottom. They belong to the Stages III to 0 (=LGM). At some places the surface of these remains of ground moraine covers is patterned by flat drainage gullies (■ on the very right). The analyses of sample 28.7.00/1 (Figure 6 No.11; Figure 17) describe the older Late Glacial to High Glacial moraine material (Stage III-0; Tab 1) of the orographic right flank in detail (foreground on the right). The selective rinsing of the ground moraine cover through rills and mudflows since the deglaciation is characteristic and results in iron-forms as typical relic- and alteration debris bodies (■ on top on the left). (⇩) marks the origin of branching gullies of this type, which start at over 5000 m and bundle the meltwaters of fresh snow throughout the summer. (△ black) is a typical mudflow fan at the exit of such a gully, consisting of re-arranged, re-sedimented moraine material. A corresponding erosion rill (↓) has dissected the moraine material of the orographic right valley flank. (△ white) is a mudflow- and alluvial fan at the exit of the Kero Lungma, which has been - and still is - deposited against the tongue end of the Chogolungma glacier. Down to the valley bottom the trough valley flanks of this side valley (ᑌ) are increasingly filled with ground moraine (■ above ᑌ). (◓) are the preserved remnants of glacigenic abrasion, testifying here to a minimum LGM-ice level (– –) at 5200 m asl. Photo M.Kuhle, 28.7.2000.

→ *Photo 125.* From the orographic right flank of the Basna valley at 3630 m asl, from the lateral moraine ledge (IV ■) with the pasture of Guma (35°51′ 05″ N/75°18′ 30″ E) toward the WNW, looking up the lower Chogolungma glacier (□ white). No.61 is the 6222 m-high Kapaltang Kun. (○) are erratic boulders of crystalline schist and granite, the rounded edges of which point to a glacigenic long-distance transport (for scale: the climbing stick is 143 cm-long). Autochthonous, edged gneiss boulders (□ black) of the local slope debris (cf. Photo 123 bedrock on the left, foreground) are mixed into this polymict moraine from the Late Glacial Stage IV. (△) indicate present-day mudflow cones, heaped up in the form of a kames behind the subrecent lateral moraine (x) of Stage X in the orographic left lateral valley of the Chogolungma glacier. They consist of dislocated ground moraine material from the valley flanks (the two ■ on the right). (■ white, on the left) are Late to High Glacial (Stage IV to 0; cf.Tab 1) ground moraine covers of the right valley flank. The preserved glacigenic abrasion roundings and -smoothings (◖) mediate to the highest verifiable glacier levels at 5600 m (– – on the left) and 5300 m asl (– – on the right). (⇩) is a representative wall gorge, which, owing to earlier deglaciation of the valley flank further above, becomes narrower lower down, taking the shape of a funnel and even tapering off in the continuous wall, c. 600-700 m above the present-day glacier. Photo M.Kuhle, 27.7.2000.

→ *Photo 127.* From the pasture of Guma (35°51′ 05″ N/75°18′ 30″ E) from the orographic right flank of the Chogolungma- or Basna valley at 3630 m asl, facing down-valley towards the ENE to the 5563 m-peak (No.64) and E to the c. 6300 m-high massif of the Hikmul Peak (No.63). (□) is the gravel floor of the Basna valley at 2800 m asl in the valley chamber of Gon, up-valley of the mudflow fan (△ white) with the settlement of Bisil. It has been discharged from the hanging Aralter- or Arater trough valley (⊔). The Aralter river is fed by the Aralter Gans (glacier between No.64 and ⊔). (△ black) is an active mudflow cone with an older ground moraine core, buried by the debris of crumblings and dislocated ground moraine material from higher slope positions. (◓) marks a mountain spur, polished back glacigenically, between the side valley inflows of the Aralter- (⊔) and Dungus valley (with the tongue end of the Dungus Gans on the right of ◓) into the Basna main valley. (■) are High- (LGM) to Late Glacial ground- and lateral moraine remnants reaching 4500-4600 m asl at maximum on the valley flanks of this photo segment (■ white). (– –) is the level of the LGM ice stream network at c. 5500 m. (■ IV) indicates the orographic right lateral moraine ledge of the youngest Late Glacial Stage, the Sirkung Stage (see Tab 1), c. 730 m above the main valley bottom. (○) is an erratic granite boulder of 130 cm in length. Photo M.Kuhle, 27.7.2000.

← *Photo 126.* 360°-panorama from the pasture of Guma (35°51′ 05″ N/ 75°18′ 30″ E) from the orographic right flank of the Chogolungma- and Basna valley respectively, at 3630 m asl: from facing W (No.61) with the 6222 m-high Kapaltang Kun, looking up the Chogolungma glacier valley, via ENE down-valley on to the 5563 m-summit (No.64) and E to the c. 6300 m-high massif of the Hikmul Peak (No.63) and in the orographic right flank of the Basna valley in the valley chamber of Arandu with the pasture of Guma (right half of the panorama in the middleground) from ESE via S up to WSW (right margin). (■ IV) and (■ white) is a late Late Glacial lateral moraine series about 730 m above the present-day surface of the Chogolungma glacier (□), which is to be classified as belonging to the Sirkung Stage (IV; cf.Tab 1). (■ black, on the very left and right respectively) marks a further remnant of this lateral moraine generation, the core of which is over 50 m-thick. Polymictic, metres-thick boulders occur at (■ IV), among them are erratic boulders of crystalline schist and granite, rounded at the edges. The walls of the pasture (behind ■ IV in the middleground) are constructed of boulders of this type. (■ white on the right) is the locality of sample 27.7.2000/1 (Figure 6 No.10; Figure 16); halfway between this locality and the bedrocks above(◓), is that of sample 28.7.2000/1 (Figure 6 No.11; Figure 17). The narrow ground moraine ramp there, mediates to the only partly preserved roundings (◓ above, white on the right) on the bedrock quartzite (Photo 123, left corner at the bottom), which, concordant with its steep bedding, breaks away over large parts (⇩ on the right). (▼) is a steep but small side valley with an avalanche- and mudflow track, which in prehistoric times accumulated a kame against the main glacier and its right lateral moraine and today cuts the latter (■ on the very right). Above the present-day surface moraine (□), the orographic left lateral moraine rampart (x) of Stage X (see Tab 1) is situated; mudflow cones- and fans (△), active every summer, are adjusted to it. They emerge from wall gorges (⇩ left) and consist of re-arranged ground moraine (■ diagonally above △). The ground moraine overlays on the valley slopes (■) and the glacigenic abrasion roundings, partly reaching 5600 m asl (◓), provide evidence of early Late Glacial (Stages I and II) glacier levels up to a High Glacial (LGM = Stage 0; Tab 1) glacier level (– –) between 5600 (– – on the left) and 5200 m. (○) is the gravel floor of the Basna valley at 2800 m asl. Photo M.Kuhle, 27.7.2000.

← *Photo 128.* At 4050 m asl from the orographic right flank of the Basna valley in the valley chamber of Arandu (35°50′ 40″ N/ 75°18′ 40″ E) above the Chogolungma glacier, looking towards the N up the Kero Lungma (⊓) to the 6041 m-peak (No.62) of the Balchish group. It makes up the southern catchment area of the Hispar glacier and also feeds the Kero Lungma- and the Hucho Aichori glacier. (■) are ground moraines on the slopes and on the valley bottom (■ below ⊓). Their increasing thickness towards the valley bottom resulted in the development of a 120 m-thick moraine pedestal (■ below ⊓), the trough-like surface of which has been shaped by the glacier ground. The moraine pedestal has been cut by the Holocene fluvial talweg and excavated over large parts. Slope ravines (▼), adjusted to the main talweg, also took part in this process. Finely furrowed erosion exposures show the beginnings of earth pyramids (■ below ⊓). The V-shaped river erosion deep into the ground moraine basement, creates the general geomorphological impression of a V-shaped valley, which, due to the moraine pedestal, subglacially was a real trough valley. Accordingly, the ground moraines on the slopes (the three ■ below) are also only debris cone- or talus-shaped relic features, modelled out of the thick ground moraine by meltwater gullies (▼) with mudflows. (△) is a kame-like alluvial- and mudflow fan, accumulated against the tongue of the Chogolungma glacier. The glacier tongue of the main valley still presses the joining Kero river against the orographic left main valley flank. (◓) are glacigenic abrasions, which are well-preserved up to levels at 4800 m (◓ on the right) or even at 5300 m asl (◓ middle) and mediate to an LGM level of the ice stream network of at least 4800 m (– – on the left) via 5400 m (– – on the right) up to 5600 m (– – background). Photo M.Kuhle, 28.7.2000.

↓ *Photo 129.* Taken from the surface moraine-covered glacier tongue end of the Chogolungma glacier (□ white and black on the left) at 2940 m asl (35°52′ 06″ N/75°19′ E) facing N into the exit of the Kero Lungma (left third of the panorama) via E down the Basna valley with the Hikmul massif (No.63) up to SE into the orographic right main valley flank with the junction of the Tippur Gans (glacier) (□ black on the right). (▲) marks several of the largely edged, and here up to 4 m-long polymict boulders (granite, gneiss, phyllite, i.e. crystalline schist and quartzite) of the 1 to 2 m-thick surface moraine (porters for scale), which have been transported over a maximum distance of 50 to 55 km. (□ white) is the dirty ice, interspersed with internal moraine, in the underlying bed of the surface moraine. (○) marks the summertime meltwater river of the Chogolungma glacier at 8.20 a.m. : c. 150 m^3/sec.. (□ black on the right) is the advancing Tippur glacier, the fresh sander apron of which reaches as far as the Arandu settlement and marginally buries the irrigation fields (△) (cf. Photo 130). (■) are deposits of ground moraines on the slopes; (□V) is a lateral kame accumulated against the orographic left neoglacial margin of the Chogolungma glacier. The remaining (■) are Late Glacial ground moraine remnants. (◓) indicate glacigenic abrasion features and (– –) is the minimum Ice Age glacier level derived from them. Photo M.Kuhle, 13.7.2000.

↑ *Photo 130.* At 2890 m asl from the fields of the Arandu settlement (35°51′ 55″ N/75°20′ 30″ E) looking into the orographic right flank of the Basna valley. The c. 6300 m-high Hikmul Peak (No.63) is situated in an E-direction seen down the main valley; the 5846 (or 5820) m-high summit of the Berginsho Church (No.60) lies in a SSW-direction. Below this mountain, covered with flank ice with large ice balconies and glacier break-offs, the steep-flanked Tippur trough valley is connected (below No.60). Its bottom is occupied by the Tippur Gans (glacier), a good 8 km-long, the tongue end of which (▽) reaches the main valley (Chogolungma- and Basna valley respectively). The Tippur glacier is advancing very fast, so that its front moraine is overthrust by ice (above ▽) and its outer slope, too, is buried by fresh moraine (▽). (○) shows an older, not yet buried section of the outer slope, overgrown with grass and bushes. The fresh debris of the moraine and sander (outwash) apron (▽) on the right and left of this overgrown section of the outer slope of the end moraine (○) has already reached the slope foot and at present is being pushed into and deposited on the artificially terraced grain fields (□) of Arandu. (■) are neoglacial and Late Glacial (■ white on the left) ground moraine remnants. In places, glacigenic flank polishings and abrasion roundings are preserved (◓); however, on a large scale the valley flanks have been roughened by the break-offs (⇩); they took place along the stratification- i.e. banking-joints of the bedrock metamorphites (phyllites), which dip steeply to the N and are very resistant here. (– –) signifies the prehistoric minimum thickness of the ice documented by the glacigenic erosion traces in this valley flank section. Photo M.Kuhle, 29.7.2000.

→ *Photo 132.* From the Basna valley at 4050 m asl towards the ENE up the Aralter valley across the Aralter Gans (glacier) (□) looking on to the 5563 m-peak (No.64) and its catchment area. The surface moraine-covered glacier tongue (□) terminates at 3940 m and proves an orographic snow-line in a W-exposition about 4620 m (5300 m mean altitude of the catchment area minus 3940 m lowest ice margin position = 1360 : 2 = 680 + 3940 = 4620). (3 △ above) are present-day debris cones, accumulated against the orographic left glacier margin, i.e. lateral kames are concerned; (▽ right below) is a prehistoric (neoglacial to historic) kame, which today lacks the abutment by a glacier. (⇓) shows a subglacial meltwater run-off rill, marginally cut into the rock threshold and -step far above the valley ground, which currently - after the thawing of the ice - no longer receives any glacier water, i.e. it has fallen dry. (■) are ground moraine covers on the valley slopes as far as 600 m above the present-day glacier terminal (□) at 4550 m (■ white); this position of the ground moraine at the valley exit, i.e. in the area of the confluence step down to the main valley bottom at 2800 m asl (Photo 127 □) provides evidence of an ice thickness of 1750 m. (◓) are glacigenic flank abrasions on outcropping edges of the strata, which are still preserved 200-300 m higher up. Their concave slope profile lines prove that the glacigenic flank polishing has widened the valley to a trough. (⇩) is a steep wall area, which has been roughened by postglacial crumblings as a result of Holocene to historic undercutting by the glacier. The crumblings are controlled by the bc-clefts of the very steeply inclined metamorphic sedimentary rocks. (– –) indicates the LGM glacier level at 5400 m, which has polished the peak No.64 and its satellites into glacial horns. Photo M.Kuhle, 28.7.2000.

← *Photo 133.* At 4050 m from the Basna (Chogolungma) valley facing NE up to ENE, looking on to the Sokha massif, with the 5979 m-peak (No.67) and the 6066 m-peak (No.68). These mountains belong to the catchment area of the Kushusum Lungpa (Photo 134), the orographic left flank abrasions of which are marked by the three (◓ black below). (– – white) is the readily verifiable minimum ice level of the LGM up to the Late Glacial (Stage 0 to I or II; cf. Tab 1), which runs about 5300 m asl in the Kushusum Lungpa. (◓ above) is a glacigenic flank abrasion form in the orographic right trough wall of the Sokha Nala (valley flank above the current Sokha glacier) reaching up to 5700 m asl. (– – black) is the LGM-level of the ice stream network at c. 5900 m beyond the flank of the 6066 m-peak in the area of the upper Biafo glacier (cf. Photo 65-69), with which the local Chogolungma ice stream network has linked up at a continuous level over the Sokha La. Behind the 5979 m-peak (No.67) lies the 5151 m-high glacier pass, the Hispar La, between Hispar- and Biafo glacier, the Ice Age surface of which has also linked up with the local Chogolungma ice stream centre. (◓ white) are glacigenic flank abrasions at 4200 m asl in the orographic left flank of the Basna valley; (⇩) shows a fresh funnel-shaped crumbling, induced by a backward rill-development. (■ large) are remnants of ground moraine covers with active mudflows in this valley flank between 3850 and 4000 m altitude; (■ small between the two ◓ black on the right at the bottom) is a ground moraine remnant characteristic of a steep relief of this type, in the left trough wall of the Kushusum Lungpa at c. 4900 m. Photo M.Kuhle, 28.7.2000.

← *Photo 131.* Panorama at 2860 m asl from the recent glacier mouth gravel floor (○) of the Tippur glacier (□) on the main valley bottom of the Basna valley (35°52′ N/75°21′ 37″ E) from facing ENE down-valley into the orographic left valley flank (left margin) via S into the right valley flank (centre) as far as W up the main valley and on to the tongue end of the joining Tippur glacier (□). At present, the debris-covered glacier tongue is advancing and its braided meltwater creek is building up the cone sander (○ also fan-shaped gravel floor). (■ black on the right) is prehistoric ground moraine, which the Chogolungma-Tippur glacier has last reshaped during the historical stages (Stages VII-X; see Tab 1). (⇓) is an erosion feature, inset by avalanches and meltwater since the retreat of the glacier. (■ white) are Late Glacial ground moraines in higher slope positions, which can be classified as belonging to the Sirkung Stage (Tab 1, IV). (■ V) show kames, accumulated against the valley glacier edge of the neoglacial Nauri Stage (Tab 1,V). They consist of dislocated ground moraine material from those slope positions (■ white, on the left) and have been dissected since the deglaciation. (△) are debris cones which are sporadically still active. They begin below ravines, which have been developed subglacially, and are made-up of displaced glacial ground moraine material from the higher orographic right slope positions (■ white centre). (◓) mark glacigenic abrasion forms, which, due to its smooth roundings, are to be dated as Late Glacial flank polishings. (– –) is the local minimum glacier level, reconstructed glaciogemorphologically at an altitude of 5200 (– – on the left) and 4700 m (– – on the right). Photo M.Kuhle, 12.7.2000.

→ *Photo 134.* Taken at 2790 m asl from the gravel floor (○) of the Basna valley (35°52′05″N/75°23′30″ E), 1.2 km down-valley of the settlement of Gon in a NNE direction, looking up the Kushusum Lungpa (or Berelter valley). No.65 is the 6102 m-peak of the Balchish group. An alluvial fan (upon which the settlement of Sulphur Spring is situated (above □) has been discharged from this side valley, distally undercut by the Chogolungma meltwater river of the main valley (□). The side valley shows a two-part cross-profile: above, a trough-shaped gorge-profile (⊔), developed by the participation of glacigenic flank abrasion (◓) (according to Kuhle 1982a; 1983a) and below a gorge-like meltwater ravine, cut into the rock ground (⇩); it has been created by subglacial meltwater erosion beneath the Late Glacial Kushusum glacier and presently is still in the process of development - as is confirmed by the fresh crumblings (⇩). (■) are ground moraine deposits of the Late Glacial. (– –) only roughly suggests the Ice Age glacier level, because it ran far higher than is visible in this photo, i.e., at least 2500 m above the main valley bottom (○). Photo M.Kuhle, 29.7.2000.

↓ *Photo 136.* 270°-panorama at 3230 m asl from the orographic right flank of the Basna valley (35°47′ 20″ N/75°22′ 55″ E) above the settlement of Tisa Birri: from facing N up-valley via NE to the Hikmul (No.63, c. 6300 m) and Ganchen (No.66, 6462 m) and via E to SE with the 5046-5778 m-high southern fore-summits (No.50) of the Ganchen massif, via S down-valley with the 5552 or 5610 m-high Munbluk massif (No.51), up to WSW to the 4687 m-high rock ribs of the right valley flank (marginal segment on the right). (□) is the present-day gravel floor with the braided arms of the Basna river at 2560 m asl. (▲ black) shows a fresh debris cone, fed by crumblings, on the undercut rock slope of this river. (▲ white) is the Holocene to historic mudflow- and alluvial debris fan on which the settlement of Bien is situated and which consists of displaced Ice Age ground moraine. (△) are debris cones and -tali, also of dislocated ground moraine, with moraine cores created in situ. (◓) marks glacigenic abrasion forms in the bedrock of the main valley flanks, mediating as far as to the LGM (Stage 0; Tab 1)-glacier level at 4800-5100 m (0 – –). (■ white) are the highest ground moraine deposits about 4100 m asl; (■ white on the right) has been reshaped to a Late Glacial cirque glacier moraine (4000 m asl) and proves a Late Glacial (Stage IV) ELA in E-exposition about 4300 m. (■ IV) are the ground moraines of the simultaneous main valley glacier (Sirkung Stage IV; cf.Tab 1) (cf. Figure 6 No.12, 30.7.2000/1, Figure 18) preserved up to an altitude of c. 3600-3700 m on both valley slopes. (○) mark erratic granite boulders up to 3 m in length. (↓ black and white) are fractures and downthrows of two typical rotation slides in this several decametres-thick Late Glacial ground moraine material, resulting from the absence of an abutment on both valley flanks (cf. Photo 120). (▌) are either striped scouring traces, left behind by the valley glacier on the ground moraine surface, or lateral-moraine-like ledges caused by the gradually thawing-off out of the glacier margin. Photo M. Kuhle, 30.7.2000.

← *Photo 135.* At 2630 m asl, from the orographic right valley slope of the Basna valley (35°48′ 40″ N/75°24′ 27″ E), looking over the settlement of Sesko (△) toward the ENE to the 6462 m-high Ganchen (No.66) and into the orographic left valley flank. No.63 is the c. 6300 m-high Hikmul. (■ white) marks the highest ground moraine deposit, preserved above Sesko at c. 3900 m, which was still glacier-covered during the Late Glacial Stage III (Dhampu Stage III, Tab 1). IV is the youngest Late Glacial ground moraine position of the Sirkung Stage. It reaches up to 3600 m asl, a good 1000 m above the talweg. (⇩) indicates the cutting of the meltwater of the Ganchen SW-glacier (not visible), which exposes the ground moraine (■ black) over a thickness of several hundred metres and, owing to this, is the cause of the development of earth pyramids, as this is usual on steep slopes. The fields of the Sesko settlement (△), too, are situated on an at least 60 m-thick ground moraine complex. Their irrigation is provided by the tapping of the glacier creek. (◓) are the glacigenic flank abrasions of the High- to Late Glacial (LGM = Stage 0-III), which are clearly preserved here up to a height of 4800 m. (– –) is the LGM minimum ice level at c. 5100 m. Currently, the Ganchen W-hanging glacier flows down to c. 4150 m asl, thus providing evidence of an orographic ELA at 5300 m. Photo M.Kuhle, 29.7.2000.

→ *Photo 137.* Taken at 2540 m asl from the confluence of the Mutuntoro Klas (valley), a right side valley, into the Basna valley (35°45′ 50″ N/75°23′ 35″ E) next to the settlement of Niesolo, up the Mutuntoro Klas toward the W. (○) is the present-day gravel bottom of this side valley, which here, in the confluence area, has been spread out to an alluvial fan and adjusted to the gravel floor of the Basna valley. The lateral erosion of the glacier creek, coming down from the Mutuntoro Gans, undercuts active breakage cones as well (△). The orographic left flank of the side valley, reaching up to the 4687 m-rock rib (see Photo 136 and 139 background, left margin), is covered with ground moraine as far as c. 4000 m (■ white). The valley ground shows a characteristic ground moraine pedestal (■ black). The dark, approximately horizontal stripes of vegetation on the slope (between ■ black and white) run along irrigation channels, which lead to the fields of Niesolo. (◓) is a roche moutonnée, mantled by moraine. (– –) indicates the minimum height of the Ice glacier level, reconstructed local-geomorphologically. Photo M.Kuhle, 31.7.2000.

↑ *Photo 139.* From the valley bottom at the beginning of the Shigar valley, i.e. at the junction of the Basna- (on the left) and Braldu (on the right) valley (35°39′ 45″ N/75°28′ 40″ E; 2390 m asl) facing N, looking on to the 5046-5778 m-high southern fore-summits (No.50) of the Ganchen massif. A high-lying valley, filled with an existing glacier a good 4 km in length, leads down from this massif (▽) into the Braldu valley. From these fore-summits, the mountain ridge stretches down to the S between the two joining valleys as an intermediate mountain ridge. It has been glacigenically polished and rounded (◓) - as well as the flanks of the two valleys - and is partly covered with ground moraine (■). The mountain ridge consists of granite; its surface shows separate, several decametres-high forms of roches moutonnées (◓ on the left below No.50). Especially the lower Braldu valley presents a typically glacigenic trough cross-profile (on the right of ▽). Its orographic right, concavely polished abrasion flank is cut by a gorge (on the right below ▽). (○) are boulders of up to several metres in length, which, due to its edged forms and kilometres-distance from the valley flanks, could be classified as Late Glacial rock avalanche moraine; according to Hewitt (1999:230-233) they might be classified as belonging to the north-westernmost of the Ghoro Choh I-III rock avalanches. In parts these boulders are covered by a several decimetres-thick overlay of wind-blown quartz sand (with wind ripple marks: foreground). (– –) are the LGM-levels of the ice stream network up to 4700 m (– – on the left; cf. Photo 136) and 4900 m (– – on the right; cf. Figure 3) established by the abrasion forms. Photo M.Kuhle, 31.7.2000.

← *Photo 138.* Panorama from the orographic right side of the lower Basna valley (35°41′ 30″ N/75°25′ 40″ E) taken at 2380 m asl from facing NW up-valley (left margin) via NE into the left valley flank with the settlement of Thurgu (△ middle of the panorama) up to SW down-valley (right margin). The Basna river carries summer high-water; only some gravel banks still become dry in the morning (○). (■) are ground moraine deposits on the slopes, partly reaching as far as the mountain ridges; (■ black) are decametres-thick moraine deposits in a removal-exposed slope position, so that backward erosion of the slope rills opens-up the moraine and prepares the development of earth pyramids. The valley flanks and mountain ridges have been rounded glacigenically up to their culminations (◓). Accordingly, the High- (LGM = Stage 0) to Late Glacial (probably Stages I to II or even III; Tab 1) levels of the ice stream network are bound to have towered above the relief (– –). (– – on the right) runs at c. 4350 m, c. 2000 m above the valley floor. The Photos 99 and 139 (on both pictures – – on the left of No.50) show the same mountain ridge and the same ice level reconstruction from a different perspective. (▽ white on the left) is an active mudflow cone of dislocated moraine material, (▽ black) is an active detrital talus with a moraine core and a mantling of broken-off rock as well as moraine material, which has been removed down-slope. (△ white on the right) marks a complex of ground- and lateral moraine, on the surface of which a mudflow fan has been piled up, deriving from dislocated ground moraine material from higher slope positions. Photo M.Kuhle, 12.7.2000.

↑ *Photo 140.* From the surface of a mudflow fan (△) accumulated through the Shigar river on the orographic left of the Shigar valley bottom, facing NE looking into the left flank of this extended, here over 4 km-wide main valley as far as the 6251 m (6400 m)-high Koser Gunge (No.47). The viewpoint is at a height of 2425 m at 35°35′ 45″ N/75°34′ 07″ E. (◓) is a mountain spur, the High- to Late Glacial rock polishings of which are devoid of the ground moraine cover which, diagonally above at the flatter upper slope, has still been preserved (■ on the right). The facette of the valley flank concerned shows the characteristics of a classic, glacially triangular-shaped slope. The steep side valley is also mantled with ground moraine up to its upper reaches (■ on the left); the ground moraine cover is undercut by the talweg and accordingly slips down (▼). At the head of the side valley ground moraine can even be observed up to a height of 4400-4600 m (■ centre). It has been - and still is - re-deposited by Late Glacial and Holocene periglacial and nival morphodynamics (solifluction). Below the steep rock walls it is overlain by crumblings (⇩). The polymictic composition of the boulders of the ground moraine can be recognized with the help of the mudflow fan (△) made up of ground moraine displaced from this side valley. The metres-sized boulders, which are rounded at the edges and partly facetted, consist of metamorphic sedimentary rock (○ white) as well as far-travelled erratic granites (○ black). Because of its tixotrophic characteristics, the clayey fine matrix especially supports the forward movement of the mudflow. (– –) is the upper limit of the glacigenic flank abrasion verifying the LGM-glacier level. Photo M.Kuhle, 16.8.1997.

→ *Photo 142*. From the bottom of the Shigar valley in the area of the Shigar settlement (2300 m asl; 35°25′ 13″ N/75°44′ 25″ E) facing ENE looking up the Baumaharet Lungpa (valley). This orographic left side valley leads down from the 6288 m-high Mango Gusor-massif (No.44; see Fig.2/1) - the c. 5500 m-high E-satellites of which are visible here - towards the WSW into the Shigar valley. The ice areas (below No.44) belong to the tongue of a c. 3 km-long hanging glacier, a SE parallel-glacier of the Bonla Lung glacier, which also discharges through the Baumaharet Lungpa. (■) are remnants of ground moraine which have only partly remained on the very steep valley flanks in the shape of a "gorge-like trough" (cf. Kuhle 1982a; 1983a). Due to the stability of the ground moraine on the one hand and its specific susceptibility to snow melting and rain on the other hand, earth pyramids have been developed here (■ on the right). Part of them is marked by a large boulder on the top, which has the effect of a protection against flushing. The valley flanks are developed in outcropping edges of more or less metamorphic sedimentary rocks (phyllites to gneisses); at many places, along wall gorges (⇩), they have crumbled away since deglaciation. The glacigenic flank abrasions (◜) reach up to a relatively clearly preserved Ice Age polish line at c. 3900 m (– –). This orographic left flank of the Baumaharet Lungpa is at the same time the NNW-face of the 5609 m-high Shinkar (No.73, see Fig.2/1), so that the upper 1700 m of this extended steep flank have been extremely roughened by the denudation of ice- (mainly in the LGM to Late Glacial) and snow avalanches as well as rock fall, but also by the discharge of meltwater. The present-day gravel floor of the mudflow fan shows polymictic, rounded boulders of sedimentary rocks (○); but quartzite- and granite boulders (○ white) are also contained. (△) is the surface of the mudflow fan which has not yet been washed by the creek of the side valley. There are fields, apricot trees and poplars on it. Photo M.Kuhle, 5.10.1997.

← *Photo 141.* 300°-panorama taken from the orographic left side of the Shigar valley (2350 m asl; 35°32′ 12″ N/75°07′ 10″ E) from the mudflow fan (▽ large) W of the Alchori settlement: from facing SE (left margin of the panorama) looking down-valley towards the Skardu Basin, via SW into the orographic right Shigar valley flank with the irrigation oases (settlements) Chundupon and Chanchupa (▽ white), the 5691 (or 5770)m-massif (No.72) and the c. 5610 (5552) m-high Mundbluk (No.51) as well as up the Basna valley to the 5820 m-high Berginsho Church (No.60). No.50 marks the southern pre-summits of the Ganchen massif about 5046-5778 m, seen looking up the Shigar valley along the orographic left flank which runs towards the NW. No.72 marks the 5242 m-peak. (○ black) are granite boulders and (○ white) boulders of sedimentary rock, which derive from re-deposited ground moraine material (■ on the very right) from the orographic left flank and have been re-sedimentated in the mudflow fan (▽ large). (□) indicates the present- day, up to 2.4 km-broad gravel bed of the Shigar river, which the glacier meltwater has accumulated in the form of a glacigenic gravel floor. (▽) are alluvial- and mudflow fans from the steep tributary valleys, heaped up on the flat bottom of the main valley and undercut by the Shigar river on the outer banks. (▲) marks a mudflow fan with a large part of dislocated ground moraine. (⇩) are sub- to postglacial V-shaped stretches incised by linear erosion of the meltwater below the trough-shaped high valley sections (⊔). (■) show High- (LGM) to Late Glacial (Stages I-IV; Tab.1) ground moraine deposits reaching up to 3000-3800 m on the orographic right flank of the Shigar valley, i.e. they lie 600-1500 m above the valley bottom (■ white between below No.74 and the right margin of the panorama). The highest ground moraine deposit is situated on a hanging valley bottom at 4600 m asl (■ on the right of ⊔). (■ black between No.74 and 51) are three remnants of a pedestal moraine which correspond with each other as to their levels at 180-200 m above the valley bottom. (◓) are glacigenic abrasion forms, which at an upper polish line break off locally and verify a prehistoric level of the glacier surface (– –) at c. 4800 m (– – on the left of No.50), 4700 m (– – on the right of No.51) and between c. 3200 and 3500 m asl (– – on the left of No.74). (↓) indicates the substantial linear erosion in the form of gullies and wall gorges on the glacially smoothed slopes of the orographic right main valley flank since the Late Glacial deglaciation. Photo M.Kuhle, 16.8.1997.

← *Photo 143.* Panorama taken from the orographic left side of the Shigar valley, 9 km above its inflow into the Skardu Basin, i.e. Indus valley, on the outer bank 40 m above the Shigar river (2240 m asl, 35°22′ 15″ N/75°44′ 20″ E): from facing WSW (left margin; in the background the Skardu Basin with the cirque glaciers of the NW-satellites of the 5343 m-peak: Fig.2/1 No.76) via NW to the bend of the right flank of the Shigar valley (centre) and via NNW up-valley to the c. 6400 (or 6251) m-high Koser Gunge (No.47; see Fig.2/1) as far as NE (right margin). The summertime snow-melt has exceeded its climax, so that the gravel banks of the glaciofluvial gravel floor already fall dry (□). (△) mark mudflow cones containing large portions of re-deposited ground moraine, but also fresh debris of postglacial crumblings (▼). (■) are ground moraine remnants reaching up to an altitude of 3400 m on the right flank of the Shigar valley (■ on the right of ▼); they are situated at the exits of the tributary valleys Baumaharet Lungpa (first ■ from the right) and Skoro Lungpa (second ■ from the right) up to heights of 3700-3800 m. In some places the ground moraines (■) are recognizable by soft rill forms. (◓) are glacigenic abrasions and rock polishings partly roughened or interrupted by crumblings (▼). They demonstrate the prehistoric, i.e. LGM- to Late Glacial glacier levels between 4600-4700 m (– – on the right below No.47) and about 3500 m asl (the rest of the – – and 0 – –). (◥ white, middle) is a polished rock spur with ground moraine at a height between 3040 and 3160 m (■ above ◥ white, middle). Photo 141 shows the same spur seen looking up-valley (Photo 141 third ◤ from the left). Photo M.Kuhle, 16.8.1997.

↑ *Photo 144.* Looking across the small, i.e. relatively only 110 m-high saddle between the left Shigar valley flank and the Indus valley (Skardu Basin) (2310 m asl; 35°21′ 20″ N/75°45′ E) from facing NW (left margin) as far as NNE into the left flank of the Shigar valley (right margin). No.47 marks the outline of the c. 6400 (or 6251) m-high Koser Gunge (see Fig.2/1) seen looking up the Shigar valley. The saddle is at least in part filled up with loose rocks (□), i.e. gravels of washed moraine with a centimetres-thick, loess-like eolian cover. At the base of the aligned roches moutonnées in phyllite bedrocks (◓ white), ground moraine has been preserved on the surface (■ centre); the polymictic, partly (○ black) erratic boulders (○) are part of it. The dark phyllite boulders (○ white) are local moraine boulders which are less far-travelled. The bedrock of which they consist is not far away. The especially large, 3-5 m-long erratic granite boulders (e.g. ○ black) may still be recognized as rounded, but they show already tafoni-like cavities and traces of weathering. (■ I-IV) are decametres-thick ground- to orographic left lateral moraines at 2600 m asl, c. 400 m above the Shigar river, which also contain light, erratic granite boulders. The surfaces of these rounded or facetted boulders are not weathered, because they are devoid of moraine matrix and relatively short. (▽) indicates the outer slope of the lateral moraine which dips toward the lateral depression. (◓ on the right of ▽) marks glacigenic flank abrasions situated above, classifying this lateral moraine (■ I-IV) as belonging to the Late Glacial (Stage I-IV). (■ on the left) are moraine accumulations on a glacigenically polished (◥ on the very left) rock pillar on the orographic right side of the Shigar valley (cf. Photo 143 ■ on the left below No.47). The overflow of the glacier - which for the last time was effective abrading the three roche-moutonnée-like rock hills (◓ white and black, centre) - took place out of the Shigar valley. This is verifiable by the steep luff- and flat lee sides of the roches moutonnées (on the right of ◓ white and black middle). (– –) is the prehistoric minimum ice level at c. 3400 m asl evidenced by a polish line. Photo M.Kuhle, 5.10.1997.

← *Photo 145.* Taken in the area of the same Ice Age transfluence pass as in Photo 144, but 1.5 km further south (2320 m asl; 35°20′ 30″ N/75°45′ 10″ E), from facing SW (left margin) via SSW (No.76 = 5343 m-peak on the SW edge of the Skardu Basin, Indus valley) and W (middle) as far as NW (right margin). Sedimentary rocks outcrop in the foreground, which have been glacigenically abraded into the Late Glacial and in the meantime roughened by postglacial frost weathering on its surface. (○) is the route of a mule track laid out in the rock. (◓) are glacigenically abraded mountain ridges and "riegels" (barrier mountains) in sedimentary bedrocks with mountain polishings (second to fourth ◓ from the left) or even a roche-moutonnée-like glacigenic rounding of the total form (◓ on the very left and right). (■) are deposits of ground moraines overlying the abraded rock ridges as only sporadic "veils" or in a thickness of metres to decametres. (↓) are exemplarily marked, large erratic granite boulders up to the size of a hut, which are rounded at the edges, facetted and partly even more strongly rounded. (■ black above ↓) is a ground moraine tail on the lee-side of the large roche moutonnée (◓ on the very right), towering up to 2925 m asl, i.e. relatively about 630 m above the bottom of this small valley (□). (– –) is the Ice Age level of the glacier surface interpolated from the arrangement of the positions of the polish lines on the flanks of the junction area of the Shigar- and Indus valley; it has run here about 3400 m asl. (◁) are flat, small special alluvial fans of outwashed moraine material. (□) marks a postglacial to historic gravel floor built up of outwashed moraine material and covered by a "veil" of wind-blown sand. (◓ and ■ below No.76) is the "riegel" (barrier mountain), situated further E in the centre of the Skardu basin, NE of the settlement of Skardu, which attains a height of c. 730 m above the Indus level. It has been abraded and covered by ground moraine. Photo M.Kuhle, 31.7.2000.

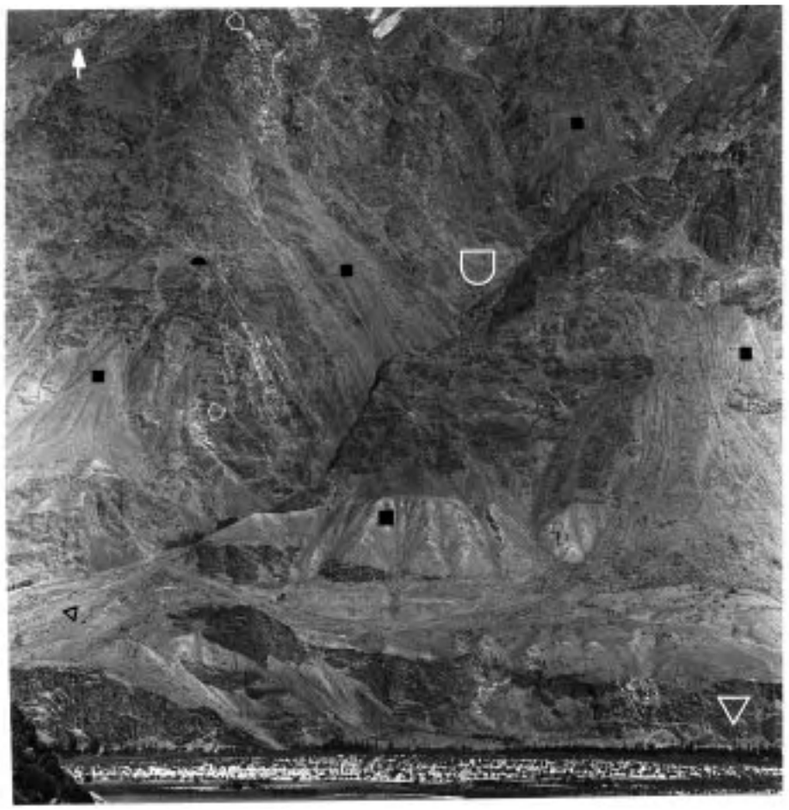
↑ *Photo 146.* Panorama from the NE-margin of the Basin of Skardu, i.e. from the orographic right flank of the Indus valley, on the SSE-slope of the prehistoric transfluence pass, forming a link between the orographic left flank of the Shigar valley and the Indus valley (2260 m asl; 35°20′ N/75°45′ 10″ E), looking across the bottom (□) of the Indus valley: from facing SSW (left margin) via W, with the glaciated summits of the 5322 m-peak (No.75) and the 5343 m-peak (No.76) as far as WNW (right margin) with a polished rock ridge of the transfluence pass (◓ on the very right) consisting of phyllites. As far as into the foreground - interrupted by islands of outcropping rock - lies ground moraine on the rocks of the transfluence pass, the strata edges of which have been abraded (■ on the right below). Erratic granite boulders up to several metres-long, are embedded (○ black) in this ground moraine cover. Here, the Indus (below △) is cut only several metres-deep into the valley bottom, accumulated in a width of c. 2 km (□). The c. 260 m-high rock cone situated in the confluence area, has been sharpened like a dorsal fin by the merging Shigar- and Indus glacier ice (second ◓ from the right). Photo 145 (◔ white on the left below No.76) shows this rock cone seen from the SE (from the Shigar valley). (■ black on the right) is a ground moraine remnant preserved at the base of the rock cone. (◓ black) is the eastern central, 730 m-high "riegel" (barrier mountain) of the Skardu Basin; (■ black below No.76) is ground moraine on the western central "riegel" of the Skardu Basin; (■ black on the right below No.75) are thick moraine covers on the orographic left flank of the Indus valley in the area of the Skardu Basin. (■ white on the left) shows a ground moraine remnant in the left flank of the Indus valley which has been heavily roughened by crumblings since deglaciation; (⇩) is a rock wall in the granite bedrock, broken away as far as high up. (△) mark debris cones and -fans containing redeposited moraine but also coarse detritus deriving from those crumblings; (△ black) probably contains a primarily deposited moraine core. (○ white) are High- to Late Glacial cirques of the Stages 0 (= LGM) to IV; the cirque bottoms lie at 3400-4000 m asl in a N-exposition. (– – black) is the LGM-glacier level about 3400 m reconstructed by means of the polish lines. Photo M.Kuhle, 16.8.1997.

→ *Photo 147.* Panorama from the orographic left bank of the Indus, here formed as an outer slope (2180 m asl; 35°17′10″ N/75°40′01″ E) taken from the margin of the Skardu settlement looking across the upper section of the Skardu Basin: from facing N (left margin) into the right flank of the Indus valley, via NE to the 5609 (or 5660) m-high Shinkar (No.73) up to E (left margin) with the orographic left flank of the Indus valley. (□) is the gravel bed of the Indus which during high water, i.e. during the snow melting period in spring, is flooded. This gravel body is still regularly thoroughly mixed. The already fixed high water bed can be diagnosed by the trees and sparse woodland population (e.g. on the left of the left □). (●) are 20 m-thick limnic sediments, deposited into a prehistoric dammed lake in the Skardu Basin. (◓ white, left) is a ″ riegel″ (barrier mountain) rising c. 730 m above the gravel floor of the Indus, which is absolutely 2882 m-high (cf. Photo 145 and 146). It consists of crystalline schists (phyllites) and has been overflowed by the Ice Age Indus glacier (– – bold on the left = local LGM to Late Glacial minimum ice level) . This is evidenced by its locally preserved glacial roundings (◓ white on the left). (⇩) is a postglacial wall gorge, developed by crumblings since the deglaciation. Its continuing process of development is shown by the fresh debris cone (▲) on the valley bottom, accumulated a few metres above the current Indus level (□) during the Holocene as long as into historic time. The "riegel" is covered by a ground moraine overlay reaching a maximum thickness of decametres (first and second ■ from the left) which contains erratic granite boulders (see Photo 148). (◓ white, on the right) is a c. 260 m-high (absolutely 2470 m) "riegel", overridden by the Ice Age glacier, situated in the area of the inflow of the Shigar valley (cf. Photo 145 and 146, second white ◓ from the right). (◓ black) shows the highest, strikingly well-preserved glacigenic flank polishings, reaching over small expanses a height of 2900 m. Separate ground moraine remnants can be observed at 3300 m (e.g. ↑). (The third ■ from the left to ■ on the very right) are further exemplary deposits of ground moraine. The maximum ice level reconstructed with the help of ground moraine remnants, triangular-shaped glacigenic abrasion slopes and rounded rock heads and -ridges ran between 3700 and 3400 m asl (– – fine from the left to the right below No.73). (0 – –) indicates the LGM ice level of a small local ice cap which simultaneously lay on this 4200-4600 m-high old plateau remnant (small plateau-like flattening). (▽ white) is a mudflow- and alluvial fan and (◁ black) a debris cone of dislocated moraine material and crumblings. (○) marks a cirque floor at 4500 m in a SW- exposition, which in the shape of a tube-cirque (Maull 1958) reaches down to 3400 m asl (not visible here). The couloirs of the back wall of the cirque filled with firn ice extend from (○) up to a height of 5100 m. Photo M.Kuhle, 15.8.1997.

← *Photo 148.* Looking from the Indus valley bottom in the Skardu Basin (2180 m asl; 35°17′12″ N/75°39′59″ E) towards the NNE to the W-face of the eastern-most of the two central "riegels" (barrier mountains) (cf. Photo 147 and 149). (⇩) are the metamorphic sedimentary bedrocks (phyllites) which break away under the control of the clefts, i.e. along ac- and bc-joints, and develop a talus (△) with coarse boulders on the surface. In their basal positions remnants of a ground moraine cover are probable. (○) is wind-blown sand, drifted up to the coarse-blocky debris which has slid and rolled down from the slope. The sand (○) has been blown out from the gravel floor of the high water bed of the Indus (□). (■) are accumulations of ground moraine deposited as far as a height of 3300 m on the orographic right flank of the Indus valley (■ on the left) and in a decametres-thickness at heights between 2640 and 2850 m asl on the "riegel" (■ on the right). (↓) mark erratic granite boulders up to the size of a hut, embedded in this ground moraine. The moraines are situated 1140 m (■ on the left) and c. 480-690 m (■ on the right) above the present-day valley bottom (□). (– –) is the LGM glacier surface at c. 3500 m asl, reconstructed according to the arrangement of the position to adjacent indicators of glacier levels. Photo M.Kuhle, 15.8.1997.

→ *Photo 149.* From the 2280 m-high SE-spur of Karpochi, the western 2698 m-high riegel (barrier mountain) of the two central riegels of the Skardu Basin from above the small fortress (in the foreground on the right) (35°18′ 10″ N/75°38′ 30″ E) looking from facing NW (left margin) to the ESE flank of the riegel, via N to the 5242 m-peak (No.74) via the orographic right Indus valley flank and via ENE to the 5609 (or 5660) m-high Shinkar (No.73) up to E, upwards of the Indus into its orographic left flank (right margin). (□) is the high water bed of the Indus situated 120 m below the viewpoint. (◓) are relatively well-preserved glacigenic rock abrasions splintered-off by weathering since the deglaciation c. 15,000 YBP ago. (The two ◓ in the foreground on the left) are glacier polishings in very resistent metamorphic sedimentary rock (phyllite), which despite a heavy jointing and - owing to black ferromanganese incrustation - an especially intensive destruction by insolation are unambiguously preserved. There are ground moraines with erratic granite boulders (see Photo 146 ■ below No.76; Photo 150) on the left side of the polished rock shoulder (◥ white). (■ black) is a ground moraine core, the surface of which has been buried by moraine material flushed-out secondarily from the riegel. (■ white) are ground moraine overlays in a metres- to decametres thickness; the two on the right (■ white) contain erratic granite boulders superimposed upon the phyllite bedrocks of the central eastern "riegel" (barrier mountain) in the Skardu Basin (see Photo 148). (▽) marks a fresh talus of rock crumblings of the phyllites outcropping under the ground moraine. (– –) is the LGM-glacier surface at 3450 m (– – on the very left), at 3500 m (– – fine, on the left and bold, centre) and at 3700 m asl (– – fine, on the right) reconstructed according to ground moraines and glacigenic abrasion lines. It lay 1290 m, 1280 m and 1470 m above today's level of the Indus valley bottom. Photo M.Kuhle, 15.8.1997.

→ *Photo 150.* Viewpoint situated only 500 m further E than that of Photo 149 (35°18′ 10″ N/75°38′ 30″ E, 2230 m asl) facing WNW looking to the Karpochi, the western "riegel" (barrier mountain) in the Skardu Basin; on the left the wall of the small fortress (cf. Photo 149 on the right). (◓) are glacigenic polishings, preserved as unambiguously identifiable prehistorically abraded rock parts. (■) is the metres- to decametres-thick ground moraine (cf. Photo 146 ■ below No.76 seen from afar) with erratic granite boulders up to the size of a hut (↓) which overlies the outcropping phyllite rocks at c. 2400-2600 m asl, i.e. 240-440 m above the Indus valley bottom. Photo M.Kuhle, 31.7.2000.



← *Photo 151.* At 2200 m asl, seen from the middle of the Skardu Basin facing N into the orographic right flank of the Indus valley (◓: 35°22′ N/75°38′ E). (⊍) is a 6 km-long side valley, the Marshakala Lungma (Photo 149 below No.74), leading down from the 5153 m-high Marshakala, an ESE tributary summit of the 5242 m-peak (Photo 149 No.74), to 2160 m. Despite its steepness the valley has been widened to a trough and glacigenically polished. The Indus and its in part thinly wooded gravel floor (□) is at 2160 m asl. Its outer bank has undercut the phyllite rocks of the valley flank (▽ white). The outcropping and very resistent metamorphic rocks are glacigenically abraded (◓) over the entire flank area depicted in this photo. (⇩) are small-scale damage to these polishings caused by postglacial to recent crumblings; the youngest crumblings can be diagnosed by its lighter colour (the ferromanganese incrustation is lacking). This applies also to the fresh tracks of the falls below (below ⇩). (■) are remnants of ground moraine on the slopes of the main- and side valleys. Since deglaciation they have been partly furrowed and partly removed (e.g. on the right and left of ■ on the very left). Here, a classic transitional glacial debris accumulation after Iturrizaga 1998, 1999 is concerned. (↑) is a highest remnant of ground moraine at 3430 m asl, 1270 m above the valley bottom. (▽ black) is ground moraine material, surficially displaced and buried by mudflow activities at the exit of the Marshkala Lungma (⊍). Photo M.Kuhle, 15.8.1997.

→ *Photo 152.* Looking from the bottom of the Indus valley, from the SE margin of the settlement of Skardu, into the orographic left slopes facing SE (2230 m asl; 35°16′ 50″ N/75°39′ 30″ E). (■) are remnants of ground moraine preserved in niches on the upper slope as far as a height of 3350 m (■ somewhat below – – and on the very right), reaching significant thicknesses of over 100 m (■ large) on the middle- and lower slope, c. 200-500 m above the valley bottom. (– –) is the LGM glacier level about 3400 m asl, identifiable according to a polish band (◓) with an upper abrasion limit, which truncates the granite bedrock. (■ on the left below) is a ground moraine accumulation mediating with a trough-shaped profile line between the valley ground and the valley flank. At the exit of steep single-ended, i.e. flank valleys it has been selectively dissected and removed by rill rinsing and linear erosion (▼). According to the cirque-like form (○) situated in a NE-exposition below the 4969 m-peak, a N-satellite of the 5321 m-peak (No.77; Fig.2/1; not visible in this photo, but in Photo 153), a prehistoric cirque glacier has to be suggested. After the LGM-glacier level had dropped, the tongue of this cirque glacier, which previously flowed into the Indus glacier, has pushed the ground moraine cover of the main glacier down-slope. Thus, the former ground moraine has been pushed as a pedestal moraine of the cirque- and hanging glacier against the lowered margin of the main glacier (■ large). Owing to this, a classic ground moraine ramp (▽) is concerned (Kuhle 1982a p 84; 1983a p 238), pressed into the gap between valley flank and main glacier which had been widened by the melting-down, so that the locally very important thickness of the ground moraine (see above) becomes understandable (■ large). (▽) is the flat ground moraine ramp on which the hanging glacier was situated. (□) are irrigated fields between which grow walnut- and apricot trees but also willows and poplars. Photo M.Kuhle, 15.8.1997.

↑ *Photo 153.* Panorama from the Karpochi, the western 2698 m-high "riegel" (barrier mountain) (right margin) of the two central "riegels" of the Skardu Basin, taken from the small fortress at 2270 m asl (35°18′ 10″ N/75°38′ 30″ E): from facing SSE with the massif of the 5321 m-peak (No.77) via the massif of the 5339 m-peak (No.78) towards the SSW, with the massif of the 5322 m-peak (No.75) and the 5343 m-high Garsinge (No.76) in the WSW up to W with the 5204 m-high Phara (No.79) looking into the orographic left flank of the Indus valley (cf. Photo 146 No.75 and 76). (■ below No.77) are remnants of ground moraine in the orographic right flank of the Satpare Lungma leading down from the Deosai plateau, above the Satpara (or Satpura) Tsho (lake). (■ from below No.78 up to the right margin) are ground moraine covers, attaining maximum heights of c. 3400 m (■ below No.76), i.e. they lie as far as c. 1300 m above the Indus valley bottom. Four types of ground moraine accumulations have to be differentiated: 1. the flat covers reaching up the highest (■ on the right below No.78 and No.76), which partly are heaped up by a thinly scattered debris of crumblings; 2. ramps as parts of a trough profile in the transition from the lower slope to the valley bottom (■ below No.75 and on the very right). Owing to their dissection they are only preserved in remnants; 3. the up to 600 m-high, decametres- to far over 100 m-thick accumulations of ground moraine, marginally dispersed into rills and earth pyramids, which lie at the exit of the 'Biansah Lungma' (valley in which the settlement of Biansah is situated) (■ on the left below ◓ below No.75) and finally 4. the up to 400 m-high and at least 300 m-thick ground moraine ramps (■ white) on which the settlement of Tindschus is situated with its irrigation fields at the exits of the three steep valleys leading down from the over 5300 m-high, still glaciated mountains (No.75 and 76). (△) are polygenetic fan features mainly built up of mudflow- and alluvial debris which for a large part consists of displaced High-(LGM)- to Late Glacial moraine material (Stage 0-IV). They overlie the bottom of the entire Skardu Basin as far as the Indus and are largely covered by wood- and bushland but also by irrigated areas with fields and fruit-trees. The fans, coming down from steep valleys, are connected with the talweg dissecting the moraines. The irrigation channels are also linked with the valley exits (e.g. below No.75 between ■ and △). (□) is a postglacial accumulation of rock avalanche from the orographic right flank of the Satpare Lungma, damming up the Satpara Tsho (lake) (cf. Hewitt 1999:222 and 230 Fig.7). (⇩) are break-out scars developed by quite important postglacial crumblings, which according to their dimensions have to be classified as rock avalanches; (▼) mark active tali made up of the fine debris of the crumblings from those break-out scars. (◓) are glacigenic flank abrasions, the roundings of which contrast with the crumbling edges and rough faces of the break-out scars (⇩). They reach up to 3400 m asl, so that this ought to have been the LGM-glacier surface (– –). (○) are cirques, which still today show snow fields or glaciers. The cirques and cirque glaciers of the 5204 m-high Phara (No.79) situated in a NE-exposition (○ below No.79) are evidence of a current orographic ELA at 4800 m asl. Photo M.Kuhle, 15.8.1997.

→ *Photo 154.* Panorama from the orographic left side of the Indus valley, taken in the lower area, i.e. at the NW-exit of the Skardu Basin (2160 m asl; 35°40′ 45″ N/75°27′ 30″ E) looking up the Indus: from facing SE (left margin) with the orographic right flank of the Indus valley, via SSE (centre) with the left valley flank, up to S (right margin) seen into an orographic left tributary valley, which drains the northern foothills of the 5204 m-high Pahra massif. (□) is a gravel bank in the Indus river bed; (○) are limnic sediments the accumulation of which is due to the damming-up of the Indus to a lake. This damming-up was caused by a rock avalanche described by Hewitt (1999, p 223-228, Fig.4-6) as "Kazarah rock avalanche", which originated from the orographic right Bragardo Lungma (cf. Photo 170) damming-up the Indus valley bottom. (▽) are the metres-sized, edged boulders of the rock avalanche on its SE margin, undercut by an outer slope of the Indus. Godwin-Austen (1864), Dainelli (1922) and finally Owen (1988a, Fig.2) have misinterpreted the rock avalanche as a moraine. (■) are accumulations of ground moraine reaching a height of c. 2850 m (■ white), 700 m above the Indus river bed (□). (▼ left) is secondarily replaced debris with moraine material beneath, which, at least on its surface, has joined the dynamic force of a mudflow. (◁ on the right) is the debris of crumblings, perhaps with a minor component of dislocated moraine, on a sloping denudation terrace in the bedrock. (⇓) mark irrigation fields with walnut-, apricot -, willow- as well as poplar trees in the Koneore settlement. (– –) are the minimum heights of the Ice Age glacier level at c. 3300 m (– – on the left) and 3100 m asl (– – on the right) estimated according to ground moraines (■), glacigenic roundings and abrasion forms (◓). Photo M.Kuhle, 11.7.2000.

→ *Photo 155.* At 2490 m asl, panorama from the orographic left margin of the Skardu Basin (Indus valley) in the area of the Mantal locality, in the junction area of the Satparu Lungma (□ above) and the Indus valley (Skardu Basin) (35°16′ N/ 75°38′ 23″ E), from facing S to the Satparu Lungma (left margin) via WSW into the flank of the mountain spur in the exit of the side valley (centre) as far as N into the Skardu Basin and down toward the 5242 m-peak beyond the Indus valley (No.74). The viewpoint is on the edge of the alluvial debris fan terrace (○) on the orographic left, c. 70 m above the Satparu river (▼). (□) are deposits of rock avalanches with megaclasts of the "Satparu Lake-Skardu rock avalanche(s)" as described by Hewitt (1999:228-231). (□ on the very left) is the highest surf-rampart of this accumulation of rock avalanches damming-up the Satparu (Satpara) Lake. These rock avalanches were multi-phased (ibid.). (The two large ■ black) are glacial remnants of ground moraine which have partly been buried by the rock avalanches, i.e. which, lying under their material, come to the surface. (■ white on the left) is also LGM-ground moraine in a higher position. It is surficially covered by crumblings in the form of debris cones and -tali (△) over large areas. (◓) are glacigenic rock abrasions, which have not yet splintered away and roughened by breakages. (– – white) is the LGM glacier level reconstructed according to the glacigenically rounded mountain spur (below – – white), which is 3200 m-high on the right and 3500 m-high on the left; it was situated at c. 3400 m asl (– – white). (■ white on the right) is the erratics-bearing ground moraine on the "Karpochi" (riegel) on the distal margin of the mudflow fan (torrential fan), discharged from the Satparu Lungma into the Skardu Basin. (■ black, small) mark deposits of ground moraine in the area of the Kuardu locality on the right flank of the Indus valley; (– – black) is the corresponding prehistoric glacier level c. 1200 m above the bottom of the Skardu Basin. Photo: M.Kuhle, 3.8.2000.

↑ *Photo 156.* In the region of the "Satparu Lake-Skardu rock avalanche(s)" at the exit of the Satpare Lungma (35°14′ 30″ N/ 75°38′ 38″ E; 2670 m asl) view towards the N down the Satparu river (⇓). (△) are the edged, coarse boulders of the rock avalanches, which, cleared of the fine material matrix by flushing, accumulate in the talweg. The river (⇓), which has been - and still is - dammed-up by the rock avalanches, so that the Satparu Tso (lake) exists down-valley at 2678 m, cuts into the rock avalanche material (□) and removes the fine material. Accordingly, the coarse boulders (△) have been compacted in the talweg. The dissection of the rock avalanche material has initially taken place as a result of the over-spill of a prehistoric Satparu Tso which was far more extended. This over-spill is still in the process of development. (◄ black) is an active talus of debris along which mainly rock avalanche material (□ on the right) slides down to the talweg (⇓). (■) marks an Ice Age ground moraine cover at 3100 m, down-slope torn away by the rock avalanches and still gradually breaking-off (▲ white). Owing to this, rounded and facetted moraine boulders occur in the rock avalanche material, even though in small portions. (◓) are glacigenic rock abrasions, further above reshaped by postglacial crumblings and rock rills (⇩). (– –) is the LGM-surface-level of the Satparu tributary glacier at c. 3500 m asl. Photo: M.Kuhle, 6.10.1997.

↑ *Photo 157.* Panorama from the orographic right flank of the Satpare Lungma (35°11′ N/75°37′ 30″ E; 2820 m asl) near the Satparu settlement, up-valley of the lowest junction of two (a left and a right) side valleys (▷ large and △ white): from facing W (left margin of the photo) via NW to the left valley flank behind the junction of the orographic left side valley (centre) and N down the Satparu Lungma with the Satparu Tso (above ⊍), up to NNE into the orographic right side valley junction (right margin). (⊍) is the glacigenic trough valley Satpare Lungma, basally filled by a fluvial alluvial debris bottom (□ black), with a mountain river and a lake which has been dammed-up by a rock avalanche ("Satparu Lake-Skardu rock avalanche(s)") at the valley exit (▲ black). (△ large and △ white) are alluvial debris fans discharged from the side valleys and heaped up on the main valley floor. They are used as field terraces. (□ white) is either a remnant of ground moraine or these are the remains of a rock avalanche accumulation not yet completely removed, which, as its polymict, partly round-edged and facetted large boulders suggest, also contains displaced moraine, as is usual for postglacial rock avalanches in prehistoric glacial valleys. (■) are up to decametres-thick (third ■ from the right) ground moraine covers on both main- and side valley flanks, lying up to an altitude at c. 3800 m (■ on the very right and fourth from the right) (Fig.47). In places this moraine material is preserved in situ (first and second ■ from the left and second from the right), in places it has been buried down-slope (first ■ from the right) or dislocated (third ■ from the right). (The third ■ from the right, II-III) is ground moraine displaced kame-like and accumulated against a Satpare Lungma glacier which has already melted down (accordingly it was a Late Glacial glacier, perhaps of the Stages II-III; Tab 1). (▼ white) indicates a mudflow cone which also contains displaced ground moraine at the slope foot. (– –) is the position of the LGM-glacier surface (Stage 0), partly reconstructed with the help of glacigenic flank abrasions (◓). (△ black, small) shows the body of a glaciofluvial gravel floor terrace, left behind by the glacier meltwater of the Satpare Lungma glacier melting back as far as the valley head during Stage IV (Tab 1). Besides older ground moraine and glaciofluvial gravels, this terrace body also contains rock avalanche material. (○) are cirques formed by their High- to Late Glacial glaciation (Stage 0 to IV, Tab 1). Photo M.Kuhle, 6.10.1997.

→ *Photo 159.* Panorama taken from 3200 m asl in the middle Satpare Lungma (35°08′ 45″ N/75°37′ 01″ E) looking up-valley facing S into the orographic right valley flank (left margin) via W into the orographic left flank (centre of the panorama) up to NW down- valley (right margin). (■ black) are ground moraines on the valley slopes. In places they attain decametres in thickness (the two■ from the right). These important ground moraines forming the inner slope of an orographic left lateral moraine (■ black on the very right with III) belong to the late Late Glacial (Stage III). They contain far-travelled and accordingly round-edged granite boulders. (■ white) is a Late Glacial end moraine (Stage IV, Sirkung Stage, see Tab 1) in a valley-blocking position, which, among other things, consists of edged (□ white) and round-edged (○ white) up to rounded (○ black) granite boulders in a fine matrix (see Fig.22 and Fig.6 No.16). (□ black) marks the current gravel bed of the Satpare river in which moraine, undercut by lateral erosion (e.g. ■ on the very left) has been - and still is being - reworked. Additionally, the gravel bed receives a supply of already re-arranged ground moraine from the mudflow cones- and fans (△) in many places. (◓) are glacigenic flank abrasions- and polishings which have been roughened - even though not completely destroyed - by postglacial reworking. Their upper limit - a more or less clear polish line - allows an approximate reconstruction of an early Late Glacial (Stage I) to LGM-glacier level (Stage 0, cf. Tab 1) (– –). The then glacier surface ran at c. 3900 m. Photo M.Kuhle, 3.8.2000.

↑ *Photo 158.* Panorama from the orographic right flank of the Satpare Lungma (35°10′ 59″ N/75°37′ 31″ E; c. 2820 m asl) looking up-valley: from facing SE (left margin of the panorama) with the orographic left flank, via NNW (centre) up to via WNW (right margin) into the lowest orographic left side valley in the area of the Satparu settlement. (□) are ground moraine remnants in the two valley flanks; below rock fractures (⇩) they are surficially covered by debris overlays (▼ white) at some places. It has been observed that these debris covers also occasionally contain displaced ground moraine material (△ white) from the upper slopes. (▼ black) is a mudflow cone consisting - at least in part - of ground moraine which has been transported down-slope. (The two first ■ from the left with II-III) are remnants of a Late Glacial ground moraine pedestal (Stage II or III, Tab 1) upthrust against the Satpare Lungma glacier from the small, steep orographic right side valley leading down from a 5032 m-high summit named Tschalsi. At that time the main glacier was probably still superimposed upon by the side glacier. This remainder of a moraine pedestal, i.e. of its upper edge (above the two first ■ from the left with II-III) is situated c. 500 m above the current gravel floor of the main valley (□). In the moraine remnant marked (■ white), a ground moraine remnant of the Satpare Lungma glacier (main valley glacier) can be recognized, in which a small remainder of the then glacigenic trough-shape of the bottom has been preserved in the loose rock. In an appropriate thickness and altitude above the main valley gravel floor (□) a moraine remnant (below ■ black small, panorama centre) has survived at the exit of an orographic left side valley. Both the ground moraine remnants show a relative height of c. 50 to 60 m. They prove that the Satpare Lungma glacier, too, has flowed on a ground moraine pedestal which has been extensively removed (with the exception of these two remnants) by the Satpare river (□). (■ small, panorama centre) shows furrowed ground moraine from which earth pyramids develop on the orographic left slope. (■ second from the right) is a further basal ground moraine remnant at 500 to 700 m above the valley bottom (□). (△ black) mark a glaciofluvial gravel floor terrace into which late Late Glacial (Holocene) rock avalanches have also been locally incorporated. Terraced irrigation fields are situated upon it. This terrace body has been accumulated by the last late Late Glacial (at the end of Stage IV, Tab 1) glacier meltwater and since then becomes dissected. (◓ black) are glacigenic flank abrasions even reaching up to 3700 m-high spur summits (◓ white). (– –) are glacier levels. (– – 0) is the LGM (= Stage 0) glacier level at 3800 m asl: ice thickness c. 1000 m. Photo M.Kuhle, 6.10.1997.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← *Photo 161.* At 4150 m asl from the Deosai plateau (35°40′ N/ 75°31′ E) facing SE (left margin) via S (centre) up to WSW (right margin) looking over a glacial landscape. No.80 is the massif of a 5375 m-high summit. (■ white) marks (Fig.48) an undulating ground moraine face extending over kilometres, which, as the arrangement of its positions suggests, is built-up by a ground moraine cover metres- to decametres-thick. (○) are round-edged and facetted polymict erratic boulders of granite and quartzite. Among them are also edged, i.e. partly edged boulders of sedimentary rock (□) already showing stronger traces of weathering, i.e. splintered post-sedimentarily. The boulders are in size up to 4 x 2.8 x 2 m. (■ black in the foreground) is the clay-containing matrix (boulder clay); (■ black in the background) are faces of ground moraine, which - only little reworked - lie up the slopes of roches moutonnées (◓ on the left) and glacially streamlined hills (first to third ◓ from the right). Near the culminations of the glacial abrasion forms, faces of rock polishing emerge from the ground moraine covers (e.g. ◓ on the left). The development of fluvial rills, which took place after the deglaciation, is only insignificant, so that the glacial forms must be young. (– –) is the LGM glacier level between c. 5000 (– – fine on the left) and 4700 m (– – bold, middle; Fig.48) reconstructed according to these glacial features. Photo M.Kuhle, 3.8.2000.

→ *Photo 164.* At 3930 m asl, from the centre of the Deosai plateau (35°00′ 32″ N/75°24′ E) looking to the SE; No.84 is the 5193 m- massif in the SSE. The large névé patches there and the small avalanche-fed glaciers on the N-exposed wall feet (below No.84) prove a current ELA about 4700 to 4800 m asl. From the foreground up to the 5193 m-massif extends a classic prehistoric glacial landscape with ground moraines (■) on which a scatter of polymict, up to over 2 m-long, round-edged, far-travelled boulders (○) can be seen, pierced by abraded glacial erosion forms (◓) as e.g. roches moutonnées (◓ on the left). (◓ on the right) is the glacigenically triangle-shaped face of a “truncated spur”. The boulders consist of metamorphic sedimentary rocks (phyllites); (◁) is a debris flow fan accumulated from dislocated moraine at the exit of a flat low ground valley after the deglaciation, i.e. during postglacial times. It is distally undercut by the present-day river in the talweg (below △). The LGM-ice-level (– –) ran between an altitude of 4800 (Fig.49) and 4900 m. Photo M.Kuhle, 3.8.2000.

← *Photo 160.* 360°-panorama taken at 3950 m from the valley head of the Satpare Lungma on the NNE-margin of the Deosai plateau (left half of the panorama) (35°05′ 25″ N/75°33′ E) from facing S up-valley (↗) via WNW onto a 4430 m-high rock head (◓ white centre) via N down-valley (▽) up to E into the orographic right valley flank (◓ white on the very right and left) with its 4580 m-high culmination (below 0 – –). (■) are ground moraine covers and -remnants preserved in many places. They can be diagnosed on the Deosai plateau (second ■ from the left) as well as in separate positions on ledges of the valley flanks (the left ■ below – – fine on the right) and on the bottom of a hanging valley (the right ■ below – – fine on the right) as far as altitudes of 4000 to 4400 m. At some other places on the slopes the ground moraines are overlain by postglacial local debris of crumblings (▽). (■ on the very left) is ground moraine marginally dissected by down-slope removal; its fine material matrix has been flushed out more heavily (⇓). Owing to this, the remnant of ground moraine cover in between emerges as a segment of a stretched slope with an edged lateral boundary (■ between the two ⇓). (◓) are glacigenic abrasions and -roundings in the metamorphic sedimentary rocks and schists (phyllites) outcropping here, which have been strongly roughened by physical weathering since deglaciation. This results in a picture of a prehistoric erosive glacial landform as can be met in the European Alpes at the St. Bernhard Pass (San Bernardino) or in the Norwegian mountains at Sulitielma (near Fauske). (◓ second from the left, black) marks a glacigenically rounded rock threshold ; (↗↖) are two ravine-like talwegs through which the Satpare river flows down and which have been cut by subglacial meltwater erosion into the rock threshold. This can be suggested because of ravine forms sharply inset into the bedrock, which are set off in an upward direction with their working edges against the round abrasion forms. In addition, the two talwegs, from which the orographic right (↗ on the left) sets in several metres higher, argue in favour of a subglacial development, because meltwater tunnels in the ice make this difference in height possible. Terminal moraines and dumped end moraines are lacking in this large-scale, very clean landscape which is poor in accumulations. The latter are absent, because the ice which flowed down from the Deosai plateau had no surface moraine cover; there were no conditions for its development, i.e. the supply with ice avalanches as a result of the steep relief, usually the norm for the Karakorum, was lacking. (– –) is the minimum height of the Ice Age (LGM = Stage 0) glacier level between c. 4500 and 4850 m. Here, in its upper reaches, the Satpare Lungma accordingly was completely filled with ice. Photo M.Kuhle, 3.8.2000.

← *Photo 163.* At 3930 m asl in the centre of the Deosai plateau (35°00′ 32″ N/75°24′ E) from facing NNW (left margin) via NNE (on the right of No.75 = 5322 m-peak) up to ENE (No.77 = 5321 m-peak). No.78 is the 5339 m-peak massif, the 5205 m-high NE satellite of which is visible here. (– –) marks the LGM glacier level about 4800 m asl (Fig.48) reconstructed with the help of the hill landscape showing an uninterrupted glacigenic abrasion (◓: glacially streamlined hills) with ground moraine covers on the slopes (■ background). (■ foreground) depicts this ground moraine in detail: it concerns boulder clay consisting of facetted to rather well-rounded boulders, in size up to 2.2 m (○) which, isolated from each other, "float" in a clay-containing matrix (■). They are made up of metamorphic silt-stones and quartzites; in part they have iron manganese crusts. On boulder surfaces of this type, traces of erosion as e.g. desquamation (←) do occur. Photo M.Kuhle, 3.8.2000.

← *Photo 162.* Panorama across the Deosai plateau, taken at 4000 m asl from the gravel plain (□ black) of a mountain river flowing down from the north-eastern marginal chains of the plateau (No.75 = 5322 m-peak) to the S (35°04′ 20″ N/75°29′ 30″ E): from facing SW with the 4812 m-high Asmor (No.81) and the 4608 m-peak (No.82) via W with the 4969 m-high Barsri (No.83) and NW with the 5339 m-peak, the 5205 m-high NE satellite of which is visible here (No.78), as far as N (right margin). This is a high plateau landscape on which a low mountain range is set, showing a vertical distance of 600 to 1300 m. (○) is a trough-shaped, cirque-like valley head belonging to a valley bottom which is adjusted to the high plateau. For the last time it has been formed after the LGM, i.e. during the Late Glacial Stages III and IV, when the glacier cover had already heavily melted-down (cf. Tab 1). (⊽) are trough-shaped, i.e. typically glacigenic cross-profiles of high valleys. (◓) mark glacigenically abraded and partly polished mountain ridges (◓ on the very left) as well as glacially streamlined hills. They are covered with ground moraine over large areas (■); this consists of polymict, in many places erratic, i.e. far-travelled, round-edged, and hence facetted boulders (see Photo 163). A few quartzite boulders, the size of a fist up to a head, are striated. Figures 23 and 6 (No.17) provide evidence of the glacigenic character of their matrix. Ground moraines (■) and abrasion forms (◓) testify to a thickness of the plateau ice of 600 to 800 m on average (Fig. 48-50); the corresponding LGM-glacier level (– –) ran about 4800 m asl. (□ white 2) is the highest, up to 15 m-high glaciofluvial terrace body (gravel field Dhampu Stage No.2; Tab.1); (● 1) is the next younger, at most 5 m-high, and also still Late Glacial terrace body (gravel field Sirkung Stage No.1), (□ black -0 to -8) is the Holocene gravel floor body from the Neoglacial (Nauri Stage V) up to the present (Stage XII) (see Tab 1). These gravel fields have been made up from dislocated and at the same time outwashed Ice Age to Late Glacial moraine. Photo M.Kuhle, 3.8.2000.

↓ *Photo 166.* Panorama at 4070 m asl from the western central region of the Deosai plateau (34°59′ 30″ N/75°19′ 05″ E) from facing E (left margin) via N (middle) up to W (right margin). No.84 is the 5193 m-peak, No.81 the Asmor (at 4812 m it is four metres higher than Mt. Blanc) and No.82 the 4608 m-peak. A hill landscape with glacially streamlined hills (the two ◓ on the left), roches moutonnées and glacigenic polish thresholds (the two ◓ on the right), nearly completely covered by ground moraine (■) with large, partly erratic (granite) boulders (e.g. ▲) lying on the surface, extends from the fore- to the background. (Below ◠) a further polish threshold occurs, over which the High Glacial ice transfluence into the W-adjacent valley system of the Khilin Gah has taken place. The streamlined hills tower a good 300 (◓ on the left) up to c. 560 m (◓ white) above the level of the corresponding neighbouring high valley bottom. The ground moraine on their slopes, which further down has been deposited at a greater thickness, is dissected by flat flushing rills (▽ white) up to a depth of several metres. At their lower ends small alluvial fans (△ black) provide evidence of the minor masses of fluvial material which at the same time has been fluvially removed. (0 – –) is the LGM (Stage 0, Tab.1) glacier level about 4800 m asl, locally reconstructed with the help of ground moraines with and without erratics and abrasion features (cf. Fig.50). Photo M.Kuhle, 3.8.2000.


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← *Photo 165.* Panorama taken at 4050 m asl from the centre of the Deosai plateau (35°00′ 30″ N/75°20′ 45″ E) looking from facing S (left margin) via WSW down-valley (◠), toward NNW up-valley (half right) up to NNE (right margin). No.78 is the 5205 m-peak of the 5339 m-massif. (○) are erratic boulders, among them far-travelled granite blocks with longitudinal extensions of 2 to 3 m (e.g. the first and second ○ from the left). These boulders are facetted, i.e. round-edged; the smaller ones are even rounded, but, owing to radial cracks, they are partly broken in situ, i.e. post-sedimentarily (second ○ from the left). Sedimentary rocks, as e.g. schists, outcrop in the underground. (■) are ground moraines on which these large boulders lie, whilst the smaller ones, which are fist- to head-sized, are increasingly embedded in the fine matrix as moraine boulders, isolated from each other. (As a rule, the large boulders are increasingly forced out of the material formation and thus come to the surface. See Kuhle 1991b:128-130). The 400 to 600 m-high low mountain relief here - which is similar to a Scandinavian fjell-landform - is completely covered by ground moraines (■) with a thickness of metres to decametres. Where the thickness of the covers decreases, i.e. in the direction of the hill-tops, glacigenic abrasions are evident (◓). (□) marks the valley bottom from glaciofluvial gravels and boulders which have been residually washed out of the ground moraine since the Late Glacial deglaciation, i.e. at postglacial times, and so have been cleared of the moraine matrix in situ and condensed on the spot. (0 – – and – –) is the large-scale reconstructed LGM-glacier-surface at c. 4800 m asl (cf. Fig.49 and 50). (◠) was a then ice transfluence over the W edge of the Deosai plateau into the orographic right (E) source branch of the Das Khilin Gah and thus to the Astor valley system and the Nanga Parbat-massif. Photo M.Kuhle, 3.8.2000.

← *Photo 167.* This panorama was taken from the W-margin of the Deosai plateau at 4180 m asl, looking over the Scheosar Tso (lake) (34°59′ 58″ N/75°14′ 22″ E) from facing ESE (left margin) via SSW (middle) up to WNW (right margin). No.84 is the 5193 m-peak. Rock thresholds and classic roches moutonnées (◓) fringe the lake basin as a classic polish depression. The high valley in the background shows a glacigenic trough-shape (∪). (■) are parts of a ground moraine cover, displaced near to the surface and dependent on the slope by solifluction processes on the roches moutonnées. The ground moraine contains erratic gneiss- and granite boulders (○), which because of their round-edged to rounded forms cannot be mistaken for slope debris weathered in situ; the matrix is unambigously glacigenic (Fig.24 and Fig.6 No.18) The LGM-thickness of the ice has decreased from E to W in the direction of the 4266 m-high transfluence pass (◠) leading over to the Das Khilin Gah, because beyond its transfluence the ice flowed down steeply toward the WNW. Accordingly, the ice level (– –) has undergone a loss in height from c. 4750 m on the left (cf. Fig.50) to c. 4450 m asl on the right (– – ◠). The roche moutonnée at the pass (◓ white) has forced the overflowing glacier ground upwards to c. 4320 m asl, so that crevasses might have been developed there; potholes, however, have not been found. Photo M.Kuhle, 3.8.2000.

← *Photo 169.* At 3300 m asl, panorama taken from the orographic right flank of the Das Khilin Gah (main valley) (35°03′ 20″ N/ 75°05′ 10″ E), 2.4 km down-valley of the Jidim settlement, looking from facing SE (left margin) up-valley, via SW into the left valley flank (middle) up to WSW (right margin) into a left trough-shaped side valley (⊍). Fig.51 shows the same valley cross-profile. No.81 indicates the position of the 4812 m-peak and No.82 that of the 4608 m-peak (cf. Fig.2/1); the peaks themselves, however, are not visible from here. The viewpoint is on an orographic right ground moraine body (■ on the very left and right below) which contains facetted, polymict boulders up to several metres in length (above ■ on the right below). (□ on the left) is the river, which in postglacial times (since the deglaciation) has condensed the ground moraine on the bottom so that a valley floor has been made up with a surface rich in boulders and gravels (□ right); the matrix is silty-sandy. In some places the ground moraine has been dislocated by mudflow dynamics to form small mudflow fans (▷ black). (◁ white) is a debris cone the surface of which is covered by rock crumblings; its core, however, consists of buried ground moraine. (○) mark Late Glacial cirque-, i.e. nivation depressions. The orographic left moraine ledge (second ■ from the left) has partly been dissected and removed by their meltwaters (▼); (■ white and black on its right side) are ground moraine remnants in situ, in parts characteristically patterned by gully washing (↑ ↑) since the deglaciation. In an upward direction this ground moraine slope peters out into a Late Glacial lateral moraine terrace (III) of the Dhampu Stage (III, see Tab 1). (◓) are relics of the High Glacial abrasion which are relatively well-preserved in the form of roundings of the rock shoulders (◓ white and black on the right). (– – black and – – white 0) is the corresponding LGM-ice-level at 3900 m (on the left) and 3700 m (cf. Fig.51). Photo M.Kuhle, 3.8.2000.

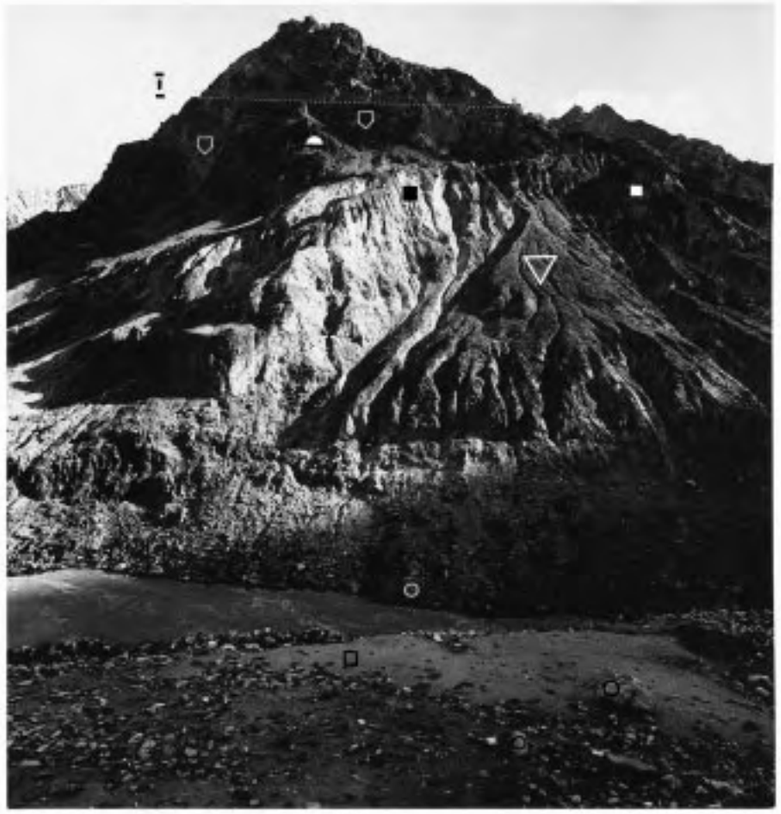
← *Photo 168.* Panorama taken at 3880 m from the orographic right (E) source branch of the Das Khilin Gah (valley), c. 9 km up-valley of the Jidim settlement, from the orographic right valley flank (35°00′ 55″ N/75°12′ E) looking from facing ENE (left margin) up-valley, via S into the left flank (⇩) up to NW into the right flank down-valley (right margin). No.81 indicates the position of the 4812 m-peak, No.82 that of the 4608 m-peak, No.86 that of the 4843 m-peak and No.85 marks the position of the 4848 m-peak (cf. Fig.2/1); the four peaks themselves are not visible from here. (◓) are glacigenic abrasion roundings and polishings locally crumbled away (⇩). (■) are two types of moraine accumulations: a.) ground moraines which have also survived in higher slope positions (■ on the right, below ▽ , ■ on the very right, above) and b.) Late Glacial lateral- (■ IV = Sirkung Stage, see Tab.1) and end moraines (■ on the left of the right ⊔). The moraines are made up from a boulder clay with large (up to 2.5 m-long) polymict, edged to round-edged boulders (○); the granite boulders are the largest. Gullies (▽), developed by the seasonal snow-meltwater, dissect the ground moraine on the slopes; more or less intensive slides also occur in it (↓). (▲) is a "tor", i.e. a c. 15 m-high rock-tower of granite, carved out of the valley ground as a sharp "riegel" (barrier mountain) and preserved despite the glacigenic ground scouring. (⊔) mark valley cross-profiles with a clearly glacigenic trough character. (– –) is the minimum height of the Ice Age (LGM = Stage 0) glacier level between c. 4450 m (– – fine, half-left) and 3900 m (– – half-right, down-valley), reconstructed with the help of the abrasion forms (◓). (0 – – and – – above ▽ and on the very right) are locally higher prehistoric glacier levels above mountain ridges. Ice influx has taken place through a transfluence over the western marginal threshold of the Deosai plateau (Photo 167) at (◠). Photo M.Kuhle, 3.8.2000.

← *Photo 171.* Panorama taken at c. 2200 m asl looking down the Indus valley, just 300 m above the Indus (◇), from the orographic right valley flank (35°35′ 16″ N/75°20′ 24″ E) between the Tungas (Tamas) settlement in the E and Dasu (▽ white) in the W near the police station at Thowar Rondu: from facing SW (No.88 = 5450 m-peak) into the left Indus valley flank, via W (centre) down-valley as far as NW (right margin) with the terraced irrigation fields of the Dasu settlement (▽) and the exit of the Tormik Lungma. The orographic left side valley joining from the right below No.88 is the Trik Lungma from the 5450 m-peak N-flank, the valley head of which currently is still glaciated; its mouth shows a trough cross-profile (between the second – – and third – – from the left). (⊔) is the glacigenic trough profile of the Indus valley depicted in Fig.53. (■ large) is the ground moraine on the valley bottom being at least 50-60 m-thick; in places it even reaches over 100 m (■ large, middle). At some places steep furrows have dispersed it into pre-forms of earth pyramids (▼ white). Obviously, the Last Glacial (LGM- to early Late Glacial Stage I-) glacier (cf. Tab 1) has also overridden the material of interglacial rock avalanches, so that it has been covered by ground moraine (■ large on the left). (■ small) are the highest ground moraines reaching up to 3150 m asl, c. 1250 m above the valley ground. Fig.53 (right side of the Indus valley) represents the moraine material on the orographic right valley flank (■ small on the right). (▲ black) are further furrows and pre-stages of earth pyramids. Here, too, the involvement of rock avalanche material cannot be excluded. (▷ black) are debris tali deriving from the rock wall above, which has been crumbling away since the deglaciation. (◓) mark rock forms, which have been glacigenically abraded through ground scouring and shaped like roche-moutonnées (◓ on the left and right; especially ◓ on the right), as well as flank polishings (◓ centre), the upper line of which indicates the polish limit of the LGM glacier level at 3150 m asl (– –), so that a thickness of the Indus glacier of c. 1200 m could be reconstructed here. (▽ white) can be interpreted as a ground moraine pedestal of the orographic right side glacier from the Tormik Lungma; a corresponding ground moraine pedestal on the orographic left is situated in the junction of the Trik Lungma (on the left above ⊔). Photo M.Kuhle, 11.7.2000.

→ *Photo 173.* At c. 1670 m asl, NW down-valley of the Changmachhu locality, 2.5 km up-valley of the valley cross-profile Fig.54 (35°41′ 40″ N/74°54′ 28″ E), looking up the Indus valley: from facing NE (left margin) into the junction of the orographic right side valley (⊓) with the 5090 m-peak (No.89), the N-crest of which mediates to the 6050 m-peak (on the left outside the panorama), via SE (centre) up the Indus as far as S and SSW (right margin) looking into the left Indus valley flank. (■) has been approached as a ground moraine ledge, i.e. a High- (LGM) to Late Glacial ground moraine body, fluvially undercut by the main- and side valley talweg, i.e. worn down or displaced by landslides and debris flows (△ black) during the postglacial period. Indications as to an alternative approach as rock avalanche have not been found. The roots of earth pyramids (←) have, however, also been observed in sediments of rock avalanches. 300 to 400 m above the Indus river, the ground moraine (■) which, according to its increase in thickness towards the talweg shows the characteristics of a pedestal moraine, clings to the polished rock slopes above (◓ black, small). Owing to this, trough cross-profiles (⊓) have been developed, which are especially clear in the side valley. (⇩ black) is a mountain spur, which has been polished back, i.e. a glacigenically triangular-shaped slope, showing fresh crumblings. (⇩ white) is a cleft-dependent crumbling rill in the gneiss bedrock (◓ white on the right), which, adjacent to it, has been glacigenically abraded (◓ white on the right). (△ white) marks an active debris cone with a mantling of the debris of crumblings; (◓ on the very left) are relatively intact abrasion faces. (◓ on the right margin) is a roche moutonnée undercut by the Indus. (□) show fluvial sands, pebbles and gravels. The classically glacigenic polish bands (◓ black, small) reach their polish line (– –) at somewhat over 3100 m. (▼) are flat, subglacial meltwater rills of a cirque glacier (situated in the area of – – on the left), which have reshaped the High Glacial polish ground (◓ on the left below ▼) during the Late Glacial. Photo M.Kuhle, 14.8.1997.

← *Photo 170.* At 2150 m asl, panorama taken from the orographic right river side of the Indus (5 m above its high-water level), 2 km WNW of the lower end of the Skardu Basin, i.e. the Indus bridge near the Bragardo settlement, at the upper start of the Indus gorge stretch (35°27′ 43″ N/75°26′ 30″ E), down-valley of the rock avalanche (□), which Hewitt (1999, pp 223-228, Fig.4-6) has described as "Kazarah rock avalanche" (cf. Photo 154): from facing E (left margin) up-valley, via SW (centre) with the mountain ridge (⇩) rising from the left, from 3886 m, to the right up to 4727 m, diagonally down the Indus, as far as WNW into the orographic right flank of the Indus valley (right margin). (◓ black on the left) is the orographic right, glacigenically abraded flank of the Skardu Basin from Bragardo up the Indus (near the left margin in Photo 154); (◓ white) are further glacigenically rounded and smoothed massive-crystalline rocks on the orographic right Indus valley flank; (◓ black on the right) show corresponding abrasions on the opposite valley flank, reaching up to (– – I) and, even more heavily roughened, up to (– – 0); (– – on the left and – – 0) is the LGM-glacier-level about 3300 m; (– – I) is that of the Late Glacial Ghasa Stage (I, Tab 1) about 2900 m asl. (⇩) marks a rock wall, which, in dependence on the clefts, has heavily crumbled away since the deglaciation; (△ white small on the right) are the pertinent debris cones derived from rock fall, which probably contain ground moraine remnants which they have carried along and which cover the ground moraine lying beneath. (□) shows the rock avalanche ("Kazarah rock avalanche" see above) emerging from the orographic right Bragardo Lungma, which has dammed-up the Indus valley bottom. The Indus river, flowing here with a water volume of c. 500 m^3/sec on average (at the time when the picture was taken it flowed an extreme summer-high-water after heavy rainfall during the night to August 1st, 2000), has already cut the rock avalanche by an over-spill of c. 50 (□ black) to 120 m (□ white) in depth, and at the same time has removed its fine material and compacted the coarse boulders, so that a terrace has been developed (▼). (■) is ground moraine the matrix of which is rich in clay, with polymict, partly rounded boulders in the erosion shadow of the half-eroded remnant of a roche moutonnée (◓ on the very right); (▽ white on the left and ▽ large) is moraine, dislocated downslope through debris flows from the here a good 3000 m-high right Indus valley flank, which stretches steeply up to the currently still glaciated 5220 m-peak, a SE-satellite of the 5770 m-peak (Fig.2/1 No.72). (▽ white, large) shows a debris flow, which had moved down 35 minutes before the photo was taken. Here, between the Skardu Basin and the inflow of the Gilgit river, 28 debris flows have moved down into the Indus valley during this night, blocking the road for ten days. This is an example of the extremely active postglacial displacement of moraine material. (○ foreground) marks a well-rounded granite boulder; (◇) is a practically unmoved, edged gneiss boulder and (○ middleground) are round-edged gneiss-, i.e. granite boulders - a mixture of dislocated rock fall-, moraine- and finally also debris flow material which is representative of the steep relief. Photo M.Kuhle, 1.8.2000 at 7 o'clock in the morning.

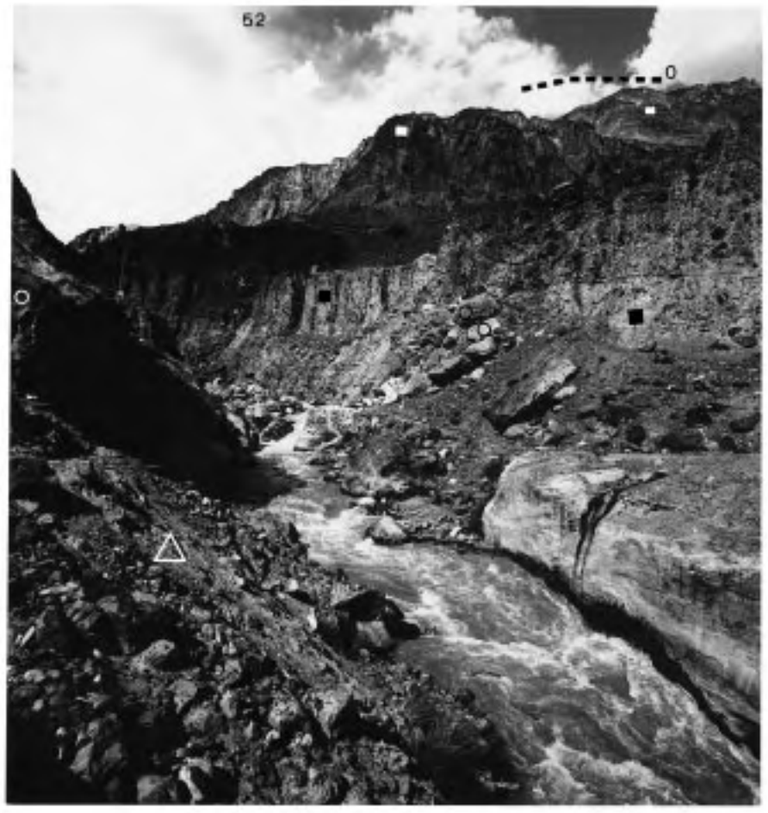
↓ *Photo 172.* Panorama at c. 1800 m, 110 m above the Indus, from the orographic right Indus valley flank (35°35′ 58″ N/75°04′ 28″ E) opposite the Tulu settlement (above ↓ white large, on the left), below the junction of the orographic left side- and hanging valley, a trough valley ('Tulu Lungma') leading down from the 5524 m-peak to the N, the valley head of which is currently still glaciated (▽). Taken from facing SSE (left margin) up the Indus valley, via SSW to the hanging trough valley (▽) up to NNW down the main valley (right margin). (◓) are orographic left glacigenic flank abrasions, part of which occurs on banking edges (◓ right half of the panorama). Due to crumblings they have been roughened more strongly there (⇩) since the deglaciation. In an upward direction the abrasions (◓) peter out into a classic polish line about 3150 m asl, c. 1400 m above the current valley ground (– –). In many places these Ice Age glacigenic faces of flank polishing (◓), which at the same time are typical triangular-shaped slopes (◓ left half above), are covered with ground moraine up to decametres in thickness (■). Their highest occurrence has been observed at nearly 3000 m (the three ■ on the right). Characteristic slides of ground moraine (↓ small), as they are wide-spread in the prehistorically glaciated Karakorum, have taken - and still take - place, where the ground moraines are thickest. The quite fresh break-out (↓ small) shows the characteristic structure of a downthrow. The ground moraine is the thickest on the confluence spur of the side- to the main valley, where furrows, and now also earth pyramids, are in the process of development (→ black). (▽) is a debris fan from dislocated ground moraine, on to which a rock fall with large, edged boulders has collapsed. (↓ large) indicates two ravine-like side valley talwegs, steeply eroded into the bedrock. One of them (↓ large on the left) is still currently active, draining the side valley (▽). Probably it has syngenetically dissected the ground moraine pedestal at the exit of the side valley. The other one (↓ large on the right) is non-active. It has only been eroded as a subglacial meltwater rill and then fallen dry after deglaciation. (○) marks a gravel terrace and (□) are limnic sediments which are embedded into a debris fan, built-up of dislocated moraine material. Both, the gravel and the limnites, have been heaped-up as subrecent to recent fluvial, i.e. glaciofluvial sediments (outwash) in the Indus valley, which, during Holocene to historic times, was temporarily blocked by rock avalanches or debris flows. After each break-through of the Indus they have been re-dissected. The fluvial cutting has taken place as far as into the bedrock itself (▼). Photo M.Kuhle, 14.8.1997.



← *Photo 174.* Taken at 1680 m asl from the orographic right side of the Indus valley (35°42′ 32″ N/74°51′ 25″ E) opposite the junction of the Bulache Gah, 3 km down-valley of the Indus valley cross- profile Fig.54, facing SE into the left flank. (◓) is rock, rounded by abrasion at c. 2250 m, 600 m above the Indus (below ○ white); adjacent to it, these roundings have been destroyed by crumblings (⇩). (– –) marks the highest prehistoric glacier level of this Indus valley cross profile, verifiable by abrasion traces (◓); it might belong to the Late Glacial Stage I (Ghasa Stage, Tab 1). (■) are deposits of ground moraine in the flow shadow of the High Glacial (LGM) Bulache Gah glacier inflow into the Indus parent glacier. This orographic left side glacier flowed down from the 5569 (or 5559) m-high massif, which is currently still glaciated and forms the dividing crest to the SW-adjacent Astor valley (cf. Kuhle 1997:131/132 Fig.28 on the right of No.46). (▽) is a ground moraine wedge, which, after the abutment had melted, slipped down, and now - like the rest of the moraine surfaces - is becoming furrowed. The ground moraine is basally undercut by the Indus (■); (○ white) is a round-edged boulder, which, farther up-valley, has been rinsed by the torrential suspension water of the Indus and transported here. It lies only temporarily (up to the next prominent high water peak) on this very unstable talus slope (= debris slope with a maximum steepness). (□) shows the surface of a fluvial Indus terrace made up of sands, pebbles and metres-long rock fall- or moraine boulders, rinsed in situ or fluvially dislocated (○ black). Photo M.Kuhle, 14.8.1997.

→ *Photo 175.* At 1580 m asl from the orographic right flank near the Shengus Gali locality (35°42′ 51″ N/74°45′ 25″ E) seen facing E up the Indus gorge. (■ black, large) are accumulations of ground moraine up to decametres in thickness on the NNE slopes of the cross-profile Fig.55. Owing to its important thickness near the talweg of this gorge-stretch (■ black, large on the right) could be misinterpreted as debris of a rock avalanche. However, it is a remnant of a ground moraine pedestal in the glacier flow shadow behind the round-polished rock rib (◓ black). (◡) marks the glacigenic trough profile, situated above the narrow gorge stretch (▼) near the talweg. (◓) are the glacigenic abrasion roundings reaching up to c. 3150 m and providing evidence of the Indus glacier level (LGM) (0 – –), so that a 1600 m-thick ice minus the height of the pedestal moraine is verifiable. (■ small) are the highest deposits of moraine. Here, too, a misinterpretation as rock avalanche debris can definitely be ruled out, because they are situated at a height of c. 800-1000 m above the Indus talweg and show a solid overlay of loose rocks on the 30 to 40°-steep slopes. (◁) is moraine material, dislocated by spring erosion, slope flushing and debris flow; (○) are polymict boulders metres in size, washed out of the moraine- and moraine-slope debris by the Indus. (⇩) is one of numerous rock crumblings as a function of the steepness of the walls. Photo M.Kuhle, 14.8.1997.

← *Photo 176.* 2 km down-valley of the cross-profile Fig.56 at 1540 m asl, from the right side of the Indus near the Burumdoir locality in the junction area of the Khalota Gah (35°46′ 05″ N/74°45′ 42″ E) facing SSW looking up the Indus valley. (■) mark the ground moraine cover of the eastern valley flank (Fig.56), which in part is many decametres-thick and reaches up to 2650 m. However, Hewitt (1998:4 Fig.1 No.96) has here recorded in his general map a “rock avalanche”. The steep moraine surfaces are furrowed by characteristic microfluvial-rills. (◓) are rounded, glacigenic abrasion forms, which in many places are still covered by ground moraine. (△ on the left above) is a debris cone adjusted to the ground moraine surface, and therefore recognizable as a post-High Glacial accumulation. (– –) indicates the LGM-glacier-level at somewhat above 3100 m. (⇩) marks rock crumblings; (△ on the right below) is ground moraine undercut by the Indus, which slides down as a talus slope. (The author agrees, if Hewitt considers this place as being the locality of his “rock avalanche”. In addition, the very thick ground moraine overlay (■ black) is in the process of a typically slow (see above) landslide since the deglaciation and the loss of an abutment connected to it). Round-edged to rounded polymict moraine boulders (○) the size of metres, washed-free or dislocated, lie on - or are embedded into - an alluvial floor of the Indus (□). Photo M.Kuhle, 14.8.1997.



↑ *Photo 178.* Panorama taken at 1440 m asl from the junction of the Phuparash Lungma and Phuparash river (foreground on the left) (Photo 177) looking from the orographic right side into the Indus main valley (35°51′ 10″ N/74°44′ 55″ E): from facing E up the Indus with the 5324 m-high Godoy-Gali-peak (or Godeli, No.90) on the W-crest of the Haramosh (7397 or 7409 m; Fig.2/1 No.53), via SW to the orographic left mountain spur (centre, to the right) and WSW down the Indus (⊍ small) as far as W again into the right Indus valley flank (right margin). (■) are ground moraine covers, i.e. - remnants which can be evidenced on the slopes as well as on flat ledges and near the valley floor. In many places they overlie glacigenically polished rock bottoms (first and second ◓ from the left) and rounded remains of barrier mountains ("riegel"), shaped like roches moutonnées (second ◓ white from the left); but also glacigenic abrasion forms without a moraine overlay (the four ◓ from the right) have been observed. The Indus valley cross-profile (⊍ small) as well as the concave polish form, still cloaked with ground moraine, situated between the roche moutonnée and the left Indus valley flank, show a typically glacigenic trough-form (⊍ large). (▲) is moraine, the round-edged boulders of which have been compacted through their downslope displacement. Intercalated rock falls have also been met. (○ white) is a c. 14 m-high historic, fluvial terrace of the Indus. (△) marks sediment of moraine and then debris flow from the Phuparash Lungma, dislocated many times. It also contains polymict, edged and rounded boulders up to several metres in length, and will be taken in by the Indus with the next high-water. (– –) is the maximum prehistoric glacier level at somewhat over 3100 m, reconstructed with the help of remnants of ground moraine and abrasion roundings. (○ black) is a present-day W-exposed cirque glacier below the Godoy-Gali-peak (or Godeli No.90), which reaches down to c. 4650 m asl (orographic ELA = 4900 m; climatic ELA = 4800 m). Photo M.Kuhle, 14.8.1997.

← *Photo 177.* At 1440 m asl, N of the Sassi settlement, looking from the Indus valley (Photo 178) (35°51′ 10″ N/74°44′ 55″ E) into the orographic right tributary valley, up the Phuparash Lungma, taken towards the NNE (No.52). (■ black) is basal ground moraine material containing rounded, polymict boulders the size of metres. Two layers of ground moraine are concerned here: (■ black on the right) is that in the underlying bed, (■ black on the left) that in the hanging layer. Above them are further ground moraine layers (■ white) into which numerous rock falls might be incorporated, so that it is not always possible to distinguish between them and the moraine. Additionally, in many places the moraine material could have slid down or been tipped over since the deglaciation. (○ black) are two round-edged boulders of light granite (○ black, below) and dark phyllite (○ black, above) which originate from an upper moraine layer (■ white) and have been tipped over downslope. (○ white) marks a bank of sedimentary bedrock, showing remnants of a pothole wall, i.e. flush bowls of the Phuparash river. (△) is prehistoric moraine material, which has been undercut and thus slides downslope. (– – 0) indicates the highest verifiable, probably High Glacial (LGM = Stage 0) glacier surface at a good 3100 m asl at the up-valley mountain spur in the confluence area of the Phuparash Lungma and Indus valley (see Photo 178 left margin). The talweg of the side valley has been dissected so steeply that, despite a glacier filling which was about 1500 m thick, no trough-profile has been developed but rather a glacigenically V-shaped valley. No.52 indicates the position of the Malubiting (7453 m) at the valley head, the summit of which is not visible from here. Photo M.Kuhle, 14.8.1997.

↑ *Photo 179.* Panorama taken at 1420 m asl on the orographic right side, c. 50 m above the Indus river (35°49′ 50″ N/74°39′ 40″ E), 2 km NE of the Shuta locality : from facing E (left margin) up the Indus valley with the Godoy-Gali-peak (or Godeli No.90), via SSE (centre) into the orographic left valley flank as far as SW (right margin) down-valley. The view up-valley shows a trough-like valley cross-profile (⊍), the concave form of which has been glacigenically widened (see also Fig.57), with decametres-thick mantlings of moraine (■ black) on to which rock avalanches (□) have come down since the deglaciation. Where the loose rock is placed in apposition to the glacigenically abraded rock (◓ on the left), fresh cone forms (▷ on the left) are situated. They consist of displaced ground moraine (■ white on the left, still in an original high position, i.e. in situ) transported down from the wall high above, but also of the debris of crumblings. Corresponding cone forms (△ middle of the panorama) of dislocated ground moraine (the three ■ on the right) are adjusted to a remnant of the Indus terrace (○). (■ white, large) shows dark ground moraine, which occurs adjacent to light ground moraine (first ■ black from the right) on the orographic left flank. It is more heavily dispersed into earth pyramids than the light one. The ground moraine (■) lies on abraded rock faces, which are in part also polished (◓ small). (◓ large, foreground) is perfectly preserved glacier scouring with a polish in fine-crystalline gneiss and fine-grained quartzite; a ferromanganese crust has developed on its surface. (– –) is the LGM-glacier-level at c. 3100 m asl, reconstructed according to ground moraines and flank abrasions. Photo M.Kuhle, 14.8.1997.

← *Photo 180.* Panorama at 1420 m asl, 2 km NE of the Shuta locality on the orographic right, 50 m above the Indus talweg (35°49′ 50″ N/74°39′ 40″ E), looking facing N up the valley slope. In the foreground below is the road, blasted into the rock slope of gneiss (the shady band below is the 1.5 m-high wall created by the blasting). (◓) is one of the numerous rounded knobs, which, under the high pressure of the ice burden and with a water film on the glacier ground, has been polished out by the Ice Age Indus glacier. Due to its banking, the rock face is horizontally grooved. Besides its rock-polish, shining in the sunlight, separate flush bowls (▽), too, point to the presence of hydrostatically confined water under the polishing glacier. (◓) indicates by its flat scour slope and steep lee slope an ice stream direction from the right to the left, following the Indus valley. These processes of detraction, dependent on regelation, could attack on the vertical release joints in the gneiss. Orientated to an only centimetres-thick ferromanganese crust, the rounded rock faces splinter-off concordantly (▼). This process has to be described as exfoliation. The glacier polish reaches 400-500 m-high up the valley flank. However, with increasing steepness, it has been more and more damaged by crumblings (⇩). (– – fine) is the highest prehistoric glacier surface about 3100 m asl, evidenced by abrasion roundings. (– – bold) runs at an altitude of c. 2000 m, above the culmination of the glacially streamlined hill (⇩ on the right) over which the ice must have flowed. This minimum height of the ice level is locally verifiable by the rounded mountain ridge. Photo M.Kuhle, 14.8.1997.

↑ *Photo 181.* At 1390 m, panorama taken c. 80 m above the Indus from the orographic right valley slope (35°47′ N/74°37′ 21″ E), 0.5 km E of the Jigi Gali locality: from facing NNW (left margin), via NE (centre) up the Indus valley, as far as SE (right margin) looking down-valley. (○) is the lowest, here c. 50 m-high, fluvial Indus terrace, which can be followed over a length of at least 17 km from the Sassi settlement as far as the inflow of the Gilgit river (cf. Photo 178 and 179). Up to the highest terrace level (□) at 1520 m asl, i.e. 210 m above the Indus river, two further fluvial terrace levels are interposed (between □ and ○). The highest terrace mantles glacigenic roche moutonnée forms (◓ on the left and right below □) in gneiss bedrock. (⊔) is the cross-profile polished to a trough in the lower section of the Indus gorge, 8 km above the inflow of the Gilgit river. (◓ white on the left) indicate abrasion forms on the outcropping edges of gneiss-strata crumbled away in many places (⇩); the edged crumbling debris (▼) develops coarse-blocky tali, covering basal ground moraine layers (■ black). Active cones of debris flow come out from larger rills (▷). However, ground moraine (■ white on the left) lies also as far as close to the glacier polish line (– – left half). (The three white ■ from the right) are ground moraine remnants in higher positions on the orographic left; they partly cover glacigenic abrasion faces of the bedrock (the three ◓ from the right) up to a thickness of decametres (e.g. ■ on the very right), the upper margins of which testify to the prehistoric ice level (– – white on the right). These ground moraines are currently dissected to rills by the down-flowing water (■ below – – white and black on the right). Photo M.Kuhle, 14.8.1997.

← *Photo 182.* Panorama at 1470 m altitude, c. 180 m above the Indus (□) from the confluence spur between the Indus- (from the left) and Gilgit river (from the right) (35°45′ 24″ N/74°37′ 42″ E), 3.5 km SSE of the Jigi Gali locality: from facing E (left margin) via S (⊔) down-valley up to SW (right margin) looking into the orographic right Gilgit valley flank. (○) are the four levels of river terraces known from Photo 178, 179 and 181 (○) up to c. 200 m (○ white) above the Indus (□). (▽) marks the c. 100 m-high, distally c. 6 km-wide debris flow fan situated near the Bundschi settlement, which has been discharged from the junction of the Bundschi (Bunji) Gah from the orographic left (E) valley side, from the 5559 m-summit (No.91 marks the position of the mountain which is not visible from here). It is largely made up from dislocated moraine material. A Late Glacial lateral moraine complex, i.e. a lateral kame, accumulated against the thawing Indus glacier, can be observed at the valley exit on the orographic left (■ I-II). 6 km behind the debris flow fan (▽) and the kame (■ I-II), also from the left (E), the Astor valley joins the Indus valley. The author's glacier reconstructions concerning this valley have already been discussed in detail (Kuhle 1988b:588; 1988c:11; 1989:271-273; 1991:299; 1993:108-110; 1996; 1997; 1998a:90-94; the 8126 m-high Nanga Parbat-massif rises behind it (on the left below No.92 in the clouds)). No.92 is the 1965 m-hill at the back of which the Saz Nala joins from the orographic right (from the W) (cf. Fig.58). Here, the Indus valley shows a trough-cross-profile (⊔; Fig.58) with abraded rock flanks (◓) and a large-scale ground moraine overlay (■). (0 – –) is the highest level of the ice stream network verifiable with the help of preserved glacier indicators like these. It runs about 3100 m and can be classified as belonging to the LGM. (▼) is a basal flank steepening developed by fluvial or subglacially fluvial undercutting. Photo M.Kuhle, 14.8.1997.

↑ *Photo 183.* Panorama from the orographic left flank of the Chitral valley, a good 4 km down-valley of Drosh, taken at c. 1350 m asl (35°32′ 30″ N/71°49′ E; Fig.2 on the left above No.97) from facing SSW down-valley towards Mirkhani (left margin) via WNW into the orographic right valley flank with the alluvial- and mudflow fan (△) of Utsiak (on the right of the middle) up to NNE up-valley as far as the confluence of Mastuj and Shishi near Drosh (right margin). (■) are ground- and lateral moraine bodies with a trough-shaped profile of the slope line, which during the melting-process of the Chitral valley glacier have first been covered kame-like by a concordant mantle of crumblings from the rock walls above, accumulated against the ice margin, and have later been dissected downward from the wall furrows (↓). (– –) is the LGM-glacier level documented by flank abrasions (◓). Photo M.Kuhle, 21.9.1995.

← *Photo 184.* Light erratic granite boulder (for scale: rucksack and a 143 cm-long stick) in ground moraine on dark sedimentary bedrock, on the culmination of the mountain ridge polished round by the glacier ice between Tirich (Mir)- (on the left) and Mastuj valley (right) NE above the Zani pass, facing NE (3850 m asl; 36°21′ N/72°12′ E). The granite boulder testifies to an ice transfluence of the Tirich Mir glacier. Photo M.Kuhle, 22.9.1995.

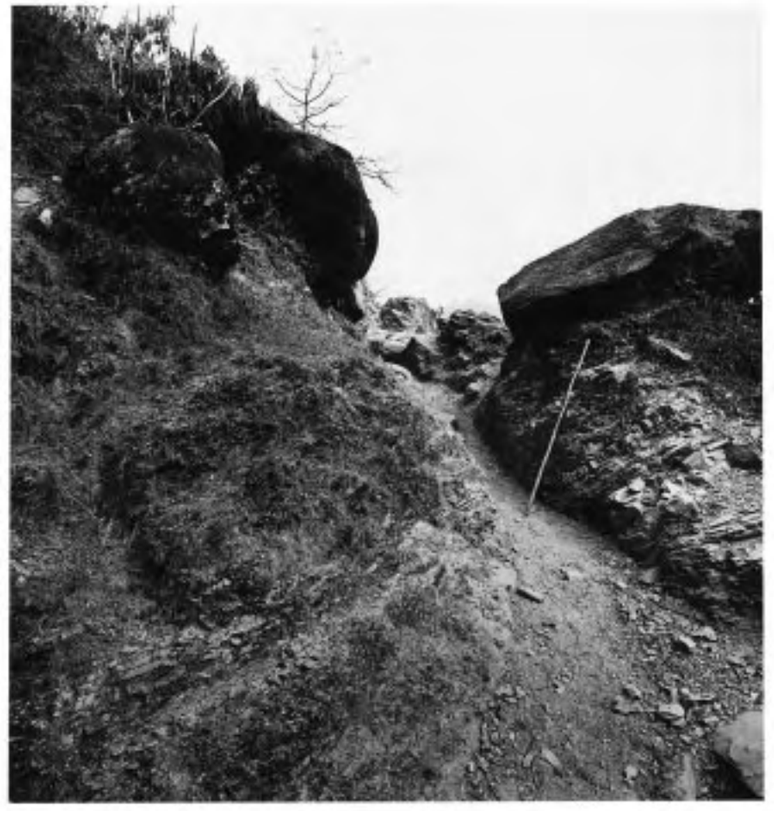
→ *Photo 185.* At 3985 m asl facing E (centre) across the saddle of the Rothang (Jot) pass (32°21′ 45″ N/77°14′ 50″ E, 3980 m) looking diagonally up the Lahaul valley. No.9 is the 5620 m-peak; (◓ black) is the orographic right flank polishing of the Lahaul valley, reaching up to 3400 m, to the polish line of the LGM (– –). (◓ white) shows a rock threshold rounded by the glacier abrasion of the Ice Age transfluence pass; (■) marks a hilly ground moraine. Photo M.Kuhle, 17.8.1993.

← *Photo 186.* At 1550 m asl looking up the Tori valley to the NE on to the 4971 m-peak (No.8). 1.5-3 m-long, round-edged erratic granite boulders (○) (32°12′40″ N/76°22′35″ E) form an orographic right lateral moraine (■) which sets in at 1660 m asl (■ on the right), c. 250 m above the talweg (▼). The bedrock in the underground consists of finely grained sedimentary rock (schist). (– –) is the surface level of the LGM-Tori glacier, which, accordingly, had still a thickness about 250 m here. It came to an end as a hammerhead-like piedmont glacier c. 2 km down-valley outside the valley. Photo M.Kuhle, 29.10.1996.

→ *Photo 190.* From a good 1500 m asl (28°20′ 64.4″ N/83°57′ 19.2″ E: GPS-measurement), 350 m above the talweg (↓), seen along the orographic right flank down the Seti Khola (valley) to the S. The erratic gneiss boulder (■) (a further large, i.e. 3 m-long boulder is situated up-slope) lies on round-polished bedrock schist (◓) in an unstable position. At the time when the Seti Khola glacier has filled the 2.5-3 km-wide valley (Stage 0, cf.Tab 1) at this thickness (350 m), it must have reached at least as far as the Yamdi Khola (⇩). Photo M.Kuhle, 24.3.1998.

← *Photo 187.* Taken at the exit of the Triund valley from the orographic left side at 1390 m asl from the left lateral moraine root (■ white) (32°12′ 55″ N/76°21′ 10″ E) facing WNW and looking on to the opposite lateral moraine (■ black). Here, the moraine ledges (■) with their erratic augen-gneiss and granite boulders metres in size (○) up to a hut (↓) reach a height about 120 m above the talweg in the bottom of the tongue basin (□). (– –) is the surface height of the piedmont glacier tongue falling steeply away at the valley exit. Red Oligocene to Miocene sandstones outcrop in the underground. Photo M.Kuhle, 31.10.1996.

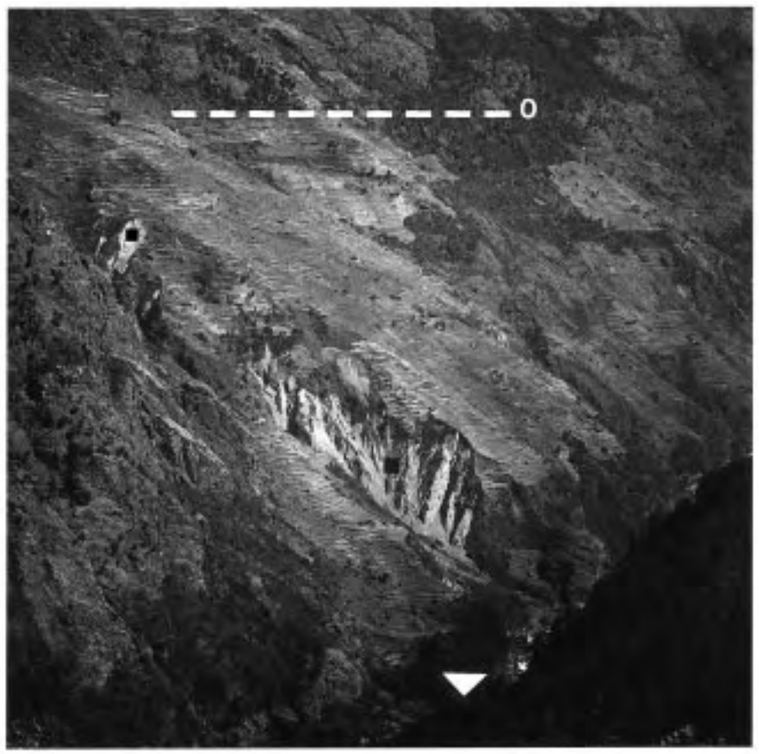
→ *Photo 191.* Edged and round-edged to facetted, but also rounded erratic granite and augen-gneiss boulders of up to 2.5 m in size from the Himalaya main-crest are situated on thinly-stratified sedimentary bedrock 60 m above the talweg on the right flank of the Madi Khola (the stick is 143 cm-long) (28°12′ 20″ N/ 84°05′ 20″ E) near the Chitepani settlement. Photo M.Kuhle, 31.1.1995.



← *Photo 188.* From Pakua (28°14′ N/83°43′ E) at c. 950 m, facing N (middle), looking at the lowest section of the trough-shaped glacier tongue basin (▢) in the lower Modi Khola between Gijan (on the right of ▢) and Dobila (left of ▢). (▢) is situated c. 1000 m up-valley of the LGM-glacier terminus (glacier mouth) of the Modi Khola glacier at c. 800 m asl. (– – 0) is the surface of its tongue, reconstructed according to the level of the kame terrace (■). Photo M.Kuhle, 16.10.1977

↓ *Photo 189.* Panorama across the Modi Khola from the orographic left flank S of Bhichuk (28°20′ 30″ N/83°48′ 20″ E, 1550 m asl) from facing SW down the trough valley (▢) with the lowest ice margin position at Dobila (↓), classified as belonging to the LGM (Stage 0), via WNW to the 3133 m-peak (No.10) up to N to the Annapurna South (No.8 = 7219 m) and to the Hiunchuli (No.9 = 6441 m), seen up-valley. (■) are ground moraine deposits; (△) shows the position of prehistoric, subglacial potholes; (– –) is the LGM glacier level. Photo M.Kuhle, 14.1.1995.

← *Photo 198.* Panorama at 1290 m asl from the orographic right flank of the Dadu valley (29°39′ 20″ N/102°11′ 10″ E) taken from 3 km upward of the junction of the Taitho: from facing NNE up the Dadu valley (⊔), via E into the orographic left flank with a bulge-shaped ground moraine cover (third ■ from the left), via SE diagonally down-valley on to a Late Glacial (Stage I,II or III, cf. Tab 1) end moraine complex (■ white) of the Taitho side glacier, as far as SSE looking into a 40 m-high ground moraine exposure (■ on the very right) on the orographic right flank of the Dadu valley. (◓) is a glacier polishing which has been freshly preserved under this moraine cover. The ground moraine (■ on the very right) contains polymict, mainly granitic, edged, round-edged to facetted boulders 1 to 2.5 m in length (○), "swimming" in a clayey matrix. (□) is a fluvial terrace of Holocene to historic age. The ground moraine accumulations (■ black) and the trough form (⊔) testify to a c. 300 m-thick prehistoric glacier-filling up to a height of the ice level about 1500 m (– –). It cannot be entirely ruled out that the over 100 m-thick, c. 400 m-high moraine remnant (■ white) concerns a lateral moraine remnant of the main glacier, which has survived in the flow shadow. However, the suggestion of a local front moraine of the Taitho-tributary glacier, which during the Late Glacial has advanced into the main valley, which was already free of ice, has to be preferred. Photo M.Kuhle, 17.6.2000.



← *Photo 192.* On the orographic right, on the slope of the Bhote Kosi, the at least 40 m-thick ground moraine (■) reaches up to 300 altitudinal-metres above the Trisuli river (▼) as far as c. 1400 m asl (– –). Here (28°12′ N/85°14′ 50″ E), between the Haku (on the right up-valley) and Donga (on the left down-valley) settlements, it testifies to a still 300 m-thick valley glacier tongue (– – 0). Photo M.Kuhle, 10.3.1998.

→ *Photo 193.* Well-preserved glacigenic flank polishings (◓) in bedrock gneiss have survived c. 800 m above the valley bottom on the orographic left, in the valley cross-profile of the Jagat settlement in the Bhote- i.e. Tamba Kosi in the SSW-slope of the Rolwaling Himalaya on the Sunthali Danda massif (27°50′ N/86°18′ E) at 2000 m asl. Photo M.Kuhle, 11.4.1998.

← *Photo 194.* Taken at 1300 m from the orographic left flank of the Tamba Kosi below the Dolakha settlement, facing NE and looking up the Tamba Kosi and then the Khare Khola. No.1 is the Cho Oyu (8205 m), No.2 the Menlungtse (7181 m), both in the Himalaya main crest. (■) is a good 200 m-high kame (27°40′05″ N/86°07′ E), heaped up against the Ice Age Tamba Kosi glacier (0 – –) from the orographic right Dolti (also Doni) Khola (→). Photo M.Kuhle, 12.4.1998.

→ *Photo 195.* Taken from 2730 m asl from the orographic left flank 1 km S of the Surke settlement (27°39′ 40″ N/86°43′ E), looking up the Dudh Kosi (valley). The Dudh Kosi glacier, which, according to glaciogeomorphologic criteria, has been classified as belonging to the LGM, has polished out a trough valley (⊔) the flanks of which indicate glacigenic abrasions (◓) as far as c. 3800 m, so that a minimum height of the prehistoric glacier surface can be reconstructed (– –). The glacier has flowed on a c. 150-200 m-thick - and in places even clearly thicker - ground moraine pedestal (■ white) over the rock bottom. In the meantime it has been dissected by the river (▼). In the pedestal of loose rock material, overthrust by the glacier, compressed glaciofluvial sediments are contained. Crumblings from the flanks, as e.g. rock falls, as well as debris fans and -cones (▽) have been deposited on its surface since the deglaciation. In the background the Late Glacial medial moraine inset (■ black) of Namche Bazar can be seen. Photo M.Kuhle 29.8.1982.

← *Photo 196.* Taken at 3200 m asl from the valley bottom of the middle Simbua Khola (27°32′ N/87°55′ 30″ E) filled with moraine, facing SW looking down-valley. (■) is a 55 m-high ground moraine exposure; opposite, on the orographic left side, the ground moraine pedestal (below ⇩) is over 200 m-high; 2.3 km down-valley at 3000 m asl, a subglacially developed ravine stretch continues. Rocks, rounded by the ground polishing, extend into it. (– – 0-I) is the LGM- to Late Glacial surface of the glacier level. (⇩) marks the position of the Ice Age Lamite Bhanjyang transfluence pass. Photo M.Kuhle, 5.5.1999.

↑ *Photo 197.* At 1580 m asl facing W, looking into the orographic right flank of the Dadu valley, made up of a mountain spur between two side valleys (30°03′ 10″ N/102°12′ E). This c. 350 m-high mountain spur has been completely overflowed and abraded by the ice (◓), so that it presents the classic form of a truncated spur. (– –) is the locally evidenced minimum surface height of the glacier. On the lower slope the spur is covered with over 10 m-thick moraine material (■ black). It contains metres-sized polymict, facetted boulders, among them granite boulders. (■ white) is a ground moraine- or kame complex at the side valley exit. Photo M.Kuhle, 9.6.2000.

In the Madi Khola (valley) the (probably LGM-) valley glacier, flowing down from the Annapurna IV, II and Lamjung Himal, has extended up to c. 630 m asl (28°12'20″ N/84°05'20″ E). This is proved by lateral moraines and erratic gneiss boulders on the orographic left (Photo 191) (Kuhle 1998a: 87).

7.4. The LGM-ice margin positions of the Langtang-, Himal SW- and Ganesh Himal SE-slope and in the S-slope of the Menlungtse-group, Rolwaling Himal (Fig. 1 No. 25)

On the orographic right flank of the Bhote Kosi as far down as its talweg (Trisuli river), decametres-thick ground moraines have been preserved (Photo 191). The lowest occurrences of ground moraine have been met at c. 900–1000 m asl near the Donga settlement. Up to here, i.e. up to the junction of the Mailung Khola (28°05′ N/85°13'20″ E), has reached the terminus of the valley glacier as a joint outlet glacier of the then connected Langtang- and Ganesh Himal ice stream network.

In the Tamba Kosi the LGM-glacier in the cross-profile at the Jagat settlement has amounted to a minimum thickness of 800 m (Photo 193) (cf. König 1999: 374). Here, at 900 m asl, a kame near the Malepu settlement (Photo 194) provides evidence of an ice thickness of still 200 m, so that the glacier tongue end might have been situated 4 km down-valley at 860 m asl, at the start of the valley narrow SW below the Marbu settlement (27°38′ N/86°06′ E).

7.5. Observations on the LGM-Dudh Kosi glacier terminus (Khumbu Himal) and the Ice Age Yalung- i.e. Simbua Khola glacier as an orographic left tributary stream of the Tamur parent glacier (Kangchendzönga) (Fig. 1 No. 4 and 26)

Heuberger (1986: 30 etc.) has described the lowest prehistoric ice margin of the Dudh Kosi glacier as being situated at 1580 m asl below the Khari-Khola inflow. The author wishes to correct his suggestion that the Dudh Kosi glacier has reached further down than up to 1800 m asl, namely up to the Deku Khola inflow (27°38′ N/86°42′ E) at 1560 m asl, during the LGM (Kuhle 1988b: 587). Due to an ice thickness about 1000-1200 m only 15 km up-valley, in the cross-profile at the Ghat settlement (Photo 195 ▬ ▬ on the right) – where the glacier surface had already lain at nearly the level of the snow-line – the author meanwhile assumes that the Dudh Kosi glacier tongue has come to an end c. 20 km further down-valley between 1100 and 900 m asl, in the confluence area with the Hingu Khola (27°29′ N/86°43′ E). Near the Jubing settlement, situated down-valley, the author has observed smooth denudation forms on the rock flanks, neither corresponding to linear erosion nor to crumblings, so that it is to be supposed that these are glacigenic abrasion forms. Unambiguous indicators, however, have not been found. Up-valley of this gorge-relief as far as the Surke settlement, these indicators, too, are largely lacking because of the extreme flushing-out and work of the torrent in the Holocene.

The author has reconstructed an Ice Age Kangchendzönga-S-slope glacier, the LGM-Tamur glacier, reaching up to the Thuma settlement at 890 m asl (Kuhle 1990b). In the lower 4 km of the Simbua Khola, Late Glacial lateral moraines of the Ghasa Stage I (cf.Tab. 1) have been found, extending at the Hellok settlement into the Tamur main valley (ibid.: 418–421). König (1999: 376, 381/82) has confirmed these results – among other findings – by an orographic right lateral moraine situated 600 m above the Simbua Khola valley bottom. During his field work in 1999, the author (Kuhle) has encountered a ground moraine pedestal in an increasing thickness in the upper to middle Simbua Khola (Photo 196 ■), which has been multifariously modified and fluvially dissected since the deglaciation. Down-valley this pedestal peters out into the level mapped as lateral moraines (Kuhle 1990b: Fig. 9, (I) half-right above Hellok). Accordingly, it is also a dissected ground moraine pedestal. In the orographic left flank of the Simbua Khola at 3400–3430 m asl, decametres-thick ground moraine deposits with rounded components and polymict boulders have been observed as far as the Lamite Bhanjyang (pass) (27°30'59″ N/87°53'45″ E; Photo 196 ⇩). All these findings prove 1. that the Simbua Khola glacier has reached the Tamur parent glacier and, until the Late Glacial, was one of its tributary streams; 2. that this valley glacier was at least 600 m-thick (▬ ▬) in its middle course and 3. has thus overflowed the Lamite Bhanjyang (pass), situated just 400 m above the valley bottom, down into the SE-adjacent Kabeli Khola at a thickness of at least 200 m. Owing to this transfluence the Simbua Khola glacier level (▬ ▬0–I) in its function as an overspill into a Himalaya fore-chain-valley without a self-glaciation worth mentioning, must have remained rather constant from the High- (LGM); Stage 0) as far as into the Late Glacial (Ghasa Stage I or even II).

7.6. The lowest LGM-ice margin position in the Dadu He valley (also Ta-tu-ho or Tung-ho) in E-Tibet (Fig. 1 No. 28)

According to field- and laboratory investigations carried out on the E-margin of Tibet, an Ice Age Dadu-He-parent-glacier has been reconstructed. Due to the fresh forms preserved and in consideration of the extremely destructive and reshaping forces of the monsoon-specific morphodynamics, it has be classified as belonging to the LGM. This main glacier has flowed down from E-Tibet and been fed by numerous side glaciers, i.e. outlet glaciers from the E-margin of the Tibetan inland ice (Kuhle 1982b, 1982c, 1987e, 1991a, 1997, 1998a), but it has also been supplied by the connection to the local ice stream network of the Minya Konka-massif. With the help of ground moraines and glacigenic lateral forms, as e.g. several hundred-metres-high kames, the LGM glacier infilling of the Che Chu (dshu), reaching the town of Kangting (also Tatsienlu, 2620 m asl) from the N, has been evidenced. Between Kangting and the inflow of the Tatsienlu-ho (valley) into the Dadu He valley at 1650 m asl, flank abrasions have widened the Tatsienlu gorge to a 'gorge-shaped trough'. Up to 600 m above the river mouth, a 30–70 m-high moraine has been preserved at the Wassöko settlement, which can be approached as a lateral-, i.e. medial-moraine between the side- and parent glacier. But on the opposite side of the tributary valley

ground moraine has also survived (30°05′ N/102°12′ E). In the course of the continuing 60 km down the Dadu valley (main valley), from Wassöko as far as the junction with the Taitho (valley), i.e. from 1620 m down to 1240 m asl, the author in many places has mapped further ground moraine covers and lateral forms in continuation of those moraines (Photo 197, 198). Additional clear evidences of the LGM-Dadu valley parent glacier occur e.g. on the orographic left side, immediately above the town of Luding (or Luting shao). Here, too, the thickness of the valley glacier might have amounted to 500–600 m. Above the inflow of the Taitho, through which the Ice Age Hailuogou- (Hailoko-) and Yan-tsöko glaciers have flowed down from the Minya Konka SE- and NE flank into the Dadu main glacier, the main glacier had still a thickness of c. 300 m (Photo 198). Accordingly, the lowest LGM-ice margin position of this eastern outlet glacier of the Tibetan inland ice must have been situated at c. 1150 m asl at 29°30′ N/102°11'30″ E. Here, below the Wantung settlement, a markedly winding, narrow gorge valley stretch starts, which was probably free of ice.

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References

Ampferer, O. (1928): Beiträge zur Glazialgeologie der westlichen Südtiroler Dolomiten.– Zeitschrift für Gletscherkunde, für Eiszeitforschung und Geschichte des Klimas, **16**: 242–260.

Bürgisser, H.M.; Gansser, A.; Pika, J. (1982): Late Glacial lake sediments of the Indus valley area, northwestern Himalaya.– Eclogae geologische Helvetica, **75** (1): 51–63.

Cronin, V.S. (1989): Structural setting of the Skardu intermontane basin, Karakoram Himalaya, Pakistan.– Geological Society of America Special Paper, **232** (Tectonics of the Western Himalayas, Eds: Manlinconico, L.L.; Lillie, R.J.): 213–216.

Dainelli, G. (1922): Studi sul Glaciale. Risultati Geologici e Geografici, Relazioni scientifiche della Spedizione Italiana De Fillipi nell' Himalaya, Caracorum e Turchestan Cinese (1913–1914). Vol. III, Ser. II.

Dreimanis, A. (1939): Eine neue Methode der quantitativen Geschiebeforschung.– Zeitschrift für Geschiebeforschung, **15**.

Dreimanis, A. (1979): Selection of genetically significant parameters for investigation of tills.– In: Schlüchter, C. (Ed): Moraines and Varves. p. 167–177; Rotterdam (Balkema).

Dreimanis, A. (1982): INQUA-Commission on Genesis and Lithology of Quaternary Deposits. Work Group (1) – Genetic classification of tills and criteria for their differentation.– In: Progress report on activities 1977–1982 and definitions of glacigenic terms. p. 12–31; Zürich (ETH Zürich).

Dreimanis, A.; Vagners, U.J. (1971): Bimodal distribution of rock and mineral fragments in basal tills.– In: Goldthwaite, R.P. (Ed): Till. p. 237–250.

Ehlers, J. (1994): Allgemeine und historische Quartärgeologie. Enke, Stuttgart. 358 p.

Engelhardt, W.v. (1973): Die Bildung von Sedimenten und Sedimentgesteinen. – Sediment-Petrologie: Engelhardt, W.v.; Füchtbauer, H.; Müller, G.; Teil III; Schweizerbart, Stuttgart. 378 p, 133 Abb., 55 Tab.

Finsterwalder, R. (1938): Die geodätischen, gletscherkundlichen und geographischen Ergebnisse der Deutschen Himalaya Expedition 1934 zum Nanga Parbat.– Deutsche Forschung, Neue Folge, mit der Karte der Nanga Parbat Gruppe 1 : 50000 und 1 : 100000, **2**.

Fort, M. (1986): Glacial extension and catastophic dynamics along the Annapurna front, Nepal Himalaya.– In: Kuhle, M. (Ed): Intern. Symp. über Tibet u. Hochasien (8.–11. Oktober 1985), Geogr. Inst. Univ. Göttingen, Göttinger Geogr. Abh. Vol. 81. S. 105–125; Göttingen.

Godwin-Austen, H.H. (1864): On the Glaciers of the Muztagh Range.– Proceedings of the Royal Geographical Society, **34**: 19–56.

Haldorsen, S. (1983): The characteristics and genesis of Norwegian tills.– In: Ehlers, J. (Ed): Glacial deposits in North-West Europe p. 11–17; Rotterdam.

Haserodt, K. (1989): Zur pleistozänen und postglazialen Vergletscherung zwischen Hindukusch, Karakorum und Westhimalaya.– Beiträge und Materialien zur Regionalen Geographie, **2**: 182–233.

Heuberger, H. (1986): Untersuchungen über die eiszeitliche Vergletscherung des Mt. Everest-Gebietes, Südseite, Nepal.– Göttinger Geographische Abhandlungen, **81** (Internationales Symposium über Tibet und Hochasien vom 8.-11.10.1985, Ed: Kuhle, M.): 29–30.

Hewitt, K. (1998): Himalayan Indus Streams in the Holocene: Glaciers-, and Landslide- 'Interupted' Fluvial Sytems.– In: Stellrecht, I. (Ed): Karakorum – Hindukush – Himalaya: Dynamics of Change. Culture Area Karakorum, Scientific Studies 1. p. 1–28; Köln (Rüdiger Köppe Verlag).

Hewitt, K. (1999): Quaternary Moraines vs Catastrophic Rock avalanches in the Karakoram Himalaya, Northern Pakistan.– Quaternary Research, **51**: 220–237.

Hewitt, K. (2001): Catastrophic Rockslides and the Geomorphology of the Hunza and Gilgit River Valleys, Karakoram Himalaya.– Erdkunde, **55**: 72–93.

Hövermann, J.; Kuhle, M. (1985): Typen von Vorlandvergletscherungen in Nordost-Tibet.– Regensburger Geographische Schriften, **19/20** (Ingo Schäfer Festschrift): 29–53.

Iturrizaga, L. (1997): Glacier outburst floods threatening the settlement Shimshal (North-West-Karakorum).– In: Mahanta, K.C. (Ed): People of the Himalayas. Journal of Human Ecology, Special Issue. Vol. 6. S. 69–76; Delhi, India (Kamla-Raj-Enterprises).

Iturrizaga, L. (1998): Die Schuttkörper in Hochasien. Eine geomorphologische Bestandsaufnahme und Typologie postglazialer Hochgebirgsschuttkörper im Hindukusch, Karakorum und Himalaya. Dissertation, Geographisches Institut der Universität Göttingen, 2 Bände (Text- und Phototeil), 320 p. & 164 p.

Iturrizaga, L. (1999): Typical debris accumulation forms and formations in High Asia.A glacial history-based concept of the origin of the Postglacial debris accumulation landscapes in subtropical high mountains with selected case examples from the Hindu Kush, the Karakoram and the Himalayas.– GeoJournal, **47** (1/2, Tibet and High Asia (V), Ed: Kuhle, M.): 277–339.

Iturrizaga, L. (2001): Lateroglacial valleys and landforms in the Karakoram Mountains (Pakistan).– GeoJournal (Tibet and High Asia VI, Glacio-geomorphology and prehistoric Glaciation in the Karakoram and Himalaya. Ed: Kuhle, M.): 291–322.

Kalvoda, J. (1992): Geomorphological Record of the Quaternary Orogeny in the Himalya and the Karakoram. Development in earth Surface Processes Elsevier, Amsterdam, Londo, New York, Tokyo. 315 p.

Kamp, U. (1999): Jungquartäre Geomorphologie und Vergletscherung im östlichen Hindukusch, Chitral, Nordpakistan.– Berliner Geographische Studien, **50** (Eds: Haserodt, K.; Weddeling, H.): 254.

Kick, W. (1956): Der Chogo-Lungma-Gletscher im Karakorum.– Zeitschrift für Gletscherkunde, **3**: 335–347.

Kick, W. (1964): Der Chogo-Lungma-Gletscher im Karakorum.– Zeitschrift für Gletscherkunde, **5**: 1–59.

Kick, W. (1991): Bericht 1989 über das Chogo-Lungma-Gletscherende.– Zeitschrift für Gletscherkunde, **25**: 139–145.

König, O. (1999): Preliminary results on the last high-glacial glaciation of the Rolwaling Himal and the Kangchenjunga Himal (Nepal, East-Himalaya).– GeoJournal, **47** (1/2, Tibet and High Asia (V), Ed: Kuhle, M.): 373–384.

Kuhle, M. (1974): Vorläufige Ausführungen morphologischer Feldarbeitsergebnisse aus den SE-Iranischen Hochgebirgen am Beispiel des Kuh-i-Jupar.– Zeitschrift für Geomorphologie, N.F. **18** (4): 472–483.

Kuhle, M. (1976): Beiträge zur Quartärgeomorphologie SE-Iranischer Hochgebirge. Die quartäre Vergletscherung des Kuh-i-Jupar.– Göttinger Geographische Abhandlungen, **67**: Bd. I: 1–209; Bd. II: 1–105.

Kuhle, M. (1980): Klimageomorphologische Untersuchungen in der Dhaulagiri und Annapurna-Gruppe (Zentraler Himalaya).– In: Tagungsbericht und wissenschaftliche Abhandlungen des 42. Deutschen Geographentag Göttingen. p. 244–247; Wiesbaden (Steiner).

Kuhle, M. (1982a): Der Dhaulagiri- und Annapurna-Himalaya. Ein Beitrag zur Geomorphologie extremer Hochgebirge.– Zeitschrift für Geomorphologie Supplement, **41** (Suppl. Bd.): Bd. I (Text): 1–229; Bd. II (Abb.): 1–183 und Geomorph. Karte 1 : 85000.

Kuhle, M. (1982b): Was spricht für eine pleistozäne Inlandvereisung Hochtibets?– Sitzungsberichte und Mitteilungen der Braunschweigischen Wissenschaftlichen Gesellschaft, **6** (Sonderband: Die Chinesisch/Deutsche Tibet-Expedition 1981, Braunschweig-Symposium vom 14.-16.04.1982): 68–77.

Kuhle, M. (1982c): Erste Chinesisch-Deutsche Gemeinschaftsexpedition nach NE-Tibet und in die Massive des Kuen-Lun-Gebirges 1981. Ein Expeditions- und vorläufiger Forschungsbericht.– In: Hagedorn, H.; Giessner, K. (Eds): Tagungsber. und wiss. Abhandlungen des 43. Deutschen Geographentages Mannheim 1981. p. 63–82; Wiesbaden (Steiner).

Kuhle, M. (1982d): An expediton to an unexplored region of Tibet. German and Chinese research in the mountains.– Reports of the DFG, German Research, **3**: 9–12.

Kuhle, M. (1982e): Periglazial- und Glazialformen und -prozesse in NE-Tibet.– Sitzungsberichte und Mitteilungen der Braunschweigischen Wissenschaftlichen Gesellschaft, Sonderheft, **6** (Die Chinesisch/Deutsche Tibet-Expedition 1981, Braunschweig-Symposium vom 14.-16.04.1982): 19–24.

Kuhle, M. (1982f): A Typology of Glaciers in relation to the vertical distance.– Journal of Glaciology and Cryopedology, **1982**: 1–26.

Kuhle, M. (1983a): Der Dhaulagiri- und Annapurna-Himalaya. Ein Beitrag zur Geomorphologie extremer Hochgebirge. Empirische Grundlage; Ergänzungsbd. III.– Zeitschrift für Geomorphologie, **41** (Suppl. Bd.): 1–383.

Kuhle, M. (1983b): A New Expedition in Tibet – a Contribution to Climatology and High Mountain Research.– Universitas, **5** (1): 59–63.

Kuhle, M. (1984a): Das Mt. Chomolungma-Massiv (Sagarmatha- oder Mt. Everest-Massiv (27°59′ N/86°56′ E) – Zur Morphologie des Himalaya zwischen tibetischem Hochland und S-lichen Vorketten.– Geographische Rundschau, **36**: 298 & 300.

Kuhle, M. (1984b): Auswertung von Spacelabaufnahmen aus Hochasien: Die Kuen-Lun-N-Abdachung zur Tsaidam-Depression (ca. 35°45′-37°40′ N/91°30'–92°52′ E) – Ausdeutung einer Satellitenphotographie über Feldarbeitsbefunde benachbarter Areale mit analoger geomorphologischer Sequenz.– Geographische Rundschau, **36**: 299 & 301.

Kuhle, M. (1984c): Zur Geomorphologie Tibets, Bortensander als Kennformen semiarider Vorlandvergletscherungen.– Berliner Geographische Abhandlungen, **36** (Ferd. v. Richthofen-Symposium 1983): 127–138.

Kuhle, M. (1984d): Former Glacier Stades in Mountain Area Surrounding Tibet.– In: 25. Congres International de Geographie Paris 1984 (27.-31.08.84), Abstracts. Vol. Tome II Thèmes 21 à 31 et 40. p. 51–52; Caen, France.

Kuhle, M. (1985a): Permafrost and Periglacial Indicators on the Tibetan Plateau from the Himalaya Mountains in the South to the Quilian Shan in the North (28–40° N).– Zeitschrift für Geomorphologie N.F., **29** (Bd. 2): 183–192.

Kuhle, M. (1985b): Ein subtropisches Inlandeis als Eiszeitauslöser. Südtibet- und Mt. Everest-Expedition 1984.– Georgia Augusta, Nachrichten aus der Universität Göttingen, **42**: 35–51.

Kuhle, M. (1985c): Glaciation Research in the Himalayas: A New Ice Age Theory.– Universitas, **27** (4): 281–294.

Kuhle, M. (1986a): Former glacial stades in the mountain areas surrounding Tibet – In the Himalayas (27–29° N: Dhaulagiri-, Annapurna-, Cho Qyu-, Gyachung Kang-areas) in the south and in the Kuen Lun and Quilian Shan (34–38° N: Animachin, Kakitu) in the north.– In: Joshi, S.C.; Haigh, M.J.; Pangtey, Y.P.S.; Joshi, D.R.; Dani, D.D. (Eds): Nepal-Himalaya – Geo-Ecological Perspektives. p. 437–473.

Kuhle, M. (1986b): New Research in High Asia, Tibet and the Himalayas (The International Symposium on Tibet and High Asia, October 8.-11. 1985 in Göttingen).– GeoJournal, **12** (3): 341–343.

Kuhle, M. (1986c): The South Tibet and Mt. Everest-Expedition 1984 – Geographical investigations in High Asia. Wissenschaftlicher Tonfilm, 45 min. Farbtonfilm Film D 1607, Produktion des Instituts für den wissenschaftlichen Film (IWF). Göttingen (German and English Version).

Kuhle, M. (1986d): Südtibet- und Mt. Everest-Expedition 1984- oder: Ein subtropisches Inlandeis als Eiszeitauslöser?– Universitas, **41** (1): 64–78.

Kuhle, M. (1986e): Die Vergletscherung Tibets und die Entstehung von Eiszeiten.– Spektrum der Wissenschaften; Scientific American, **9/86**: 42–54.

Kuhle, M. (1987a): Absolute Datierungen zur jüngeren Gletschergeschichte im Mt Everest-Gebiet und die mathematische Korrektur von Schneegrenz-berechnungen.– In: Hütteroth, W.-D. (Ed): Tagunsbericht und wissenschaftliche Abhandlungen des 45. Deutschen Geographentages Berlin 1985. p. 200–208; Stuttgart (Steiner).

Kuhle, M. (1987b): A numerical classification of glaciers by means of specific relief parameter.– Journal of Glaciology and Geocryology, **9** (3, Sept. 1987, Chinese Society of Glaciology and Cryopedology, Academia Sinica): 207–214.

Kuhle, M. (1987c): Glacial, Nival and Periglacial Environments in Northeastern Quinghai-Xizang-Plateau.– In: Hövermann, J.; Wenjing, W. (Eds): Reports on the Northeastern part of the Quinhai-Xizang (Tibet)-Plateau by the Sino-West-German Scientific Expedition 1981. p. 176–244; Beijing, China (Science Press).

Kuhle, M. (1987d): Die Rekonstruktion des kaltzeitlichen Tibet-Eises und Energiebilanzmessungen bis 6650m ü.M. als Basis einer reliefspezifischen Eiszeittheorie.– In: Becker, H. (Ed): Tagungsbericht und wissenschaftliche Abhandlungen des 46. Deutschen Geographentages München 1987. Vol. 46. Ak-Sitzung 'Neuere Forschungen in der Klimatologie'. p. 600–601; Stuttgart (Steiner).

Kuhle, M. (1987e): The Problem of a Pleistocene Inland Glaciation of the Northeastern Qinghai-Xizang-Plateau.– In: Hövermann, J.; Wenjing, W. (Eds): Reports on the Northeastern Part of Quinghai-Xizang (Tibet)-Plateau by the Sino-German Scientific Expedition 1981. p. 250–315; Beijing, China (Science Press).

Kuhle, M. (1987f): Subtropical Mountain- and Highland-Glaciation as Ice Age Triggers and the Waning of the Glacial Periods in the Pleistocene.– GeoJournal, **14** (4): 393–421.

Kuhle, M. (1987g): Die Wiege der Eiszeit.– Geo, **1987** (2): 80–94.

Kuhle, M. (1988a): Neueste physisch-geographische Forschungsergebnisse aus Hochtibet und angrenzenden Gebieten.– In: Becker, H. (Ed): Tagungsbericht und wissenschaftliche Abhandlungen des 46. Deutschen Geographentages München 1987. p. 605–607; Stuttgart (Steiner).

Kuhle, M. (1988b): The Pleistocene Glaciation of Tibet and the Onset of Ice Ages- An Autocycle Hypothesis.– GeoJournal, **17** (4, Tibet and High-Asia. Results of the Sino-German Joint Expeditions (I), Eds: Kuhle, M.; Wang Wenjing): 581–596.

Kuhle, M. (1988c): The Pleistocene Glaciation of Tibet and the Onset of Ice Ages – An Autocyclic Hypothesis.– In: International Congress 'The Neogene of Karakoram and Himalayas' March 21th – 23rd, 1988. p. 11; Leicester, UK; Abstract (Department of Geography, University of Leicester).

Kuhle, M. (1988d): Zur Geomorphologie der nivalen und subnivalen Höhenstufe in der Karakorum-N-Abdachung zwischen Shaksgam-Tal und K2 Nordsporn: Die quartäre Vergletscherung und ihre geoökologische Konsequenz.– In: Becker, H. (Ed): Tagungsbericht und wissenschaftliche Abhandlung des 46. Deutschen Geographentag 1987 München. p. 413–419; Stuttgart (Steiner).

Kuhle, M. (1988e): Die eiszeitliche Vergletscherung W-Tibets zwischen Karakorum und Tarim-Becken und ihr Einfluâ auf die globale Energiebilanz.– Geographische Zeitschrift, **76** (3): 135–148.

Kuhle, M. (1988f): Zur Auslöserrolle Tibets bei der Entstehung von Eiszeiten.– Spektrum der Wissenschaften; Scientific American, **1/88**: 16–20.

Kuhle, M. (1988g): Geomorphological Findings on the Build-up of Pleistocene Glaciation in Southern Tibet, and on the Problem of Inland Ice. Results of the Shisha Pangma and Mt. Everest Expedition 1984.– Geo-

Journal, 17 (4, Tibet and High-Asia, Results of the Sino-German Joint Expeditions (I), Eds: Kuhle, M.; Wang Wenjing): 457–513.

Kuhle, M. (1988h): Letzteiszeitliche Gletscherausdehnung vom NW-Karakorum bis zum Nanga Parbat (Hunza-Gilgit- und Indusgletschersystem).– In: Becker, H. (Ed): Tagungsbericht und wissenschaftliche Abhandlungen des 46. Deutschen Geographentages München 1987. AK- Sitzung 'Neueste physisch-geographische Forschungsergebnisse aus Hochtibet und angrenzenden Gebieten'. p. 606–607; Stuttgart (Steiner).

Kuhle, M. (1988i): Die Depression der Schneegrenzen – Neuere Erkenntnisse zur Eiszeit.– Forschung – Mitteilungen der DFG, **1/88**: 19–22.

Kuhle, M. (1988j): Eine reliefspezifische Eiszeittheorie. Nachweis einer tibetischen Inlandvereisung und ihrer energetischen Konsequenzen.– Die Geowissenschaften, **6** (5): 142–150.

Kuhle, M. (1988k): Snow-Line Plunge changed the Face of the Old World.– Reports of the DFG, German Research, **3**: 15–18.

Kuhle, M. (1988l): Topography as a Fundamental Element of Glacial Systems. A New Approach to ELA-Calculation and Typological Classification of Paleo- and Recent Glaciation.– GeoJournal, **17** (4, Tibet and High-Asia, Results of the Sino-German Joint Expeditions (I), Eds: Kuhle, M.; Wang Wenjing): 545–568.

Kuhle, M. (1988m): Subtropical Mountain- and Highland-Glaciation as Ice Age Triggers and the Waning of the Glacial Periods in the Pleistocene.– Chinese Translation Bulletin of Glaciology and Geocryology, **5** (4): 1–17.

Kuhle, M. (1988n): Heutige und eiszeitliche Vergletscherung Hochtibets. Ergebnisse der Südtibet- und Mt. Everest Expedition 1984.– Publikationen zu wissenschaftlichen Filmen des Institutes für den Wissenschaftlichen Film (IWF), Sektion Naturwissenschaften, Serie 10, D 1649: 1–36.

Kuhle, M. (1988o): Heutige und eiszeitliche Vergletscherung Hochtibets. Ergebnisse der Südtibet- und Mt.-Everest-Expedition 1984. Wissenschaftlicher Tonfilm, 43,5 min. Farbtonfilm Film D 1649, Produktion des Instituts für den wissenschaftlichen Film (IWF). Göttingen (German and English version).

Kuhle, M. (1989): Die Inlandvereisung Tibets als Basis einer in der Globalstrahlungsgeometrie fussenden, reliefspezifischen Eiszeittheorie.– Petermanns Geographische Mitteilungen, **133** (4): 265–285.

Kuhle, M. (1989a): The cyclus of the ice-age – an Ice-Age-Theory on the reconstruction of a Tibetan Ice Sheet.– Studia Geomorphologica carpathobalcanica, **13**: 163–186.

Kuhle, M. (1989b): Ice-Marginal Ramps: An Indicator of Semiarid Piedmont Glaciations.– GeoJournal, **18**: 223–238.

Kuhle, M. (1989c): Die terrestrisch induzierte Eiszeitära des Quartärs und der extraterrestrisch ausgelöste Interglazialzyklus.– In: Jahrbuch der Marburger Geographischen Gesellschaft und des Fachbereichs Geographie der Phillipps-Universität (MGG). p. 178–180; Marburg/Lahn.

Kuhle, M. (1990a): The Cold Deserts of High Asia (Tibet and Contiguous Mountains).– GeoJournal, **20** (3): 319–323.

Kuhle, M. (1990b): New Data on the Pleistocene Glacial Cover of the Southern Border of Tibet: The Glaciation of the Kangchendzönga Massif (8585m, E-Himalaya).– GeoJournal, **20**: 415–421.

Kuhle, M. (1990c): The Probability of Proof in Geomorphology – an Example of the Application of Information Theory to a New Kind of Glacigenic Morphological Type, the Ice-marginal Ramp (Bortensander).– GeoJournal, **21** (3): 195–222.

Kuhle, M. (1990d): Geographische Forschungen in Hochasien. Neue Daten zur Rekonstruktion des pleistozänen Tibetischen Inlandeises – Befunde der Expedition 1989.– In: Jahrbuch der Marburger Geographischen Gesellschaft und des Fachbereiches Geographie der Phillipps-Universität. Vol. 1990. p. 19–22; Marburg/Lahn ().

Kuhle, M. (1990e): Bericht über Beiträge der Arbeitskreissitzung: Neue Forschungen in Hochasien (Arbeitskreis Hochasien) auf dem Deutschen Geographentag in Saarbrücken 1989.– Geographische Rundschau, **42** (6): 356–357.

Kuhle, M. (1990f): The Glaciation of Tibet and its Global Climatic Effects.– Universitas, **32** (3): 229–240.

Kuhle, M. (1990g): Ice Marginal Ramps and Alluvial Fans in Semi-Arid Mountains: Convergence and Difference.– In: Rachocki, A.H.; Church, M. (Eds): Alluvial fans – A field approach. Vol. 3. p. 55–68;Chester-New York-Brisbane-Toronto-Singapore (John Wiley & Sons Ltd).

Kuhle, M. (1991): Die Vergletscherung Tibets und ihre Bedeutung für die Geschichte des nordhemisphärischen Inlandeises.– Sitzungsberichte der Akademie der Wissenschaften und der Literatur Mainz, Paläoklimaforschung, **1** (Klimageschichtliche Probleme der letzten 130 000 Jahre, Ed: Frenzel, B.): 293–306.

Kuhle, M. (1991a): Observations Supporting the Pleistocene Inland Glaciation of High Asia.– GeoJournal, **25** (2/3, Tibet and High Asia, Results of the Sino-German Joint Expeditons (II), Eds: Kuhle, M.; Xu Daoming): 133–233.

Kuhle, M. (1991b): Glazialgeomorphologie. Wissenschaftliche Buchgesellschaft, Darmstadt. 213 p.

Kuhle, M. (1991c): New Results on the Pleistocene Glaciation of Tibet and its impact in Glacioisostatic Movement of the Plateau.– Bulletin of the INQUA-Neotectonics-Commission, **14**: 87.

Kuhle, M. (1991d): The Pleistocene Glaciation of Tibet and the Onset of Ice-Ages – An Autocycle Hypothesis. International Union for Quarternary Research, Special Proceedings, Review Reports; INQUA 1991, Symposia 4: Quaternary Paleo-Ice-Cap and Inland-Ice of the Tibetan plateau; XIII International Congress, August 2–9, 1991, Beijing, China: 72.

Kuhle, M. (1992): New Findings on the Ice-cover in between Issyk-Kul and K2 (Tian Shan, Karakorum) during the Last Glaciation.– In: (): Abstracts. International Symposium on the Karakorum an Kunlun Mountains June 5–9, 1992 Kashi China. p. 76;Kashi, China (Chinese Academy of Sciences (CAS), National Natural Science Foundation of China (NSFC), Centre National de la Recherche Scientifique (CNRS)).

Kuhle, M. (1993): The Pleistocene Glaciation of the Himalaya and Tibet and its Impact on the Global Climate: A Relief-specific Ice Age Theory.– Journal of the Nepal Research Center (JNRC), **9**: 101–140.

Kuhle, M. (1993a): Eine Autozyklentheorie zur Entstehung und Abfolge der quartären Kalt- und Warmzeiten auf der Grundlage epirogener und glazialisostatischer Bewegungsinterferenzen im Bereich des tibetischen Hochlandes.– Petermanns Geographische Mitteilungen, **137** (3): 133–152.

Kuhle, M. (1993b): A Short Report of the Tibet Excursion 14–A, Part of the XIII INQUA Congress 1991 Beijing.– GeoJournal, **29** (4): 426–427.

Kuhle, M. (1994a): Tibet and High-Asia. Results of the Sino-German and Russian-German Joint Expeditions (III).– GeoJournal, **33** (2/3, Tibet and High Asia, Ed: Kuhle, M.): 131–328.

Kuhle, M. (1994b): Present and Pleistocene Glaciation on the North-Western Margin of Tibet between the Karakorum Main Ridge and the Tarim Basin Supporting the Evidence of a Pleistocene Inland Glaciation in Tibet.– GeoJournal, **33** (2/3, Tibet and High Asia, Results of the Sino-German and Russian-German Joint Expeditions (III), Ed: Kuhle, M.): 133–272.

Kuhle, M. (1994c): New Findings on the Glaciation in High Asia: Results of the Expeditions 1989, 1992, 1993 to Central Tibet and the Western Karakorum and Himalaya Mountains. International Symposium and Field Workshop on Glacial Deposits in Monsoon Asia, 27.07.1997, Lanzhou, China; Abstract: 13.

Kuhle, M. (1994d): New Findings on the Ice-cover between Issyk-Kul and K2 (Tian Shan, Karakorum) during the Last Glaciation.– In: Zheng Du; Zhang Qingsong; Pan Yusheng (Eds): Proceedings of the International Symposium on the Karakorum and Kunlun Mountains (ISKKM), Kashi, China, June 1992. p. 185–194; Beijing (China Meteorological Press).

Kuhle, M. (1995a): Glacial Isostatic Uplift of Tibet as a Consequence of a Former Ice Sheet.– GeoJournal, **37** (4): 431–449.

Kuhle, M. (1995b): New Results Concerning the Age Glaciation of Pamir, Karakorum and Himalaya: Findings of the Expeditions 1992–1994/95. Abstracts of the International Symposium on Karakorum-Hindukush-Himalaya: Dynamics of Change, Sept. 29th- Oct. 2nd, 1995, Islamabad, Pakistan.

Kuhle, M. (1995c): New Results concerning the Ice Age Glaciation in High Asia, in particular the Ice Sheet Glaciation of Tibet – Findings of the Expeditions 1991–1995.– Terra Nostra, Schriften der Alfred-Wegener-Stiftung, **2** (International Union for Quaternary Research XIV, International Congress, Berlin): 149.

Kuhle, M. (1995d): New Findings on the Former Glaciation of Russian Tian Shan (Kirgizia) and Eastern Sajan Mountains in South Sibiria and its Climatic Implication. Global Changes and Geography, The IGU Conference Moscow, Russia, August 14.–18., 1995, Moscow; Abstract: 193.

Kuhle, M. (1996): Rekonstruktion der maximalen eiszeitlichen Gletscherbedeckung im Nanga Parbat Massiv (35°05′–40° N/74°20′–75° E).– Beiträge und Materialien zur Regionalen Geographie, **8**

(Forschung am Nanga Parbat. Geschichte und Ergebnisse, Ed: Kick, W.) Inst. f. Geographie, Technische Universität Berlin: 135–156.

Kuhle, M. (1996a): Die Entstehung von Eiszeiten als Folge der Hebung eines subtropischen Hochlandes über die Schneegrenze – dargestellt am Beispiel Tibets.– Der Aufschluss, **47** (4): 145–164.

Kuhle, M. (1996b): Glazial-geomorphologische Expedition in die Karakorum-Nordseite 1986.– Publikationen zu wissenschaftlichen Filmen des Institutes für den Wissenschaftlichen Film (IWF), Technische Wissenschaft/Naturwissenschaft, **12** (Film C 1856): 185–256.

Kuhle, M. (1997): New Findings concerning the Ice Age (Last Glacial Maximum) Glacier Cover of the East-Pamir, of the Nanga Parbat up to the Central Himalaya and of Tibet, as well as the Age of the Tibetan Inland Ice.– GeoJournal, **42** (2–3, Tibet and High Asia. Results of Investigations into High Mountain Geomorphology, Paleo- Glaciology and Climatology of the Pleistocene (Ice Age Research) IV, Ed: Kuhle, M.): 87–257.

Kuhle, M. (1997a): Tibet and High-Asia IV, Results of Investigations into High Mountain Geomorphology, Paleo-Glaciology and Climatology of the Pleistocene (Ice Age Research). Geojournal **42** (2/3); Ed. Kuhle, M. Kluwer, London/ Dordrecht/ Boston. 85–336 p.

Kuhle, M. (1997b): The Ice-Age Glaciation of West-Tibet between Karakorum and Tarim Basin (W-Tibet) and its Impact on the Global Energy Budget.– In: Shams, F.A.; Nawaz, M. (Eds): Volume of Abstracts. Colloquium on Geology and the Human Life Lahore: 4.-6.01.1997. p. 53–54;Lahore (Pakistan Academy of Geological Science).

Kuhle, M. (1997c): Periglacial Keyforms and Indicators of Permafrost and their Relationships with Ice Age Glacier Surfaces in Asia.– Frozen Ground, International Permafrost Association, **21**: 11.

Kuhle, M. (1998a): Reconstruction of the 2.4 Million qkm Late Pleistocene Ice Sheet on the Tibetan Plateau and its Impact on the Global Climate.– Quaternary International, **45/46**: 71–108 (Erratum: Vol. 47/48:173–182 (1998) included).

Kuhle, M. (1998b): Neue Befunde zur hochglazialen (riâ- bis würmzeitlichen) Inlandvereisung Tibets aus Süd- bis Zentralwest-Tibet mit weiteren Hinweisen auf ihre global-klimatische Bedeutung als Eiszeitauslöser.– Berliner Geographische Abhandlungen, **63** (Forschungsergebnisse zur Klimageschichte und Reliefentwicklung Nordafrikas und Asiens. Dieter Jäkel-Festschrift, Eds: Böse, M.; Hofmann, J.): 121–151.

Kuhle, M. (1998c): New Findings on the Inland Glaciation of Tibet from South and Central West Tibet with Evidences for its Importance as an Ice Age Trigger.– Himalayan Geology, **19** (2, The role of the Tibetan Plateau in forcing global climatic changes, Ed: Tandon, O.P.): 3–22.

Kuhle, M. (1998d): Weitere Befunde zur hoch- (pre-LGM und LGM) und spätglazialen Gletscherbedeckung in Süd-, Zentral- und Westtibet.– In: Hubberten (Ed): Band für Alfred Wegener Institut, Potsdam, 8. u. 9.5.1998.

Kuhle, M. (1998e): New Findings Supporting the Pleistocene Ice Sheet on the Tibetan Plateau: Results of the researches 1992–1997.– In: Fukusawa, H. (Ed): Palaeohydrology with an emphasis on humid, temperate and tectonically active Zones. Kumagaya and the Japan Alps 4-11.09.1998. Abstracts.;Kumagaya/Japan; Abstract ().

Kuhle, M. (1998f): Late Pleistocene Megaflood Deposits as a product of numerous outbreaks of Late Glacial ice dammed lakes in Tibet and its bordering mountains.– A new concept for High Asia deduced from a very extended glaciation.– In: (): Symposium on flood and Megaflood Deposits: Recent and ancient examples. 15th International Sedimentological Congress IAS, Alicante, Spain, 13–17th, April 1998. p. 2; Alicante.

Kuhle, M. (1998g): Landschaftsentwicklung extremen Hochgebirges. Karakorum und Kuenlun. Begleittext zum Film C 2017 'Karakorum'.– Publikationen zu wissenschaftlichen Filmen des Institutes für den Wissenschaftlichen Film (IWF), Technische Wissenschaft/Naturwissenschaft, **13**: 97–147.

Kuhle, M. (1998h): Neue Ergebnisse zur Eiszeitforschung Hochasiens in Zusammenschau mit den Untersuchungen der letzten 20 Jahre.– Petermanns Geographische Mitteilungen, 142, **3/4** (Eds: Pachur, H.-J.; Wünnemann, B.): 219–226.

Kuhle, M. (1998i): The Mechanism of the Genesis of Ice Ages induced by the Uplift of the Tibetan Plateau.– In: Owen, L. (Ed): 1998 Annual Meeting of IGCP 415 Grand & Meetings of Working Groups 2 & 7, Manali and the Lahul Himalaya, Abstracts. p. 4; Riverside (University of California).

Kuhle, M. (1998j): New Findings Supporting the Pleistocene Ice Sheet on the Tibetean Plateau: Results of the researches 1992–1997.– In: Owen, L. (Ed): 1998 Annual Meeting of IGCP 415 Grand & Meetings of Working Groups 2 & 7, Manali and the Lahul Himalaya, Abstracts. p. 3; Riverside (University of California).

Kuhle, M. (1998k): The Ice Age Glaciation of East-Pamir (36°40′–39°10′ N/74°40′—76°10′ E).– In: Stellrecht, I. (Ed): Karakorum – Hindukush – Himalaya: Dynamics of Change. Culture Area Karakorum, Scientific Studies 4/1. p. 29–47; Köln (Rüdiger Köppe Verlag).

Kuhle, M. (1999): Reconstruction of an approximately complete Quaternary Tibetan Inland Glaciation between the Mt. Everest- and Cho Oyu Massifs and the Aksai Chin. – A new glaciogeomorphological southeast-northwest diagonal profile through Tibet and its consequences for the glacial isostasy and Ice Age cycle.– GeoJournal, **47** (1–2, (Results of Investigations into High Mountain Geomorphology, Paleo-Glaciology and Climatology of the Pleistocene), Tibet and High Asia (V), Ed: Kuhle, M.): 3–276.

Kuhle, M. (1999a): Tibet and High Asia (V) (Results of Investigations into High Mountain Geomorphology, Paleo-Glaciology and Climatology of the Pleistocene) GeoJournal **47** (1/2); Ed. Kuhle, M. Kluwer Academic Press, London/ Dordrecht/ Boston. 394 p.

Kuhle, M. (1999b): Maximum ice cover in High Asia during the Ice Age – its extent, age and paleoclimatic impact.– Terra Nostra, Schriften der Alfred-Wegener-Stiftung, **99** (2, 14th Himalaya-Karakorum-Tibet Workshop, Kloster Ettal 24.–26. March 1999, Eds: Sobel, E.; Appel, E.; Strecker, M.; Ratschbacher, L.; Blisniuk, P.): 90–91.

Kuhle, M. (1999c): The Uplift of Tibet above the Snowline and its Complete Glaciation as Trigger of the Quaternary Ice Ages – A Hypothesis for the Ice Age Development. Abstract.– Geological Society of America (GSA) Publications, **31**: 141.

Kuhle, M. (2000a): The Uplift of Tibet above the Snowline and its Complete Glaciation as Trigger of the Quaternary Ice Ages. – A Hypothesis for Ice Age Development.– International Project on Paleolimnology and Late Cenozoic Climate IPPCCE, **13** (Ed: Shoji Horie): 36–59.

Kuhle, M. (2000b): Pleistocene Glaciations in the Himalayas and Tibet: New Findings from the Himalaya North Slopes to Central and Western Tibet.– Marburger Geographische Schriften, **135** (Environmental Changes in High Asia. Proceedings of an International Symposium 29th of May to 1st of June 1997 under the auspices of the UNESCO, Eds: Miehe, G.; Zhang Yili): 1–14.

Kuhle, M. (2000c): New Findings Supporting the Pleistocene Ice Sheet on the Tibetan Plateau as a Trigger of the Quaternary Ice Ages – A Hypothesis for Ice Age Development.– In: Zheng Du; Zhu Liping (Eds): Formation and Evolution, Enviromental Changes and Sustainable Development on the Tibetan Plateau – Proccedings of International Symposium on the Qinghai-Tibetan Plateau (Xining 1998). p. 96–115; Xining, China (Academy Press).

Kuhle, M. (2002): A relief-specific model of the ice age on the basis of uplift-controlled glacier areas in Tibet and the corresponding albedo increase as well as their positiv climatological feedback by means of the global radiation geometry.– Climate Research, **20**: 1–7.

Kuhle, M.; Grosswald, M.G.; Dyurgerov, M.B. (1997): Quaternary Glaciation in North-Western High-Asia.– Data of Glaciological Studies, **81** (Proceedings of the International Symposium 'Seasonal and Longterm Fluctuations of Nival and Glacial Processes in Mountains', Tashkent Symposium 12-19.09.1993): 70–79.

Kuhle, M.; Herterich, K.; Calov, R. (1989): On the Ice Age Glaciation of the Tibetan Highlands and its Transformation into a 3-D Model.– GeoJournal, **19** (2): 201–206.

Kuhle, M.; Jacobsen, J.P. (1988): On the Geoecology of Southern Tibet – Measurements of Climate Parameters including Surface- and Soil-Temperatures in Debris, Rock, Snow, Firn and Ice during the South Tibet- and Mt. Everest Expedition in 1984.– GeoJournal, **17** (4, Tibet and High-Asia, Results of the Sino-German Joint Expeditions (I), Eds: Kuhle, M.; Wang Wenjing): 597–615.

Kuhle, M.; Kleindienst-Andreé, D. (1994): Glazial-geomorphologische Expedition in die Karakorum-Nordseite 1986. Filmton-Farbfilm 16mm, Dauer 88min, produziert im Institut für den wissenschaftlichen Film (IWF); Film: V 2520–C 1856, Göttingen (German and English Version).

Kuhle, M.; Kleindienst-Andreé, D. (1998): Landschaftsentwicklung extremen Hochgebirges. Karakorum und Kuenlun. Lichtton-Farbfilm C 2017 'Karakorum',Institut für den Wissenschaftlichen Film (IWF), 50 Min; Göttingen (German and English version).

Kuhle, M.; Kuhle, S. (1997): Der quartäre Klimawandel – System oder geschichtliches Ereignis? Überlegungen zur geographischen Methode am Beispiel von Eiszeittheorien.– Erdkunde, **51**: 114–130.

Kuhle, M.; Meiners, S.; Iturrizaga, L. (1998): Glacier-Induced Hazards as a Consequence of Glacigenic Mountain Landscapes, in Particular Glacier- and Moraine-Dammed Laks Outbursts and Holocene Debris Production.– In: Kalvoda, J.; Rosenfeld, C.L. (Eds): Geomorphological Hazards in High Mountain Areas. (GeoJournal Library.), p. 63–96; Netherlands (Kluver Academic Publishers).

Kuhle, M.; Wenjing, W. (1988): The Sino-German Joint Expedition to Southern Tibet, Sisha Pangma and the Northern Flank of Chomolungma (Mt. Everest) 1984.– GeoJournal, **17** (4, Tibet and High-Asia, Results of the Sino-German Joint Expeditions (I), Eds: Kuhle, M.; Wang Wenjing): 447–455.

Kuhle, M.; Daoming, X. (1991): Results of the Sino-German Joint Expeditions (II).– GeoJournal, **25** (2/3, Tibet and High Asia, Eds: Kuhle, M.; Xu Daoming): 131–303.

Kuhle, M.; Xu Daoming (1999): Quaternary glaciation in the Qinghai-Xizang (Tibetan) Plateau.– In: Zheng Benxing; Shen Yongping (Eds): Problems on Quaternary Glaciation Research in the Qinghai-Tibetan Plateau. Contributions Collections of Research on Quaternary Glaciation and Environments in the Qinghai-Tibetan Plateau. Vol. 3. p. 480–484; Lanzhou, China (Lanzhou Institute of Glaciology and Geocryology, Chinese Academy of Sciences).

Lydekker, R. (1881): Geology of part of Dardistan, Baltistan and Neighbouring Districts.– Rec. GsuI., **14**.

Lydekker, R. (1883): The Geology of Kashmir and Chamba Territories.– Mem. Gsul., **22**.

Maull, O. (1958): Handbuch der Geomorphologie. 2nd ed. Verlag Franz Deuticke, Wien. 642 p.

Meiners, S. (1996): Zur Rezenten, Historischen und Postglazialen Vergletscherung an ausgewählten Beispielen des Tien Shan und des Nord-West-Karakorum.– GeoAktuell, **2**: 1–200.

Meiners, S. (1997): Historical to Postglacial glaciation and their differentiation from the Late Glacial period on examples of the Tian Shan and the N.W. Karakorum.– GeoJournal, **42** (2–3, Tibet and High Asia, Results of Investigations into High Mountain Geomorphology, Paleo-Glaciology and Climatology of the Pleistocene (Ice Age Research IV), Ed: Kuhle, M.): 259–302.

Meiners, S. (1998): Beobachtungen zur jüngeren Vergletscherungsgeschichte im Nordwestkarakorum und zentralen Tienschan.– Petermanns Geographische Mitteilungen, **142** (3/4): 227–232.

Meiners, S. (2001): The post to late glacial valley reconstruction on the Haramosh north side (Mani, Baska, Phuparash valleys).– GeoJournal, (Tibet and High Asia VI, Glacio-geomorphology and prehistoric Glaciation in the Karakoram and Himalaya): Ed.: Kuhle, M.): 323–344.

Nielsen, P.E. (1983): Lithology and genesis of Danish tills.– In: Ehlers, J. (Ed): Glacial deposits in North-West Europe. p. 193–196; Rotterdam.

Norin, E. (1925): Preliminary notes on the late Quaternary glaciation of the Northwest Himalaya.– Geografiske Annaler, **7**.

Oestreich, K. (1906): Die Täler des nordwestlichen Himalaya.– Petermanns Geographische Mitteilungen, Ergänzungsband, **155**: 1–106.

Owen, L. (1988a): Terraces, Uplift and Climate, the Karakoram Mountains, Northern Pakistan. Unpublished Ph.D. thesis, Department of Geography, university of Leicester, UK (unpublished).

Owen, L. (1988b): Wet-sediment deformtion of Quaternary and recent sediments in the Skardu Basin, Karakoram mountains, Pakistan.– In: Grott, D.G. (Ed): Glaciotectonics. Forms and Processes; Rotterdam (Balkema).

Schneider, H.J. (1956): Geologische und erdmagnetische Arbeiten im NW-Karakorum.– Erdkunde, **10**: 1–93.

Schneider, H.J. (1957): Tektonik und Magmatismus im NW-Karakorum.– Geologische Rundschau, **46**: 426–476.

Schreiner, A. (1992): Einführung in die Quartärgeologie. 257 p.

Searle, M.P. (1991): Geology and Tectonics of the Karakoram Mountains. John Wiley & Sons, New York, London. 358 S.

Shroder, J.F. (1989): Geolosphic development of the W-Himalayas.

Shroder, J.F., Jr.; Owen, L.; Derbyshire, E. (1993): Quaternary glaciation of the Karakoram and Nanga Parbat Himalaya.– In: Shroder, J.F., Jr. (Ed): Himalaya to the sea: Geology, Geomorphology and the Quaternary. p. 132–158; New York (Routledge).

Troll, C. (1938a): Der Nanga Parbat als geographische Erscheinung. Ein Bildbericht.– Zeitschrift für Erdkunde, **6** (1/7): .

Troll, C. (1938b): Der Nanga Parbat als Ziel deutscher Forschung.– Zeitschrift der Gesellschaft für Erdkunde Berlin, **73**: 1–26.

Tucker, M. (1996): Methoden der Sedimentologie. 366 p.

Visser, P.C. (1935): Gletscherbeobachtungen im Karakorum.– Zeitschrift für Gletscherkunde, **22**: 20–45.

Visser, P.C. (1938): Glaziologie. Wissenschaftliche Ergebnisse der niederländischen Expedition in den Karakorum und die angrenzenden Gebiete in den Jahren 1922, 1925 und 1929/30 und 1935. Hersg. DH. C. Visser u. Jenny Visso-Hooft; Bd. II; E.J. Brill, Leiden: 1–216.

Wissmann, H.v. (1959): Die heutige Vergletscherung und Schneegrenze in Hochasien mit Hinweis auf die Vergletscherung der letzten Eiszeit.– Akademie der Wissenschaften und der Literatur Mainz, Mathetematisch-naturwissenschaftliche Klasse, **14**: 1103–1407.

Zanettin, B. (1964): Geology and Petrology of Haramosh Mango Gusor Area.– In: Italian Expeditions to the Karakoram (K2) and Hindu Kush. Vol. III Geology-Petrology; Leiden (Brill).