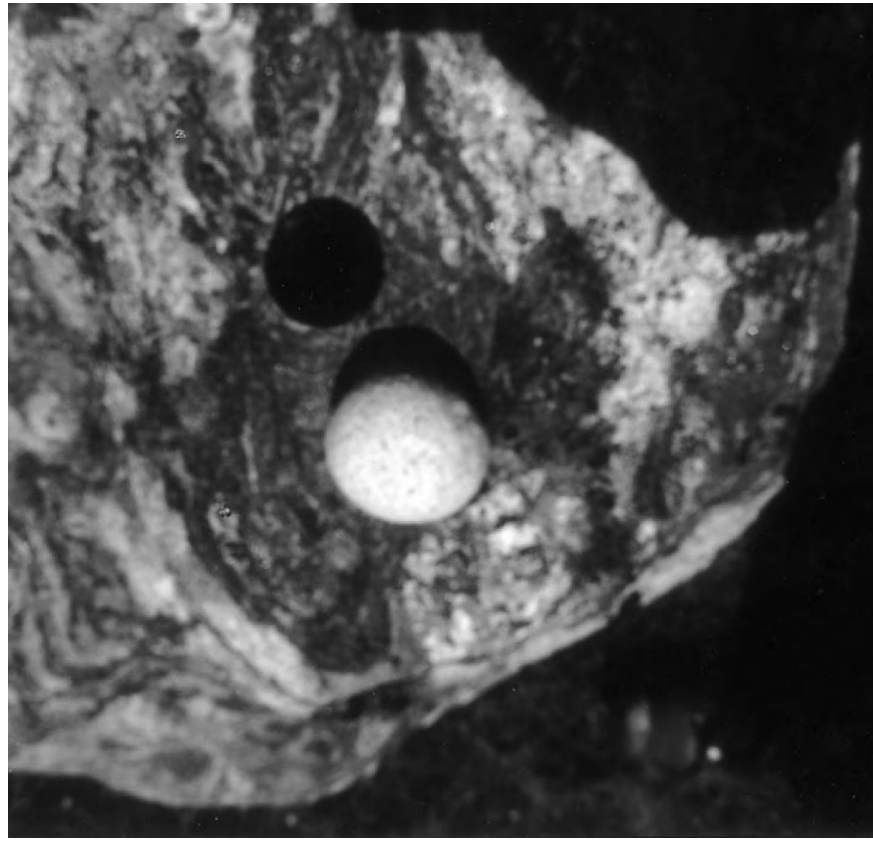


← *Photo 173.* Panorama photograph taken from the orographic right valley flank of the Bote Koshi Drangka WNW above the Thame Teng alpine pasture at 4550 m a.s.l. (Figure 3 Panorama 173) from facing N (left margin) along the orographic right valley flank up the Bote Koshi Drangka on to the 7352 m-high Nangpai Gosum (No. 5) up to facing NNE with the 8202 m-high Cho Oyu (No. 4) and the 5941 m-peak (No. 72) situated 15 km nearer, into the orographic left flank of the Bote Koshi (right margin). On the valley flanks ground moraine covers (■) are preserved up to altitudes of 4800 m a.s.l. (up to above ■ black on the right). (IV) marks late Late Glacial remnants of ground moraine pedestals (terraces of pedestal moraines) of the Sir-kung-Stage (Table 1), the terraces of which (IV black, bold) reach altitudes of 400–500 m above the valley bottom. (IV vertically below No. 4) is the sampling locality of sample 30.3.03/1 (Figure 77; Figure 37 No. 34). (V) are the tongue basins and end moraines of neoglacial side- and hanging glacier tongues of the Nauri-Stage, adjusted to this terrace of pedestal moraine. (VII) are end moraines of the middle Dhaulagiri-Stage. (▼) are gullies which since the Late Glacial deglaciation have been cut into the decametres-thick ground moraine pedestal. (▽) is a debris cone as a corresponding full-form. (●) is a classic, glacially triangle-shaped slope face developed from a truncated spur polished back by the Ice Age Bote Koshi glacier (Figure 3 on the left of No. 91). (○, ◐) are glacialic flank abrasions which together with the truncated spur (●) indicate the Würmian glacier trim-line at 5850 m (... on the left of No. 72) up to 5700 m a.s.l. (... on the right of No. 72) and further down-valley about 5500 m (Figure 34) to 5300 m a.s.l. (... on the right). Analogue photo M. Kuhle, 5/4/2003.



← Photo 172. 350°-panorama taken at 4970 m a.s.l. from the orographic left valley flank of the Bote Koshi Drangka E above the Arye alpine pasture (Figure 3 Panorama 172) from facing NNE (left margin) with the orographic left hanging side valley of the Bote Koshi, via facing WSW into its left flank with the 5949 m-peak (No. 90; Table 5), facing SW with the 5970 m-peak (No. 91) situated 2.7 km to the S, via facing S down the main valley on to the 6187 m-high Kongde Ri (No. 60), via facing WSW into the orographic right flank of the Bote Koshi with the 5967 m-peak (No. 89), via facing WNW on to the 6425 m-peak (No. 98) and the 6705 m-high Kang Korob (No. 80), then up the Chhule Drangka facing NW with the summits of Pangbug Ri (No. 78, 6716 m) and the 6589 m-peak (No. 96) up to facing N (right margin) across the orographic left main valley flank. (IV) is the more than 500 m-high pedestal moraine terrace and its down-valley remnants of the Sirkung Stage (Table 1); (V and VI) are local neoglacial lateral- and end moraines in the Bote Koshi side- and main valley originating from the Nauri- and older Dhaulagiri-Stage (Table 1); there are also (VI) front moraines of local hanging- and cirque glaciers. (□) is the tongue basin of the neoglacial Chhule Drangka glacier. (△) are current cloaks of debris cones covering older material of ground moraine. (■) shows remnants of ground moraine covers in high positions at 4500 m (■ below No. 60), 4850 m (■ below No. 89), 4950–5200 m (■ on the very left, below No. 96 and on the very right) and at 5250–5450 m a.s.l. (■ below Nos. 90, 98 and 78). (●) is a very clear, triangle-shaped glacial slope face developed from a truncated spur (Figure 3 above No. 89). (○) are glacial flanks in the bedrock gneiss indicated by rock roundings. (...) is the High Würmian glacier trimline, running about 5700 m a.s.l. (... right and left margin up to left of No. 90) above the hanging side valley, down to ca. 5500 m a.s.l. in this section of the main valley (... below No. 90 up to left below 89) (Figure 34). Up the main valley (... below No. 98 and 96) its altitude was ca. 5800 m a.s.l. Analogue photo M. Kuhle, 30/3/2003.



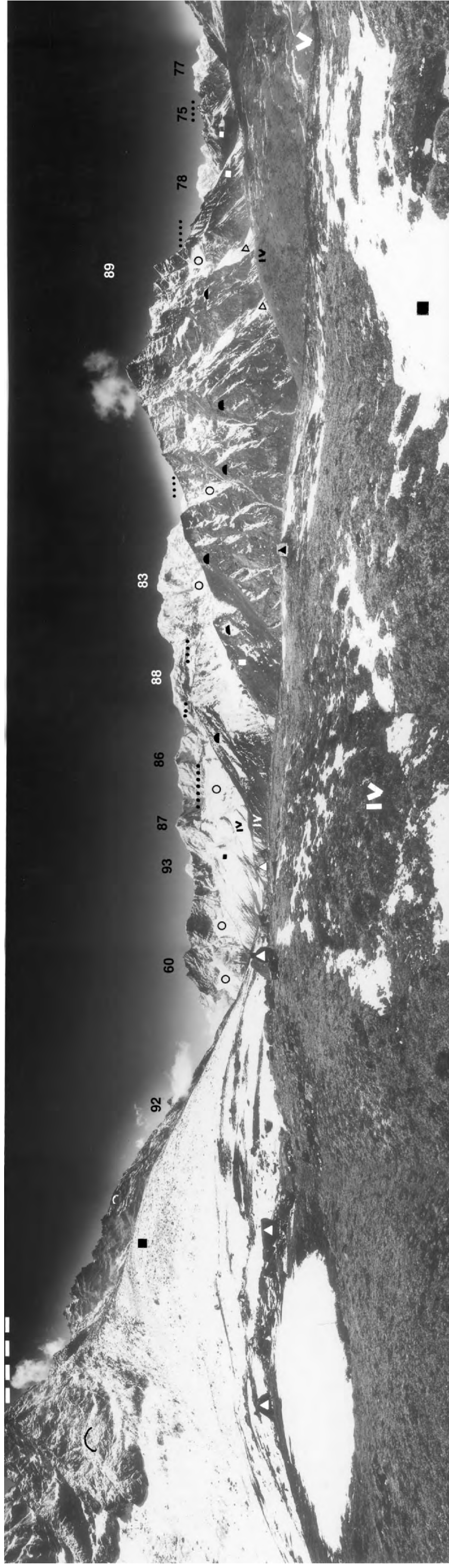
← Photo 175. Picture taken from the orographic left valley side of the upper Bote Koshi Drangka between the Arye and Chihule alpine pastures at ca. 4450 m a.s.l. (Figure 3 Photo 175) on the ground moraine in the neoglacial tongue basin of the Nauri Stage (V; Table 1): perfectly rounded granite gravels with approx. the form of a ball (diameter of the lens cap on the right above = 9 cm). Analogue photo M. Kuhle, 02/04/2003.



← *Photo 174.* 360°-panorama photo taken at 4380 m a.s.l. from the orographic left valley side of the Bote Koshi Drangka from the Arve alpine pasture down-valley in a S-direction (Figure 3 Panorama 174) from facing NNW (left margin) up the trough valley (Figure 34) to the 5719 m-peak (No. 75), via facing W into the orographic left valley flank to the 5949 m-peak (No. 90), via WSW and SW with the 6186 m-high Kyajo Ri (No. 68) and the 5970 m-peak (No. 91), via facing S down-valley (Figure 35) with the 6187 m-high Kongde Ri (No. 60), via facing W into the orographic right valley flank with the 5967 m-peak (No. 89) and again facing NNW (right margin). (■) are ground moraine covers, mainly preserved in the lower slope regions of both valley flanks. In many places they have been reshaped and overlain by debris flow cones and -fans (▽). (○ small) are granitic, round-edged moraine boulders, dislocated by debris flows such as these. They have been transported out of a gully (⊕), which has been cut into a pedestal moraine terrace (IV) (Figure 3 Panoramas 171 and 172) of the Late Glacial Sirkung Stage (Table 1). (□) is the gravel bed of the current Bote Koshi river, incised as talweg into the ground moraine of the valley bottom. (○ large) shows an E-exposed cirque-like form (Figure 3 on the right of No. 89). It has been reworked for the last time by a Late Glacial hanging glacier. (○, ∩, ∪) are glacial forms of flank abrasion, i.e. rock smoothings and -roundings; (●) is a very well preserved, classic, glacially triangle-shaped slope area derived from a truncated spur, which has been polished back by the Ice Age Bote Koshi glacier (Figure 3 on the left of No. 68). (...) are High Würmian glacier trim-lines (Stage 0, Table 1) verified by abrasion lines: (...) on the very left and very right) run about 6000–5900 m a.s.l., (...) on the right of No. 75) about 5800 m, (...) below Nos. 90 and 68 as well as on the left of No. 89 and on the right of No. 60) about 5500 m, (...) on the left of No. 60) about 5200 m a.s.l. Analogue photo M. Kuhle, 28/03/2003.



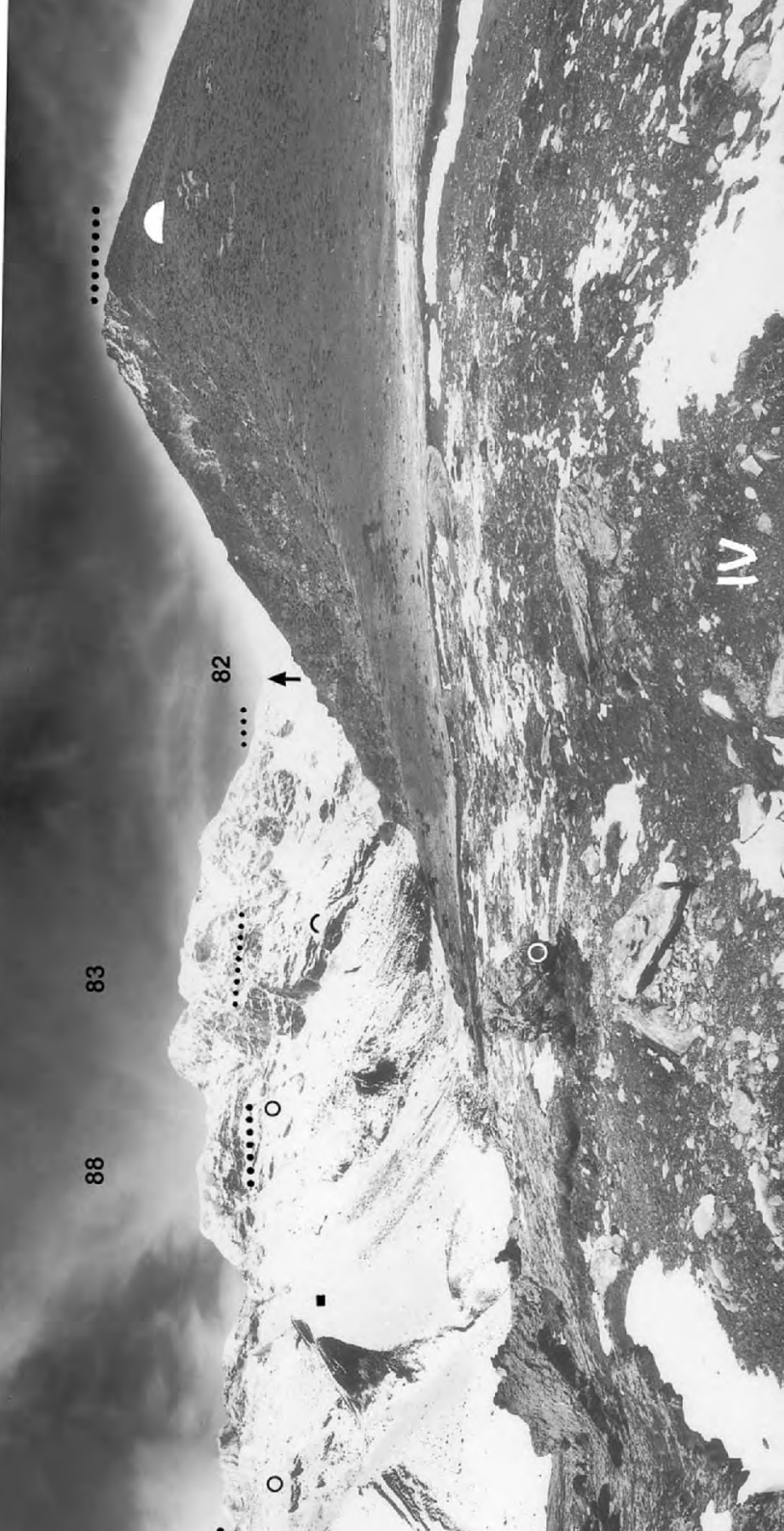
→ *Photo 176.* Panorama photo taken at 4360 m a.s.l. from the orographic left valley flank of the Bote Koshi Drangka down-valley from the Lungare settlement in a NW-direction (Figure 3 Panorama 176) from facing WNW (left margin) with the right valley flank, via facing NNW up-valley to the 5719 m-peak (No. 75), up to facing ENE to the 5949 m-peak (No. 90) in the orographic left valley flank. (■) are ground moraine covers and -deposits with a thickness of up to 200 m (■ white) (Figure 34); the latter are Late Glacial remnants of a ground moraine pedestal (IV, Figure 3 Panorama 171 and on the right below Panorama 174). (▽) are alluvial- and debris flow fans of dislocated ground moraine, which have been adjusted to the surfaces of ground moraine and accumulated. (○) are rounded and edged granite- and gneiss boulders metres in size, which are typical of moraine. (For scale see below of (□) a small expedition caravan with five persons and two loaded Sobjoks (Zaus)). (□) is the gravel bed of the current Bote Koshi river, which during the Holocene – along with its vertical erosion as a fluvial gravel floor – has been set into the ground moraine. (∩) is a convex rounding of the rock flank by glacial abrasion. (...) indicates the High Würmian glacier level in the upper Bote Koshi about 6000–5900 m a.s.l., (---) is the one further down-valley about 5800 m a.s.l. Analogue photo M. Kuhle, 28/03/2003.

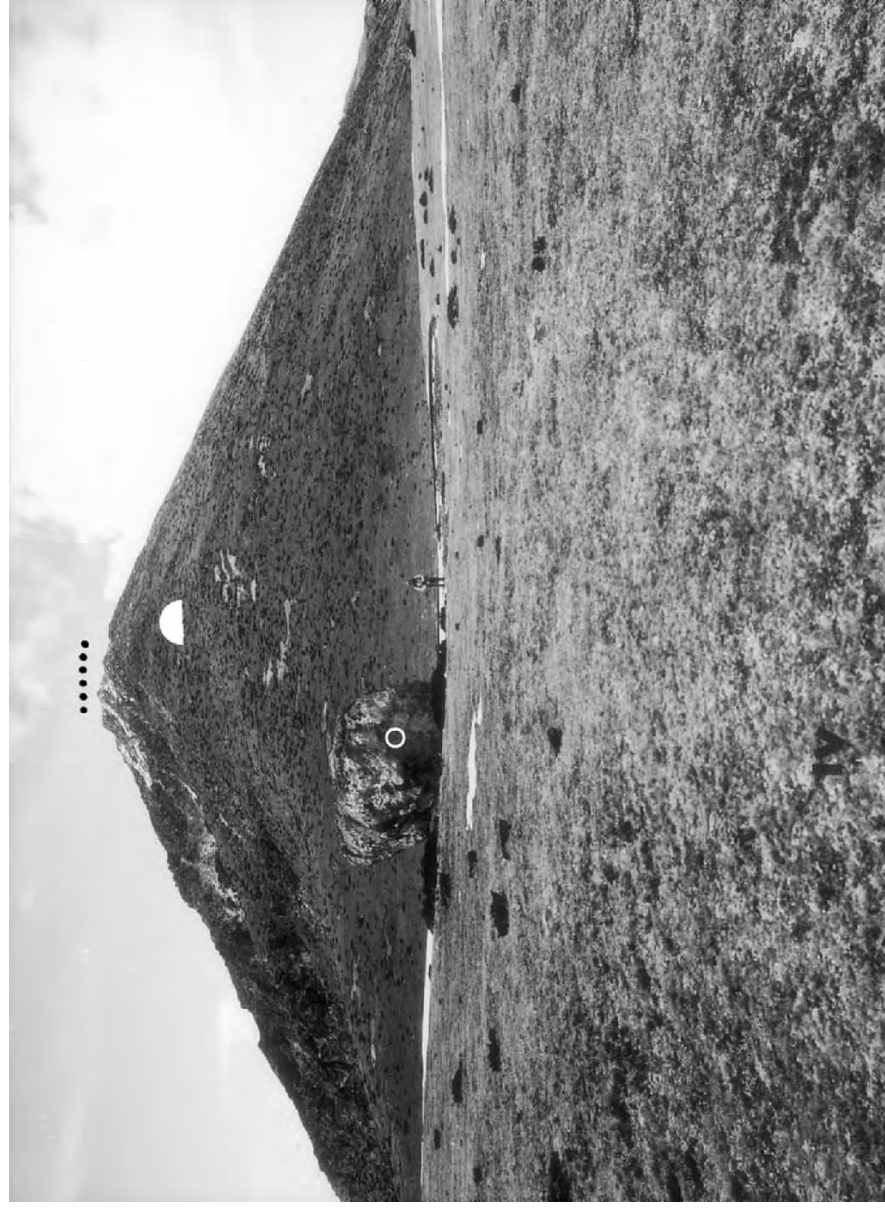




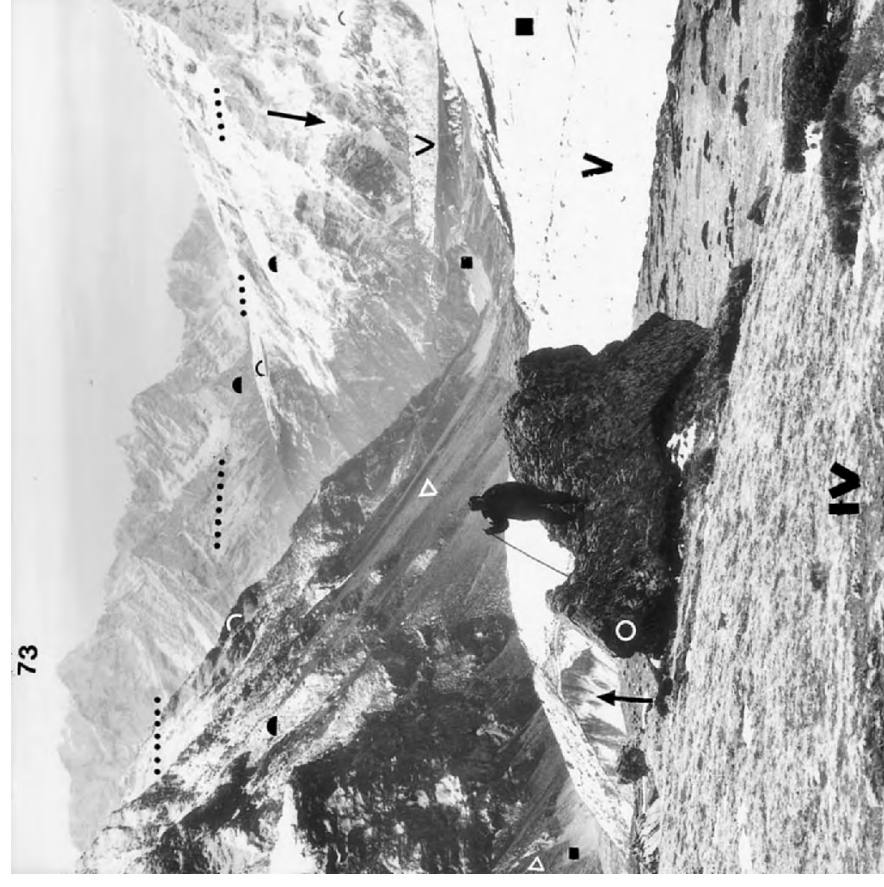
←Photo 177. 380°-panorama photo taken at 4725 m a.s.l. from the orographic left valley flank of the middle Bote Koshi Drangka ENE above the Marulung settlement (Figure 3 Panorama 177) from facing E (left margin) with the orographic left valley slope below the 5970 m-peak (No. 91), via facing SSE to Kabsale (No. 92, 5583 m) and facing S with the 6187 m-high Kongde Ri (No. 60), via facing SSW with the 6959 m-high summit of Numbur (No. 93) and the summits of Teng Kangpoche (No. 87, 6500 m) and Panayo Tappa (No. 86, 6696 m) in the crest in front of it, via facing SW up to WSW with the 6180 m-peak (No. 88) and Tangi Ragi Tau (No. 83, 6940 m) situated in a crest still further in front of it, via facing WNW with the 5967 m-peak (No. 89), via facing NW to NNW to Pangbug Ri (No. 87, No. 78), the rocky 5719 m-peak (No. 75) and the 6907 m-massif (No. 77), up-valley to the inflow of the Chhule Drangka, via facing NE to the 5949 m-peak (No. 90) and Kyajo Ri (No. 68, 6186 m), up to facing E (right margin). The evenness of a ground moraine terrace stretches in the foreground (■ large and IV in the foreground) at least 500 m above the talweg. It is a remnant of the late Late Glacial ground moraine pedestal, which has filled the Bote Koshi. (IV large in the foreground) shows the sampling locality of sample 3.4.03/1 (Figures 78 and 37 No. 40). (▲) are polymictic, in part erratic boulders up to the size of a metre, superimposed on the ground moraine pedestal. They consist of at least eight rock species: gneisses with smoky quartz, augen-gneisses, banded gneisses, fine-grained granites, reddish, brown, grey quartzites, phyllites from silt- and sandstone. They are edged, round-edged and faceted; in part secondarily frost-weathered due to radial cracks. The rest of the ground moraine terraces marked with IV are corresponding remnants of this basement of a pedestal- or ground moraine (see Figure 3; Figures 34 and 35). (■) are older to High Würmian remnants of a ground moraine cover, part of which lies higher up (up to over 5000 m a.s.l.; ■ below No. 78). (V) is the neoglacial (Nauri Stage, Table 1) front moraine of a hanging side valley glacier, the tongue basin of which is covered with current and recent gravel covers (□). (○) are cirques and cirque-like forms in which small glaciers and glacier remnants have in part still survived. (●) are remnants of glacially triangular-shaped slopes, developed by the back-polishing of rock spurs; (●) is a very well-preserved glacially triangular-shaped slope (Figure 3 on the left below No. 90), (▽ and △) are debris cones, debris flow cones and -fans containing ground moraine, which has been superficially re-worked and buried by the detritus of rock fall. (○, ◌, ◐) are glacial rock roundings in the outcropping Lower Tibetan gneiss (6b), in part developed in the longitudinal direction of the valley (○, ◌ on the left of No. 92 and on the left below No. 90) and in part abraded by hanging glaciers, i.e. in the direction of dip (◌, ◐ below No. 90 up to the right margin). (...) are the upper abrasion limits and thus High Würmian glacier trim-lines: (...) below No. 75 and on the right of it) run at 5900–5800 m a.s.l., (...) below No. 89 and on the left below No. 90) run at 5700–5500 m (Figure 34) and (...) on the right and left below No. 83 up to below No. 87) between an altitude of 6000 and 5300 m lead the glacier trim-lines out of the orographic right side valleys; (—) is the clearly verifiable abrasion limit of the main valley about 5000 m a.s.l. (Figure 35). Analogue photo M. Kuhle, 03/04/2003.

←Photo 178. 390°-panorama photo at 4380 m a.s.l. from the orographic right valley flank of the middle Bote Koshi Drangka from the area where the Langmoche Drangka joins (Figure 3 Panorama 178) from facing NW (left margin) with the 5080 m-high ridge (Figure 35) between Langmoche Drangka and the orographic left valley flank of the main valley, via facing N up the Bote Koshi Drangka to the 8202 m-high Cho Oyu (No. 4), via facing NNE to NE to the 5949 m-peak (No. 90), to Kyajo Ri (No. 68, 6186 m) and the 5970 m-peak (No. 91) m via facing E to Kabsale (No. 92, 5583 m), via facing SE down the Bote Koshi, i.e. Nangpo Tsangpo Drangka to Kusum Kanguru (No. 73, 6369 m), via SSE to the 6187 m-high Kongde Ri (No. 60), via facing SW up to WSW with the summits of the 6180 m-peak (No. 88) and the 6940 m high Tangi Ragi Tau (No. 83), via WNW with the 5890 m-pass (No. 82) to the adjacent Drolum Bau glacier in the Rolwaling Himal, up to facing NNW (right margin) again into the right Bote Koshi valley flank. The evenness of a ground moraine terrace (IV) stretches in the foreground, 390 m above the talweg, as a remnant of the late Late Glacial (Sirkung Stage, Table 1) ground moraine pedestal, which has filled the Bote Koshi Drangka (Figure 35). (IV large, foreground on the left) is the sampling locality of sample 27.3.03/1 (Figure 81 and 37 No. 32). (IV large on the right) also marks fine matrix between large boulders. (○ white) are boulders superimposed on the ground moraine pedestal or integrated into the matrix of the fine material. They are polymictic, in part erratic, in size from a metre up to that of a hut (○ white on the left with person on its left), edged to faceted, weathered or not weathered, made up from different metamorphic crystalline schist, granite and gneiss. The minor-metamorphic schists are heavily frost-weathered on their surface. (●) are well- to very well preserved glacially triangular-shaped slopes (cf. Figure 3), created by the back-polishing of rock spurs; (○, ◌) are glacial rock roundings in the outcropping Lower Tibetan gneiss (6b), which occur in a longitudinal direction of the valley and also show the beginnings of triangular-shaped slopes. (■) are up to High Würmian remnants of ground moraine preserved up to ca. 4900 m a.s.l. (■ black on the left below No. 92), which in part cover the abrasion forms. (IV small): in the core a Late Glacial remnant of ground moraine is concerned, reaching up to the level of the ground moraine pedestal of Stage IV (Table 1). It has been reshaped since the Late Glacial deglaciation. (V) shows the orographic right lateral- and end moraine of the Langmoche glacier during the holocene Nauri Stage (Table 1). (○ black) are cirques and related forms of past hanging glaciers. (▽) are debris cones and -slopes reshaping the past basal glacial slopes. (...) is the High Würmian level of the ice stream network reconstructed by the upper limits of abrasion. It runs: (...) on the right below No. 4) about 6000 m a.s.l. (see Figure 33) and fell away via 5500 m (...) on the left below No. 90, Figure 34), ca. 5000 m (...) on the very left, i.e. on the right and below and on the right of No. 91, Figure 35), 4600–4400 m (...) below No. 73 and below and half-left below No. 60, Figure 36) down to 4000 m a.s.l. (...) half-right below No. 73; Figure 52). From the valley head of the Langmoche Drangka, from the 5890 m-high (No. 82) transfluence pass (●) to or from the neighbouring Rolwaling main valley, the glacier level ran from ca. 6200 m (...) on the left of No. 82), via 6100 (...) below No. 83), 6000 (...) below No. 88) and 5100 m a.s.l. (...) on the right somewhat below No. 60) and eventually steeply down into the Nangpo Tsangpo (... below No. 60). Analogue photo M. Kuhle, 27/03/2003.

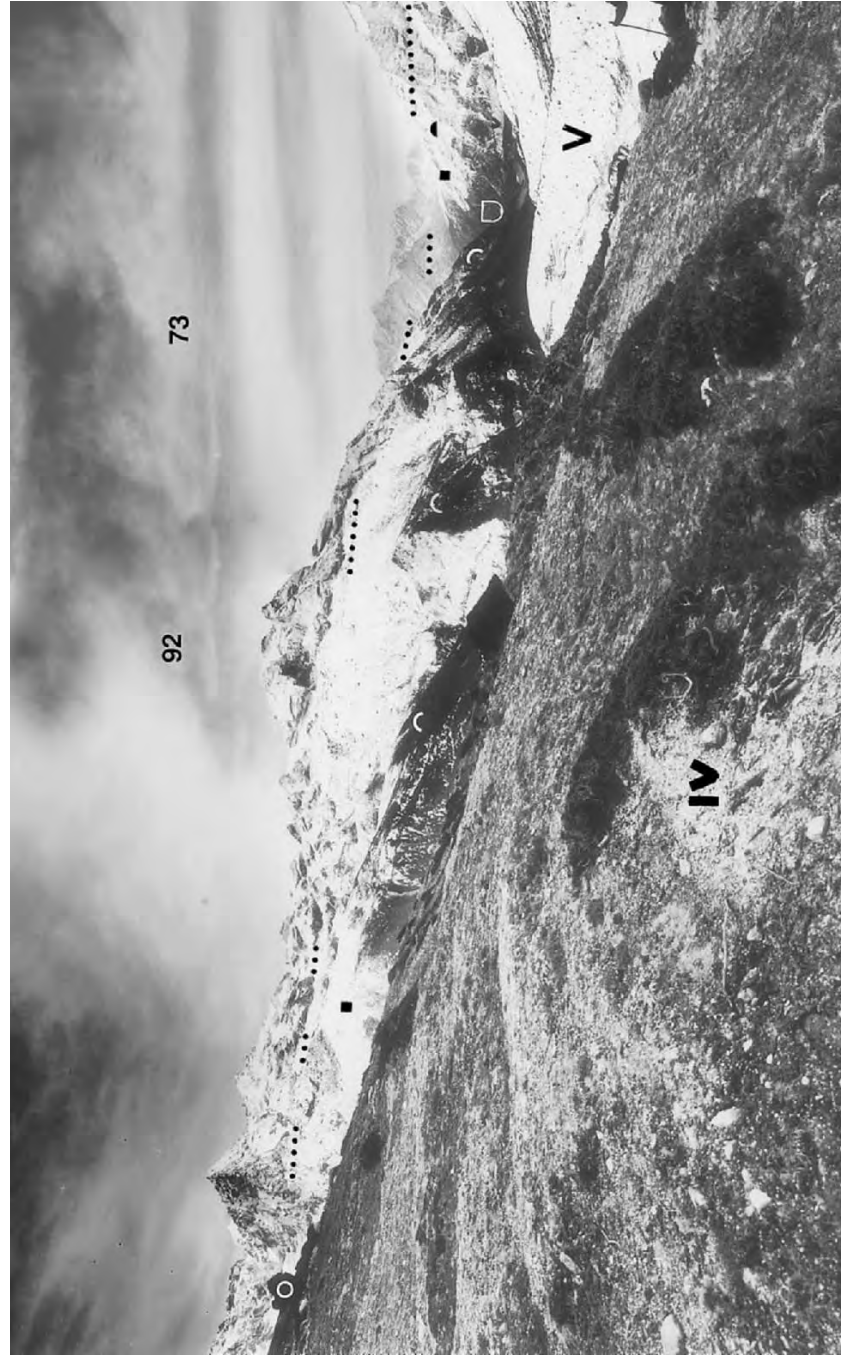




← *Photo 179.* Picture at 4390 m from the orographic right valley flank of the middle Bote Koshi Drangka in the area where the Langmoche Drangka joins (Figure 3 Photo 179), taken from the remnant of the even ground moraine pedestal (IV) facing NW to the 5080 m-ridge (Figure 35). (●) is a completely preserved glaciogenically triangle-shaped slope (see also Figure 3) covered by ground moraine with a decreasing thickness in an upward direction. (...) is the Würmian minimum ice level between 5000 to 5200 m a.s.l. at this locality indicated by this glacial erosive form. (○) is a gneiss boulder the size of a hut (cf. person on the right) situated ca. 100 m away from the slope foot. Its material does not outcrop on the triangular-shaped slope behind it. Accordingly, this is an erratic moraine boulder 400 m above the talweg on this cross-profile of the Bote Koshi (Figure 35). Analogue photo M. Kuhle, 27/03/2003.

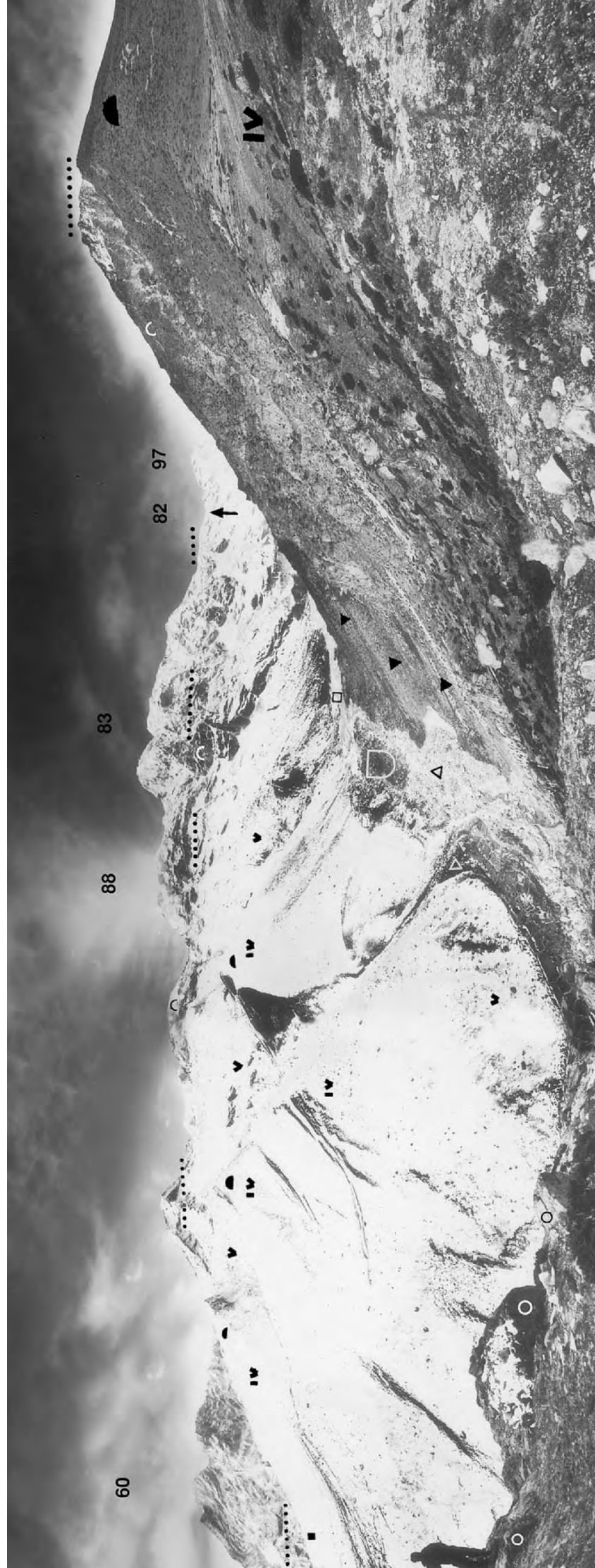


← *Photo 180.* At 4380 m a.s.l., picture taken from the orographic left valley flank of the lower Langmoche Drangka in the area where it joins the middle Bote Koshi Drangka (Figure 3 Photo 180) from the triangle-shaped remnant of the Late Glacial ground moraine pedestal (IV) facing SE down the main valley to the 6369 m-high Kusum Kanguru (No. 73). This erratic augen-gneiss boulder (○) is situated 480 m above the talweg of the Bote Koshi (below ■ on the left margin). Weathering has shaped it into an extremely angular and rough form and surface. (●) are High Würmian to Late Glacial remnants of ground moraine near to the valley bottom, in part modified by postglacial debris bodies down the slope (▽). (▲) are glaciogenically back-polished rock spurs. (↓) is a channel caused by current avalanche- or rock fall, from which these forms of debris cones emerge in a down-slope direction. (○, ◊) are past glaciogenic flank roundings and -abrasions, the upper limit of which indicates the Würmian glacier trim-line (...). It runs from approx. 4400 m (... half-left below No. 73 and on the very right; Figure 36) down to 4000 m a.s.l. (the two ... on the right below No. 73; Figure 52). (◊ white) is a classic glacial band polishing of the outcropping edges of the stratum ('Schichtkopfstreifenschliff' after v. Klebelsberg, 1948/49) on the outcropping gneiss banks. (V) are two orographic right lateral moraines of the neoglacial Nauri-Stage (Table 1), approximately parallel in arrangement, at the exit of the Langmoche-(V below) and the Arabisen Drangka. (↑) is a slide of the inner moraine slope of the lateral moraine at the valley exit of Langmoche, triggered by an outburst of a moraine lake (Dig Tsho) in 1985. (■ small) show two further slides of slopes in the loose rock near to the valley bottom caused by this event. Analogue photo M. Kuhle, 27/03/2003.

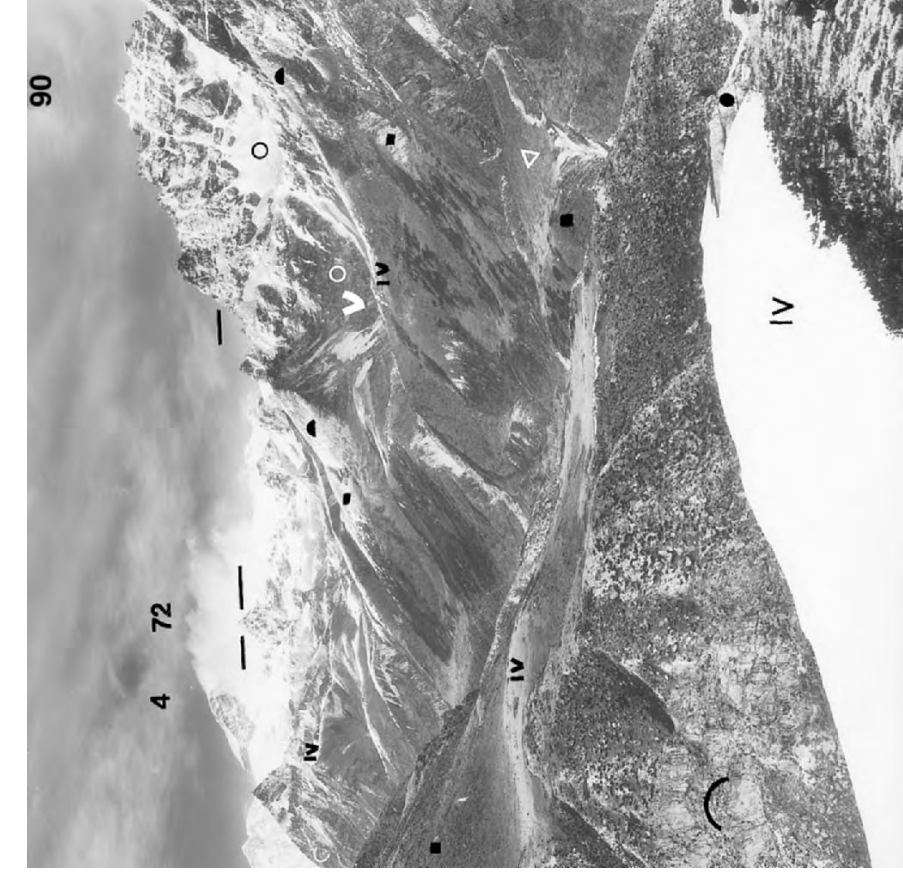
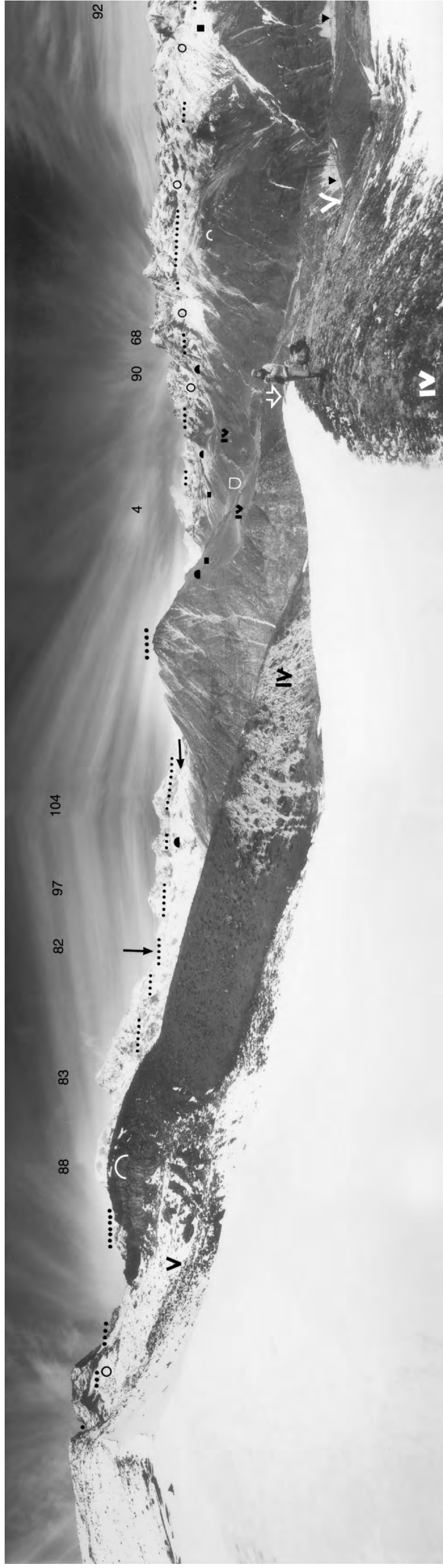




← *Photo 182.* Picture from the orographic left valley flank of the lower Langmoche Drangka in the area of its inflow into the middle Bote Koshi Drangka at 4390 m a.s.l. (Figure 3 Photo 182) taken from the triangle-shaped, extended terrace remnant of the Late Glacial ground moraine pedestal (IV in the foreground), i.e., from its western, snow-covered section, facing WSW to the 6180 m-peak (No. 88). No. 83 is the 6940 m-high Tangi Ragi Tau and No. 86 the 6696 m-high Panayo Tuppa, recognizable beyond the valley divide between Langmoche- and Arabisen Drangka. The round-edged and edged moraine boulders consist of banded gneiss, augen-gneiss and granite; they are erratic and have more or less been transported over a long distance. (■) is a rock slope covered with metre-thick ground moraine. (IV small) are late Late Glacial remnants of ground moraine of the Sirkung Stage (Table 1). A tongue basin of a hanging glacier of the neoglacial Nauri Stage (V) has been set into them during the Holocene. (...) is the High Würmian glacier level between ca. 6100 m (... below No. 83) and 5100 m a.s.l. (... left margin), verified by an upper abrasion limit (below No. 83) and two glaciogenic polish cavettos (... below No. 88 and near the left margin). Obviously there was an ice transfluence (... on the right below No. 86; see Figure 3 transfluence pass half-left below Panorama 186) between the Langmoche- and the Arabtsen Drangka situated beyond. Analogue photo M. Kuhle, 27/03/2003.



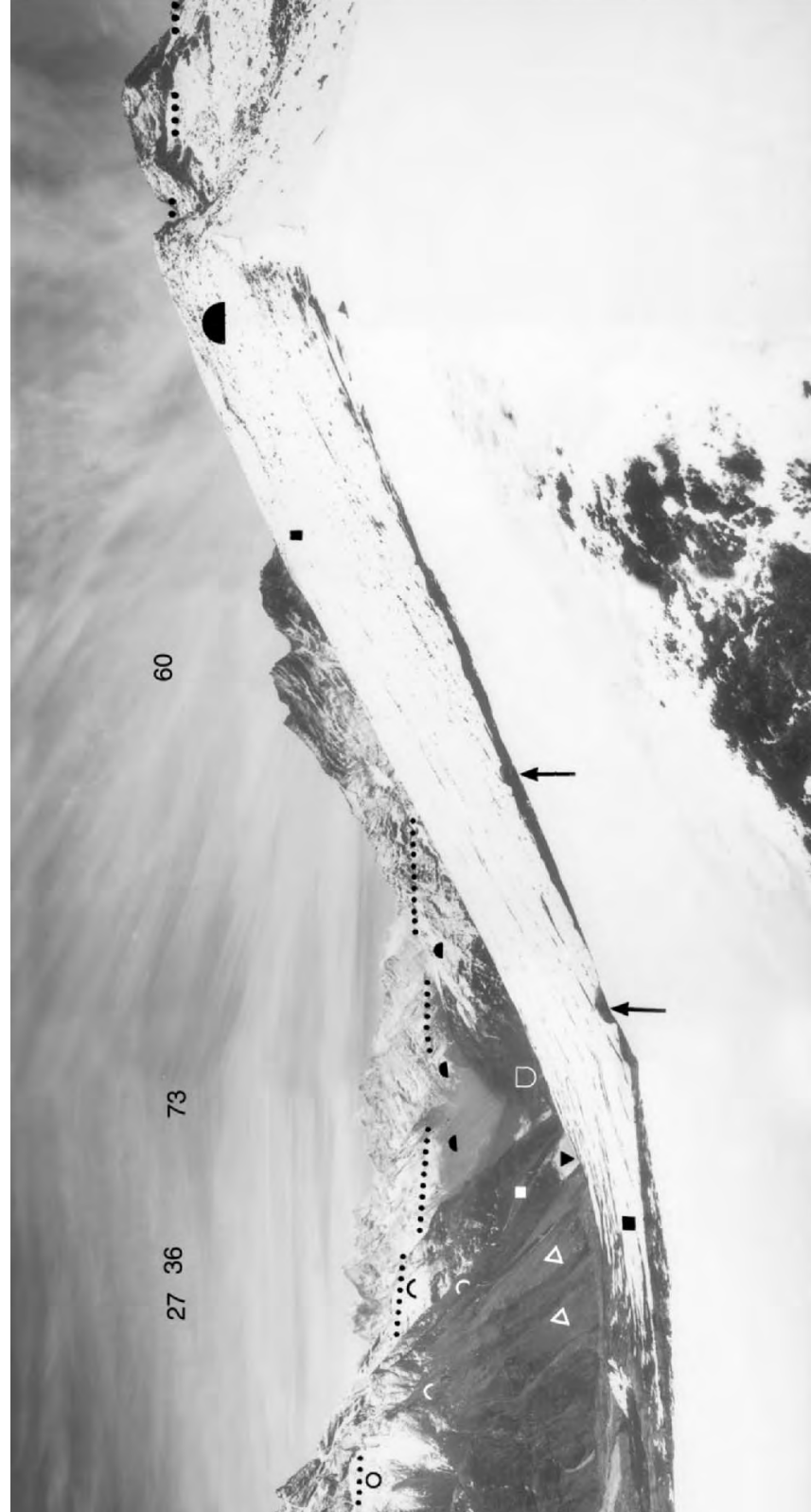
← *Photo 181.* Panorama photo from the orographic left valley flank of the lower Langmoche Drangka in the area of its inflow into the middle Bote Koshi Drangka at 4360 m a.s.l. (Figure 3 Panorama 181) taken from facing ENE (left margin) via facing E with the 5583 m-high Kabsale (No. 92) in the left flank of the Bote Koshi Drangka, via facing SE down the Nangpo Tsangpo Drangka to the 6369 m-high Kusum Kanguru (No. 73), facing SSE to the 6187 m-high Kongde Ri (No. 20) and facing SW into the right flank of the tributary valley to the 6180 m-peak (No. 88), facing W to Tangi Ragi Tau (6940 m, No. 83), via facing WNW to the 5890 m-pass (No. 82), which leads to the Drolum Bau glacier (Figure 3) and the 6362 m-summit (No. 97), situated on the watershed to the W-adjacent Rolwaling Himal, up to facing NW to the 5080 m-high mountain spur between Langmoche- and Bote Koshi Drangka (5080 m-ridge Figure 35) (right margin). (○) are up to several metres-long, round-edged and edged, weathered and unweathered, and in part erratic, boulders (here granite). They are embedded into the clay-containing matrix of the ground moraine terrace (IV large) and consist of granite (○ black), varying metamorphic crystalline schists and gneiss. The surfaces of the minor-metamorphic schists are heavily frost-weathered. (IV small) are remnants of ground moraine, which during the Sirkung Stage (Table 1) were last covered by a glacier. (V small) are holocene basins of hanging glacier tongues, formed during the neoglacial Nauri-Stage (Table 1). (V large) is the orographic right lateral- to end moraine of a Langmoche glacier tongue of the same age. The Langmoche trough valley (□ large) has been reshaped and partly filled by debris cones (▼), a glaciofluvial gravel floor (□) and alluvial- and debris flow fans (▽△). (□ small) shows the trough-shaped valley form of the Nangpo Tsangpo main valley. (■) mark truncated spurs, i.e. glaciogenically triangular-shaped slopes. (○, ◐, ◑) are glaciogenic flank abrasions, the upper limits of which, in combination with glaciogenic polish cavettos in accordance with which crumbings are orientated (... below No. 88), render the reconstruction of the High Würmian glacier trim-lines (...) possible. They run from ca. 5000 m a.s.l. (... on the very left and right; Figure 35) to 4000 m (... below No. 73; Figure 52) and ca. 6200 m (... at the transfluence passf) down to 4400 m a.s.l. (... below No. 60; Figure 36). Analogue photo M. Kuhle, 27/03/2003.



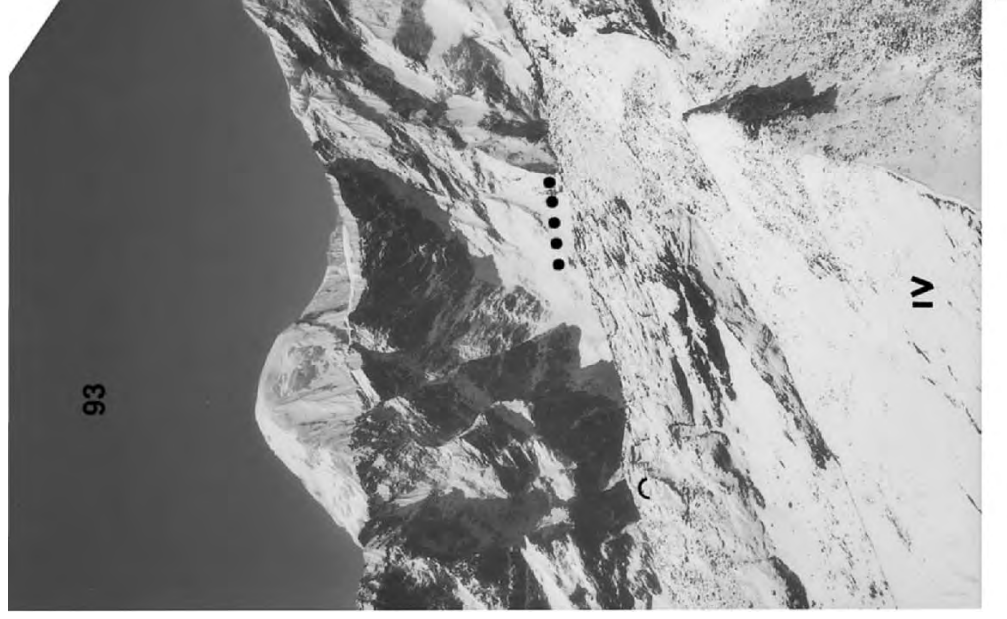
← *Photo 184.* Long-distance photo from the orographic right valley flank of the middle Bote Koshi Drangka below the inflow of the Langmoche Drangka at 4550 m a.s.l. (Figure 3 Photo 183) facing NNE up the Bote Koshi main valley. No. 4 is the 8202 m-high Cho Oyu, No. 72 the 5941 m-peak, No. 90 the 5949 m-peak. (IV) are late Late Glacial remnants of ground moraine of the Sirkung Stage (Table 1), which in many places (IV small) are preserved as terrace remnants. (●●) are up to 3 m-long edged to round-edged moraine boulders of gneiss, among them far-travelled augen-gneiss. (■) are ground moraine remnants in the form of covers, verifiable up to 4800 m a.s.l. (■ below No. 90). (△) is the remnant of a ground moraine pedestal, superficially covered by an alluvial- and debris flow fan (Figure 3 on the left above Panorama 191) from dislocated ground moraine situated higher up. (V) is a neoglacial (Nauri Stage, Table 1) tongue basin of a holocene hanging glacier, which has filled two poorly developed cirque steps (○ and ○); Figure 3 on the left diagonally below No. 68). The glacier has removed the High- to late Late Glacial accumulations of ground moraine, i.e., dug its tongue basin into them. (●) are glacially triangular-shaped slopes in the bedrock; (○, ○) are glacialic abrasions in the form of rock smoothings and -roundings, in some places roughened by crumbings. (□) is the High Würmian glacier level at 6000 m (□ on the right below No. 4; cf. Figure 33), 5900 m (□ below No. 72) and 5500 m a.s.l. (□ on the left below No. 90; Figure 34). Analogue photo M. Kuhle, 05/04/2003.

→ *Photo 185.* Picture taken from the orographic right valley flank of the middle Bote Koshi Drangka above the inflow of the Langmoche Drangka at 4390 m a.s.l. (Figure 3 Photo 185) from the triangle-shaped large-scale terrace remnant of the Late Glacial ground moraine pedestal (IV) facing NNE up the Bote Koshi Drangka. No. 4 is the 8202 m-high Cho Oyu, No. 72 the 5941 m-peak. (■ black) is a neoglacial front moraine of the Stages VI-VII (older and middle Dhaulagiri Stage, Table 1; see Figure 3 below No. 72 VI-VII). (■ white) are High Würmian (Stage 0) to Late Glacial (Stages I-IV) parts of a ground moraine cover, attached to the valley flanks. (○) is a gneiss boulder the size of a hut on the ground moraine cover. (○) marks polished gneiss bedrock in a roche-moutonnée-like form, which has been roughened and damaged by rock crumbings since the deglaciation. Analogue photo M. Kuhle, 27/03/2003.





→ Photo 187. Long-distance panorama from the orographic left valley flank of the middle Bote Koshi Drangka ENE above the Marulung settlement at 4725 m a.s.l. (Figure 3 Panorama 187) from facing SSW (left margin) with the 6959 m-summit Numbur (No. 93) and the summits of Teng Kangpoche (No. 87, 6500 m) and Panayo Tuppa (No. 86, 6696 m) in the crest in front of them, up to facing SW (right margin). (○) are N-exposed cirques and similar forms in the intermediate valley ridge between Langmoche- (foreground) and Arabtsen Drangka (below Nos. 87 and 86) again situated in front of it. (VII-X) show holocene to historic front moraines of a small hanging glacier of the middle Dhaulagiri Stage up to Stage X (Table 1; Figure 3 on the right of No. 88). (V) are the bottoms of the tongue basin of the Nauri Stage covered with ground moraine, the holocene hanging glaciers of which have cleared out part of the late Late Glacial accumulations of ground moraine (IV) (Sirkung Stage, Table 1). (■) is a High Würmian to Late Glacial ground moraine cover on the orographic right flank of the Bote Koshi Drangka. (∩) are rock heads rounded by the High Würmian ice stream network. (...) marks the level of the ice surface at that time, which has fallen away from at least 5300 m on the right to ca. 5000 m on the left. Analogue photo M. Kuhle, 03/04/2003.



← Photo 183. 390°-panorama from the orographic right valley flank of the lower Langmoche Drangka, i.e. the right valley flank of the main valley in the area where the Langmoche Drangka joins the middle Bote Koshi Drangka, taken at 4550 m a.s.l. (Figure 3 Panorama 183) from facing SSW (left margin) via facing WSW with the 6180 m-peak (No. 88) in the background, facing W to the 6940 m-high Tangi Ragi Tau (No. 83), via facing WNW to the 5890 m-pass (No. 82) and the 6362 m-peak (No. 97), via facing NW to the 6263 m-peak (No. 104), via facing approx. N, up the Bote Koshi Drangka to Cho Oyu (No. 4, 8202 m), via facing NNE to the 5949 m-peak and the 6186 m-high Kyajo Ri (No. 90 and 68), via facing E to Kabsale (No. 92, 5583 m) and facing ESE to Kang Taiga (No. 27, 6779 m) and Tramserku (No. 36, 6608 m), via facing SE to the 6369 m-high Kusum Kanguru (No. 73), looking down the Nangpo Tsangpo Drangka and facing SSE to the 6187 m-high Kongde Ri (No. 60), up to again facing SSW (right margin). (IV white) marks the sampling locality of Figure 84 and 37 No. 43. This ground moraine remnant of the Sirkung Stage (Table 1) continues up the tributary valley (IV black, large) and up the main valley (IV small). It reaches up to 4600 m and consists of 1–3 m long, round-edged to slightly edged and edged polymict boulders of metamorphites, granite (↑) and gneisses (⇄); the latter are erratic. (V black) is the tongue basin of a neoglacial (Nauri Stage V, Table 1) hanging glacier, which has flowed down from a cirque (○) on the very left. It is covered with ground moraine. (V white) is the end moraine of the Langmoche glacier from the Nauri Stage; due to a slide its inner slope has crumbled away (▼) on the right near V white). (The two ▼ further right) are further slides in the loose rock, also developed by the lateral undercutting of the slope triggered by the water surge of this outburst of a moraine lake, which has come down from the Langmoche Drangka in 1985. (○) are past cirques and cirque-like forms. (■) are High- to Late Glacial remnants of a ground moraine cover, recognizable on the slopes down to 4800 m a.s.l. (■ below No. 92). (△) are overlays of ground moraine modified into debris cones and slopes. (▲) show glaciogenically triangular-shaped slopes in the bedrock; (∩, ∪) are glaciogenic abrasions in the form of rock smoothings and -roundings, which genetically coincide with the trough-shaped valley cross-profiles (∩) (cf. Figures 34–36). (∩ large) is a roche moutonnée form (Figure 3 on the left of Panorama 178). (↓ and ←) are transfluence passes between 5800 and 5950 m a.s.l. rounded by the overflowing High Würmian ice. (...) is the High Würmian level of the ice stream network between 6200 and 6000 m a.s.l. (...) below Nos. 83–104 and on the right below No. 4). It has dropped from the side valleys down to the main valley to 4000 m a.s.l. (...) below No. 73) practically without any intermediate steps. Analogue photo M. Kuhle, 05/04/2003.



← *Photo 186.* Panorama from the orographic right valley flank of the lower Langmoche Drangka, i.e. the right valley flank of the main valley in the area where the Langmoche Drangka joins the middle Bote Koshi Drangka, taken at 4550 m a.s.l. (Figure 3 Panorama 186) from facing WSW with the 6180 m-peak (No. 88) in the background, facing W to the 6940 m-high Tangi Ragi Tau (No. 83), via facing WNW to the 5890 m-pass (No. 82) and the 6362 m-peak (No. 97), via facing NW to the 6263 m-peak (No. 104) up the Langmoche Drangka, up to facing NNW (right margin). (V) is ground moraine of the holocene Nauri Stage (Table 1) in a N-exposed cirque bottom; (○ large) is a roche-moutonnée-like and smoothed form of a Late Glacial rock ridge in the bedrock gneiss, neoglacially undercut by that N-exposed cirque glacier (V) and on the flanks already decomposed by rock crumbings (▶). (IV) is a late Late Glacial ground moraine complex of the Sirkung Stage (Table 1), preserved as a narrow bridge between this and the cirque bottom situated behind. (○) are boulders metres in size, which are round-edged, i.e. faceted and edged. They are embedded into a clay-containing matrix. (X) is an end moraine remnant of the historical Stage X (ca. 180–30 before 1950; Table 1), ca. 200 m below the current glacier terminal. (■) is a High Würmian to Late Glacial remnant of ground moraine cover, interrupted by flank abrasions in the bedrock (○). (○) are further glacial flank abrasions, which, in accordance with a dropping ice level, have increasingly been modified down the slope (parallel to the line of slope). (●) is a back-polished rock spur (Figure 3 on the right of No. 97), indicating especially clearly that the polishing, in dependence on very thick ice, must have taken place transversely to the actual direction of the cirque glacier, i.e., from the transfluence pass (←) in the N, from the Chhule Drangka. From which side the 5890 m-high transfluence pass (↑) has been overflowed, i.e. from or to the W, is still open. The highest High Würmian abrasion lines, i.e. glacier trim-lines run about 6000–6200 m a.s.l. (...). Analogue photo M. Kuhle, 05/04/2003.

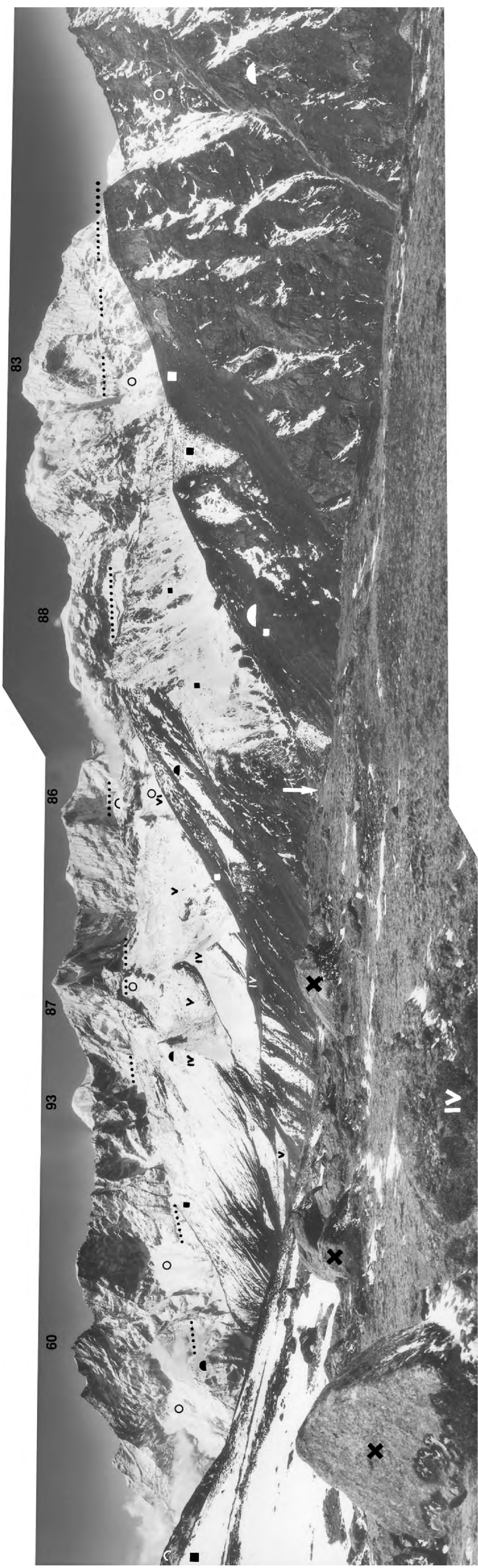
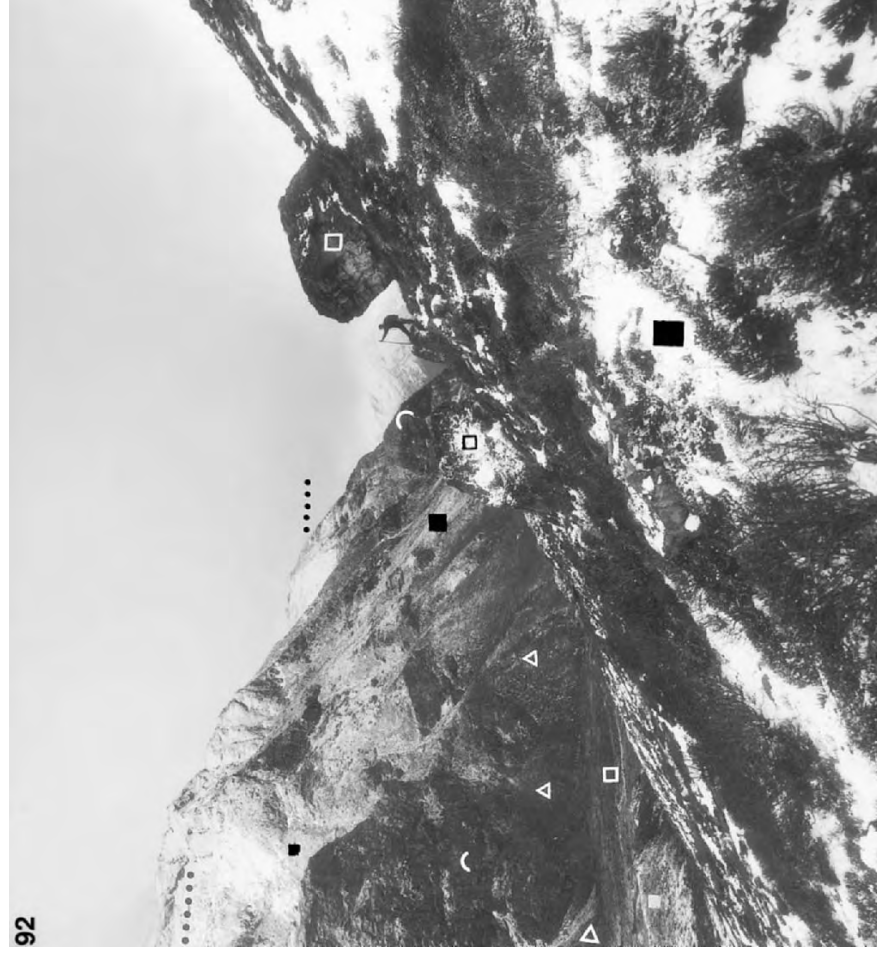
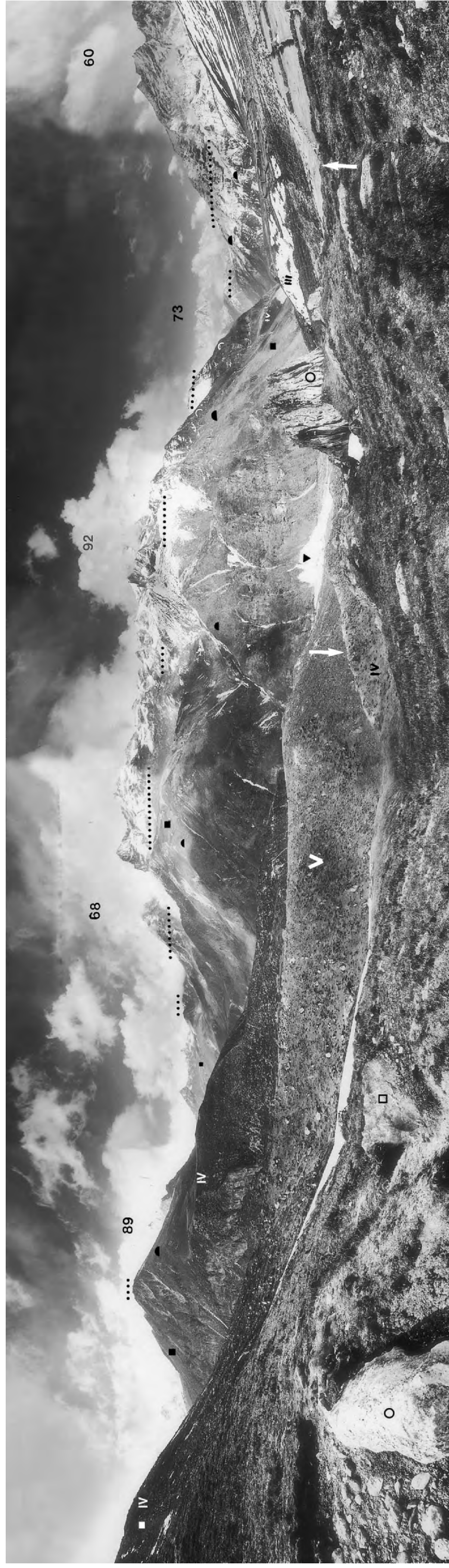


Photo 188. Panorama-photo from the orographic left valley flank of the middle Bote Koshi Drangka ENE above the Marulung settlement at 4725 m a.s.l. (Figure 3 Panorama 188) from facing SSE (left margin) via facing S with the 6187 m-high Kongde Ri (No. 60), via facing SSW with the 6959 m-summit of Numbur (No. 93) and the summits of Teng Kangpoche (No. 87; 6500 m) and Panayo Tuppa (No. 86, 6696 m) in the crest in front of them, via facing SW to WSW with the 6180 m-peak (No. 88) and Tangi Ragi Tau (No. 83, 6940 m) in a crest situated still further in front of it, up to facing W (right margin). In the foreground a ground moraine terrace (IV large) extends at least 500 m above the talweg. It is a remnant of the late Late Glacial ground moraine pedestal, which has filled the Bote Koshi (Figure 35). (X) are several polymictic boulders in size up to one metre, superimposed on this ground moraine pedestal; part of them is erratic. They consist of at least eight rock species: gneiss with smoky quartz, augen-gneiss, banded gneiss (second and third X from the left), fine-grained, erratic granite (X on the left in the foreground), reddish, brown, grey quartzite, phyllite of silt- and sand stone. They are edged, round-edged and faceted; in part secondarily frost-weathered by radial cracks. (IV white small) marks a corresponding ground moraine remnant of this pedestal- or ground moraine basement (see Figure 3 above Panorama 181); Sample Figure 80 (see also Sample 37 No. 31) has been taken (Figure 3, 26.3.03/1) from a further remnant of this ground moraine pedestal at this level (↓). (IV black, small) are further remnants of ground moraine of the late Late Glacial Sirkung Stage. Neoglacial tongue basins of hanging glaciers (O) have selectively removed these remnants. (O) are cirque-like hanging niches and hollow forms of the wall foot, in part still containing glaciers (second O from the right) (VI). The cirque bottom (O below No. 86) is covered by ground moraine of the older Dhaulagiri Stage (VI) (Table 1). (■) are High Würmian to Late Glacial remnants of a ground moraine cover, interrupted by flank abrasions in the bedrock (○, ○). (●) show back-polished rock spurs in the form of glacigenically triangular-shaped slopes. (...) is the course of the glacier trim-line of the Würmian ice stream network, reconstructed according to ground moraine covers and flank abrasions. This glacier trim-line has run from ca. 6200 m a.s.l. on the right (... on the right below No. 83) to ca. 4400 m (... below No. 60; Figure 36) down into the Nangpo Tsangpo main valley. Analogue photo M. Kuhle, 03/04/2003.

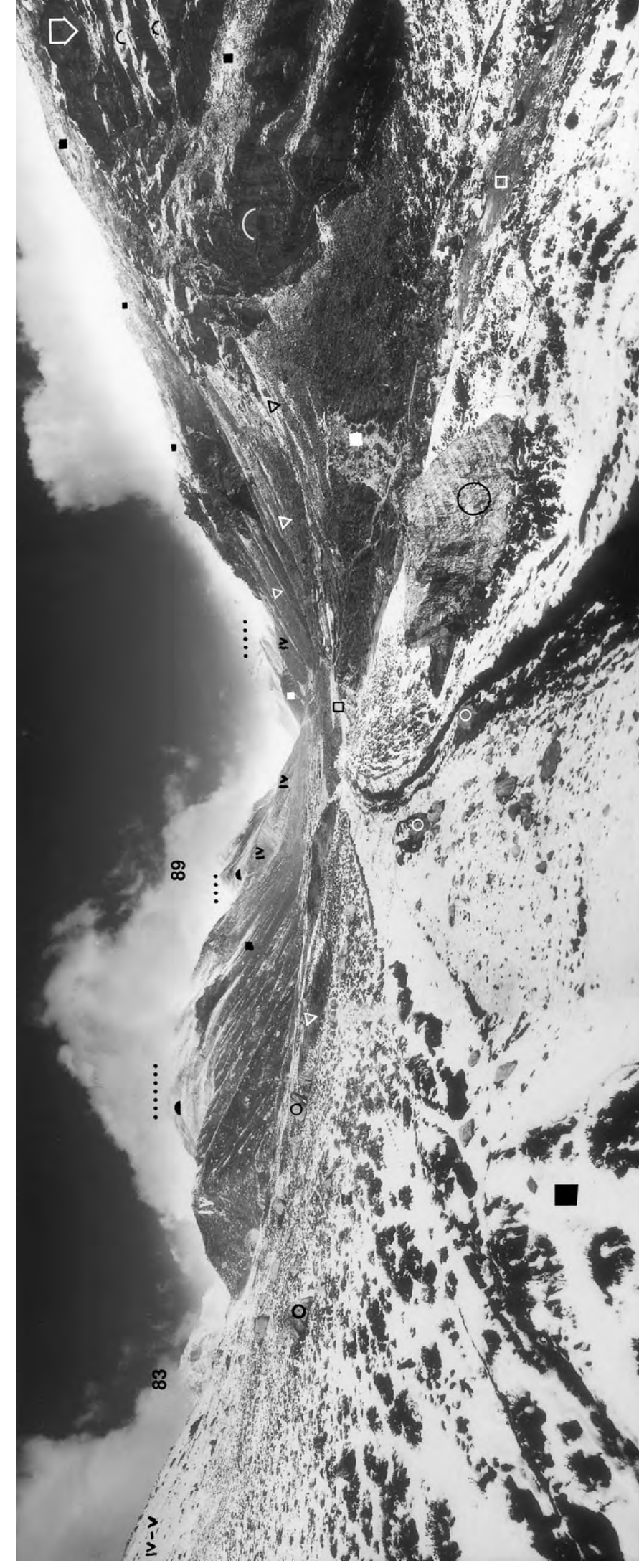


←Photo 190. Picture taken from the orographic right valley flank of the lower Bote Koshi Drangka down-valley from the inflow of the Langmoche Drangka at ca. 4150 m a.s.l. (Figure 3 Photo 190) from E below the highest alpine pasture of the Thame Teng hamlet facing SE down the main valley. (□ black and white on the right) are two edged boulders of augen-gneiss up to 5 m in length; between them a third round-edged boulder on which a person stands. They are situated on and in part in a moraine slope (■ foreground), 270 m above the valley floor (□ white on the left). (■ black) are High Würmian to Late Glacial covers of ground moraine on the valley slopes. (■ white) is late Late Glacial ground moraine material, which, due to some process coming down from the Langmoche Drangka, has probably been reshaped during the Holocene. (△) are debris cones of dislocated ground moraine material from the upper slope. (○, ⊃) are High Würmian to Late Glacial flank abrasions in the bedrock, which on the steep valley slopes pierce the remnants of ground moraine. (...) are the High Würmian upper limits of abrasion and thus glacier trim-lines reconstructed at 4700 m (... on the left) and 4400 m (... on the right). Analogue photo M. Kuhle, 05/04/2003.

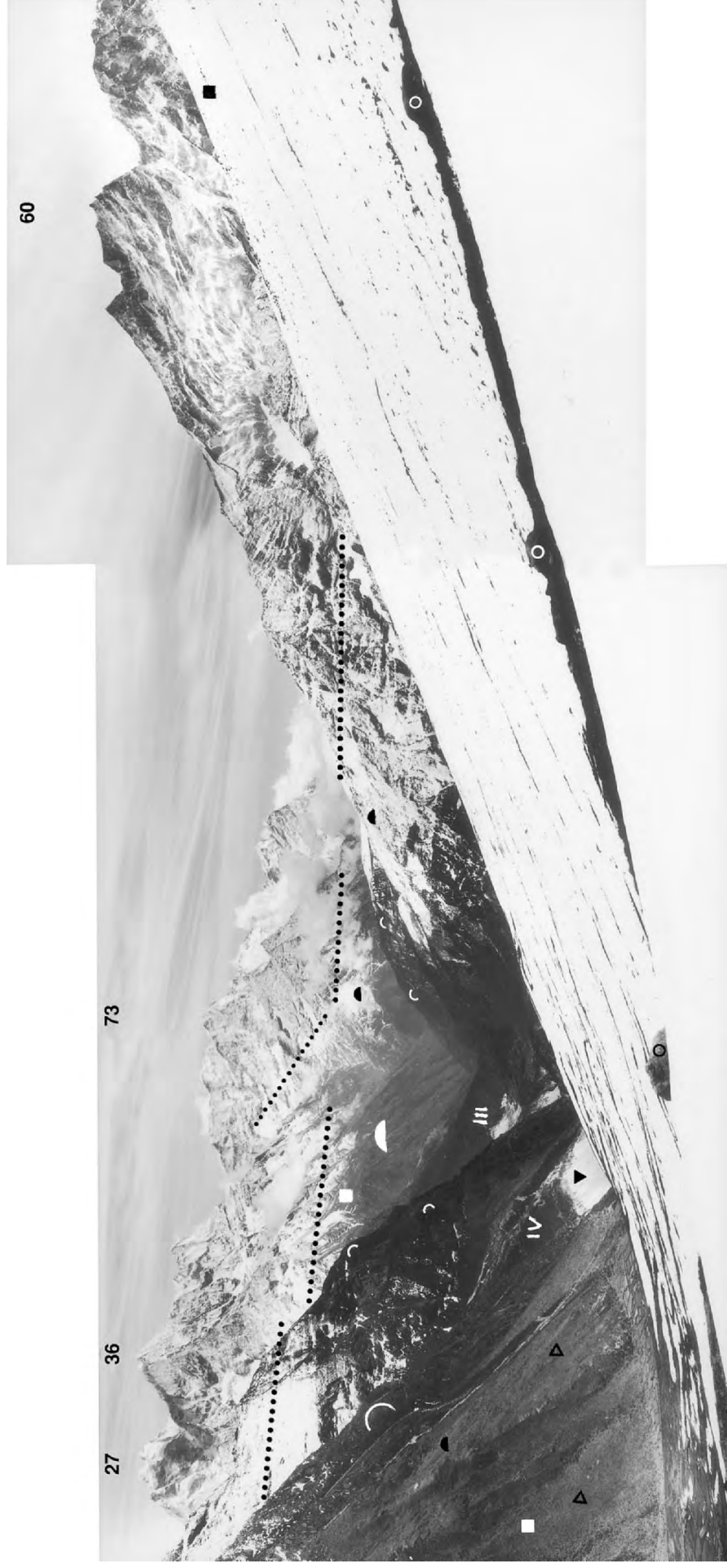


←Photo 189. Panorama-photo from the orographic right valley flank of the lower Bote Koshi Drangka, 0.5 km N from the highest alpine pasture of the Thame Teng hamlet (on the right margin), taken at 4300 m a.s.l. (Figure 3 Panorama 189) from facing NW (left margin) diagonally upwards into the Langmoche Drangka, joining here the Bote Koshi, via facing NNW to the 5967 m-peak (No. 89) along the right valley flank up the main valley, via facing NNE to Kyojo Ri (No. 68, 6186 m) in the orographic left main valley flank, via facing W to the 5583 m-high Kabsale (No. 52), via facing SE looking down the Nangpo Tsangpo Drangka (lower Bote Koshi main valley), via facing SSE to Kongde Ri (No. 60, 6187 m), up to facing SSW into the right flank of the main valley (right margin). (△) is the sampling locality of Sample Figure 82 (see also Figure 37 No. 41, Figure 3, 4.4.03/1) and (▽) that of Sample Figure 83 (see also Figure 37 No. 42, Figure 3, 5.4.03/1). (V) is the orographic right lateral moraine of the neoglacial Langmoche glacier (Nauri Stage, Table 1); (IV) are remnants of ground moraines and ground moraine pedestals of the late Late Glacial Sirkung Stage (Table 1). (○ and □) are round-edged to one-sided rounded and edged moraine boulders of erratic granite (○ on the left) and gneiss (□ on the right) in size up to 6 m (1.5 m-long stick for scale). (III) is a remnant of ground moraine of the Dhampu Stage (Table 1). (■) are High Würmian and Late Glacial remnants of ground moraine covers; (○) are flank abrasions in the bedrock and (●) are back-polished rock spurs, showing the form of glaciogenically triangular-shaped slopes; in many places ground moraines have remained on them. (▼ and half-left above III) are ca. 20 year- old slides in the loose rock (moraine- or gravel material) on the valley bottom, caused by the lateral undercutting of the slope due to the outburst of the moraine lake (Dig Tsho), coming down from the Langmoche Drangka in 1985. (...) is the High Würmian glacier trim-line running from ca. 5500 m (...) on the right somewhat below No. 89, Figure 34), via ca. 5000 m (...) on the left of No. 89 and on the right below No. 68; Figure 35), via ca. 4400 m (...) on the left somewhat below No. 73 and on the left below No. 60, Figure 36) down to 4000 m a.s.l. (... below No. 73, Figure 52). Analogue photo M. Kuhle, 05/04/2003.

→Photo 192. Picture taken from the inflow of the Langmoche Drangka mountain river (above ○ and □) into the lower Bote Koshi Drangka at 4110 m a.s.l. (Figure 3 Photo 192) facing WNW up the Langmoche Drangka. (V) is the inner slope of the orographic right lateral- to end moraine of the Nauri Stage (Table 1) of the neoglacial Langmoche glacier. (■) is corresponding moraine material, which here, on the lower slope, has been in part re-deposited. (△) are fresh, snow-covered debris cones of dislocated moraine material from that orographic right moraine. Below (V) a crumpling edge can be observed running across the moraine slope. It has been created by the excavation of the lower slope due to the outburst of the Dig Tsho moraine lake of the Langmoche glacier on August 8th, 1985, caused by fluvial undercutting (Photo 180). (□) is the 30-60 m-extended gravel bed developed by the water surge of the outburst of the moraine lake. (○) is an erratic boulder of tourmaline granite of 2 m in length, which several times has been re-deposited glaciogenically and last fluvially. Analogue photo M. Kuhle, 26/03/2003.



←Photo 191. Panorama photo from the valley bottom of the middle Bote Koshi Drangka up-valley of the junction with the Langmoche Drangka taken at 4030 m a.s.l. (Figure 3 Panorama 191) across the valley chamber of the Tarnga settlement, from facing W (left margin) with the 6940 m-high summit of Tangi Ragi Tau (No. 83) in the background, via facing NW up-valley to the 5967 m-summit (No. 89) in the orographic right valley flank and via the orographic left valley flank up to facing ENE (right margin). (□) is the Bote Koshi river in the talweg. (■) show ground moraine covers and -remnants, in some places superficially reshaped by debris- and debris flow cones (the two ▽ in the centre). Their material has also been dislocated in debris flow cones and -fans (▽ on the very left and right) (Figure 3 on the left above Panorama 191). (○) are edged and faceted, slightly dislocated moraine boulders of far-travelled granite (e.g. second ○ from the left) and augen-gneiss (○ large, with the inscription “Om mani padme hum” arranged in lines); the largest one is 6.5 m-long (○ large). (IV-V) is the orographic left neoglacial lateral moraine of the Nauri Stage (Table 1) at the exit of the Langmoche Drangka, containing a late Late Glacial moraine core of the Sirkung Stage. (IV) are several remnants of the ground moraine pedestal from which samples have been taken. They are from the Sirkung Stage and reach altitudes up to 500 m above the talweg. (○) are glaciogenic flank abrasions on the outcropping edges of the strata of the Lower Tibetan gneiss (6b, Nepal Geological Map 1: 125,000 (1985); Sheet No. 721-B), damaged by crumbings (b) during the deglaciation in the Late Glacial. (●) are very well preserved back-polished rock spurs, which show the form of glaciogenically triangular-shaped slopes and indicate the glaciogenic shaping of the flanks up to in excess of 5000 m a.s.l. (...) are the corresponding High Würmian glacier trim-lines, running from ca. 5700 m (...) on the right), via ca. 5500 m (...) below No. 89; Figure 34) down to ca. 5000 m altitude (...) on the left; Figure 35). Analogue photo M. Kuhle, 26/03/2003.



← *Photo 193.* Panorama photo from the orographic right valley flank of the lower Langmoche Drangka, i.e. the right valley flank of the main valley in the confluence zone of the Langmoche- into the middle Bote Koshi Drangka taken at 4550 m a.s.l. (Figure 3 Panorama 193) from facing ESE to Kang Taiga (No. 27, 6779 m) and Tramskeru (No. 36, 6608 m), via Nangpo Tsangpo Drangka, and facing SSE to the 6187 m-high Kongde Ri (No. 60) up to facing S (right margin). (■ black) is the High Würmian to Late Glacial ground moraine reaching up to 4600 m a.s.l. It consists of 1–3 m-long, round-edged to slightly rounded and edged polymictic boulders of metamorphites, granite (○ black) and gneisses (○ white); granite and augen-gneiss are erratic. (■ white on the very left) are corresponding ground moraine remnants on the left valley flank, superficially reshaped by down-slope movement of debris (△). (■ white on the right) are High Würmian (Stage 0, Table 1) ground moraine remnants (cf. Figure 32) on the left valley flank in the confluence area of the Inja- and Nangpo Tsangpo Drangka (to the Dudh Koshi Nadi) reaching ca. 4300 m a.s.l. (IV and III) are orographic left moraines from the side valleys, which from the Kabsale SW-hanging-valley (IV) and the Kyayo Drangka (III) have been pushed into the main valley. (▼) is a slide in this moraine material caused by the outburst of the moraine lake of the Langmoche glacier (Dig Tsho) in 1985 due to fluvial undercutting. (●) are exemplarily well-preserved, back-polished rock spurs, which present the form of glaciogenically triangular-shaped slopes and provide evidence of the glaciogenic flank development up to 4400 m (● on the very right), i.e. up to 4000 m a.s.l. (● below No. 73); (▲ white and on the very left) are triangular-shaped slopes, showing a ground moraine cover, into which slope gullies have been eroded since the deglaciation. (○, ○) are flank abrasions, which locally are especially well-preserved; (...) mark their upper limits and thus the minimum height of the High Würmian glacier level: (...) on the very right, on the very left and on the right below No. 36) the level has run at 4400 to 4300 m a.s.l.; it has dropped into the Dudh Koshi Nadi (...) half-glacier trim-line of the High Würmian Kyashar glacier running down with the steep incline of the Kyashar Khola side valley. Analogue photo M. Kuhle, 05/04/2003.



→ *Photo 194.* Picture taken at 3880 m a.s.l. up-valley from the inflow of the Arabtsen Drangka into the lower Bote Koshi-, i.e. Nangpo Tsangpo Drangka (Figure 3 Photo 194) facing NNW up the Bote Koshi Drangka via the Or-sha hamlet (buildings on the left, middle ground) to the 5967 m-peak (No. 89). (V) is the outer slope of the orographic right lateral-to-end moraine of the Langmoche glacier (Nauri Stage, Table 1) at the exit of the Langmoche Drangka. This neoglacial lateral moraine has a Late Glacial ground moraine core. (IV) is the late Late Glacial terrace of the ground moraine pedestal of the Sirkung Stage (Table 1) in the triangular-shaped inset between the Bote Koshi- and Langmoche Drangka, 400 m above the main valley bottom. (●) are High Würmian to Late Glacial remnants of ground moraine covers and – pedestals, in places exposed by fresh slides (■ below and ▼). (□) is a neoglacial, glaciofluvial gravel cover. (●) marks a classic, glaciogenically triangular-shaped slope. (▼) are postglacial rock rills, developed since the deglaciation. (...) is the High Würmian level of the ice stream network about 5000–5100 m a.s.l. (Figure 35). Analogue photo M. Kuhle, 08/11/1982.



↑Photo 195. Panorama photo from up-valley of the junction of the Arabitsen Drangka and the lower Bote Koshi, i.e. Nangpo Tsangpo Drangka taken at 3880 m a.s.l. (Figure 3, Panorama 195) from facing SW (left margin) and WSW up the Arabitsen Drangka to the 6500 m-high Teng Kangpoche (No. 87), via facing NNW up the Bote Koshi Drangka via the Orsha hamlet (buildings on the left, middleground) to the 5967 m-peak (No. 89), up to facing NE to the 5583 m-high Kabsale (No. 92) into the orographic left main valley flank. (□black) is the current gravel floor of the Bote Koshi river. (■ large, black) is ground moraine on the valley floor, part of which is fluviably washed; (■ black and white, small) are deposits of ground moraine, occurring on the flanks of the two valleys up to heights of 4600 m a.s.l. (■ black, small and white on the right), (▽) are debris cones and alluvial debris fans, reshaping and displacing the ground moraine covers on the slopes since the deglaciation. (□ white) is a glaciofluvial gravel cover, overlying truncated ground moraine. (IV) are late Late Glacial remnants of a ground moraine pedestal of the Sirkung Stage (Table 1), reshaped during the Holocene. The tongue end of the neoglacial Kabsale SW-hanging glacier has been adjusted to the ground moraine terrace (IV on the right) at the exit of the Kabsale SW-hanging valley (□). In addition, the meltwaters of still younger margins of the hanging glaciers have modified the ground moraine terrace. (V) is the outer slope of the end moraine of the Holocene Arabitsen glacier, shaped in the Nauri Stage (Table 1). (○) are several gneiss boulders in size from metres up to that of a house (○ black) on the moraine slope. (▼, ■ large black, □ white) are exposures of slides on the sediments of the valley bottom, developed, i.e. enlarged by fluvial undercutting due to the outburst of the moraine lake of the Langmoche glacier (Dig Tsho) on August 4th, 1985 (cf. Photo 194 from 1982). (○, ○, ○) are glaciogenic flank abrasions, the upper limits of which, in combination with the glaciogenically triangular-shaped slopes as a result of back-polished mountain spurs (●●), provide evidence of the High Würmian glacier trim-line (...). The glacier trim-line has run between 5200–5000 m a.s.l. (... on the right below No. 87 and on the left of No. 89; Figure 35) and 4800–4700 m a.s.l. (on the left of No. 92). The Kabsale SW-hanging valley is an early- to Late Glacial tube cirque with a trough-shaped cross-profile (□); (4) shows a postglacial rock crumbling and below a slope of boulder debris. Analogue photo M. Kuhle, 26/03/2003.

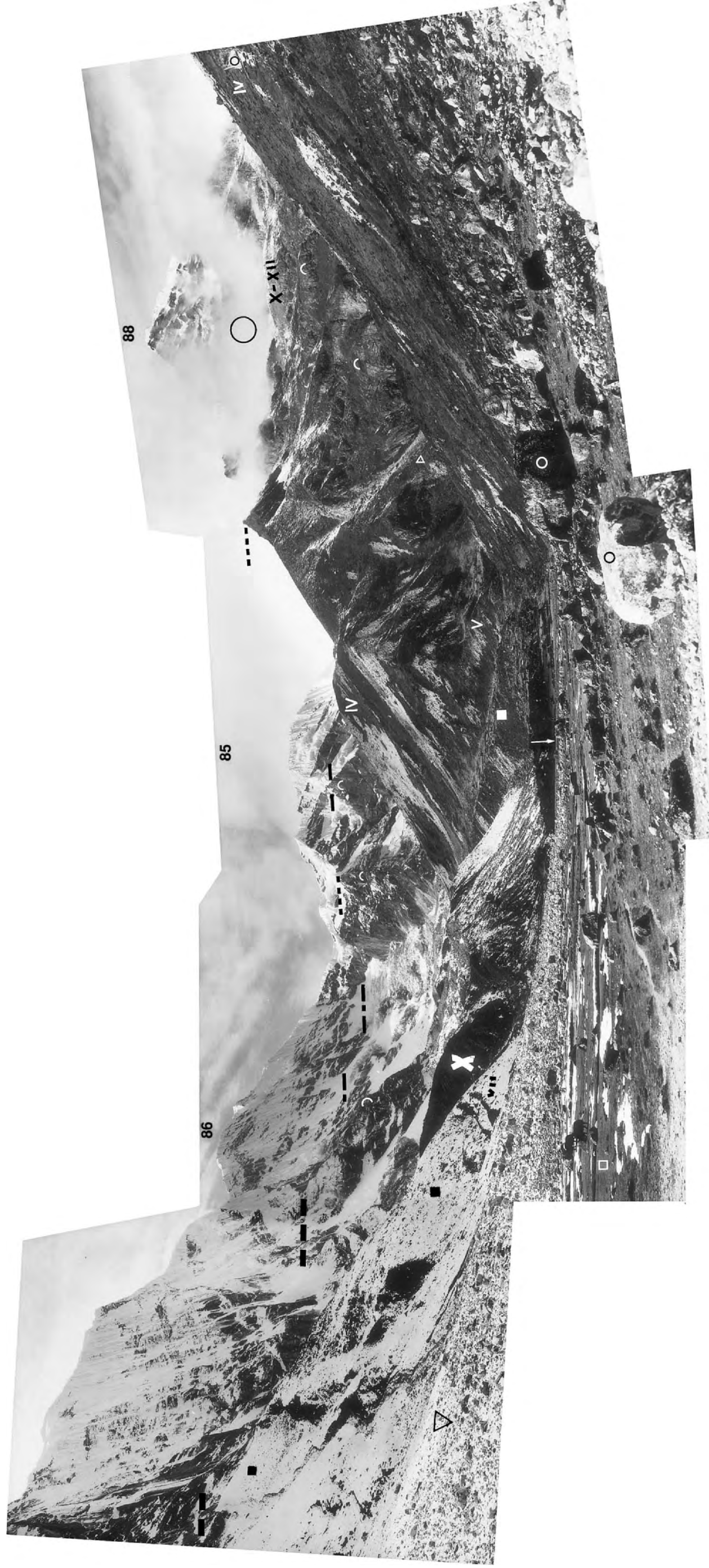
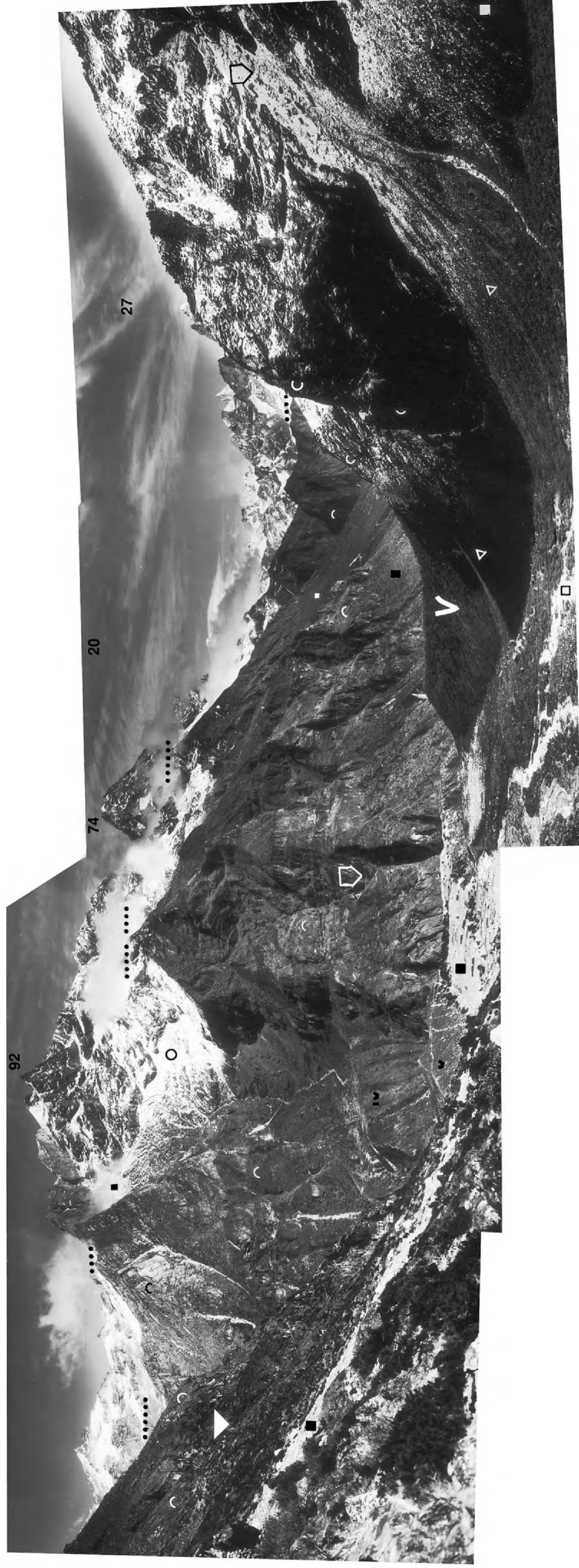


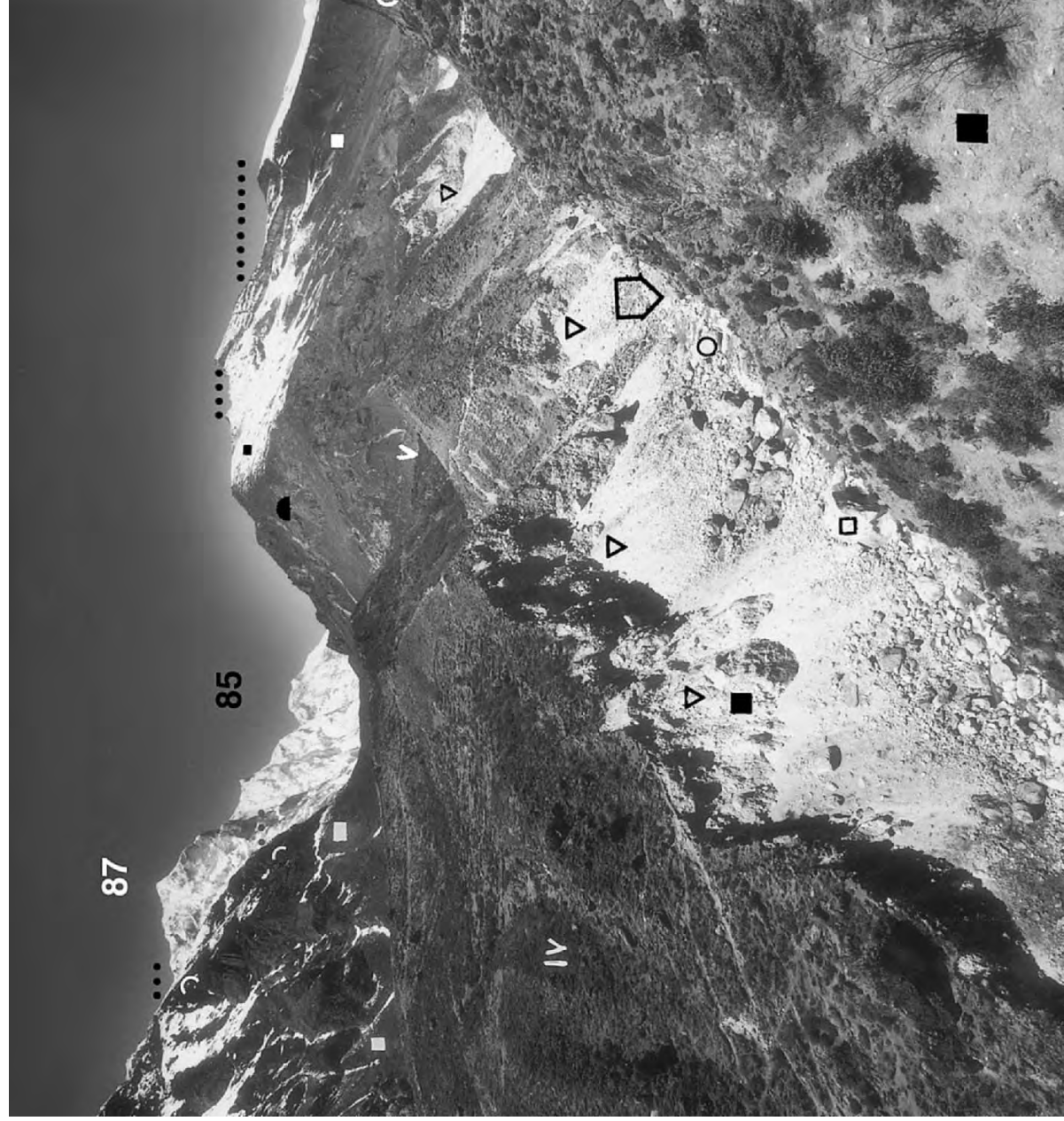
Photo 196. Panorama photo at 4290 m from the valley floor (Figure 3 Panorama 196) into the valley head of the Arabitsen Drangka from facing SW (left margin) via WSW into the N-face of Panayo Tuppa (No. 86, 6696 m) and to the 6718 m-high Pigpherago Shar (No. 85) with the Thengpo alpine pasture in the middleground (below ■ white), via facing WNW to the 6180 m- peak (No. 88), up to facing NW (right margin). (♣) is the sampling locality of the C14-dating (Figure 3 and Table 2: No. 10). (X white) is the orographic right lateral moraine of the Thengpo glacier during the historical Stage X (Table 1); on the right of (X white) the contemporaneous Thengpo glacier is situated, covered with surface moraine. (VII) on the orographic right side is a triple ledge of lateral moraine of its Younger Dhaulagiri Stage. (X-XII) shows the front moraine of the corresponding stages (Table 1) of the 6180 m-peak ESE-glacier, flowing down from a cirque (○ large). (V) is a neoglacial moraine remnant of the Nauri Stage belonging to the Thengpo glacier, which at that time was twice as wide. (■ white) is a terrace-shaped related remnant of a ground moraine pedestal. (IV) are two late Late Glacial remnants of a ground moraine pedestal of the Sirkung-Stage, interrupted since the deglaciation by the inflow of the orographic left tributary valley and separated from each other by erosion. (○ small) are polymictic moraine boulders in size from metres up to that of a hut, transported out of the moraine formation and re-sedimentated. (■ black) are remnants of ground moraine cover on the orographic right valley flank; (▽ black) is a debris- or debris flow come derived from wall crumbings and dislocated ground moraine (■ on the very left). It is adjusted to the valley floor consisting of the youngest glaciofluvial gravels of the historical glacier forefield (□). Grazing yaks provide a scale for the rockfall- and moraine boulders situated there. (▽ white) is a steep debris cone with a core made up of ground moraine and a surface of the debris of crumbings. (○, ♣) are more or less well-preserved glacialic roundings of abrasion on the Lower Tibetan gneiss bedrock (6b); on the flat, nearly horizontal rock bottoms these forms show the character of roches moutonnées (the two ○ on the right). The glacier trim-line (---), reconstructed according to the upper limits of abrasion, has reached an altitude of ca. 6200-6100 m a.s.l. at the valley head (below No. 85). To the E (---) on the left margin and on the left below No. 86) it runs down to ca. 5800 m. Analogue photo M. Kuhle, 09/11/1982.



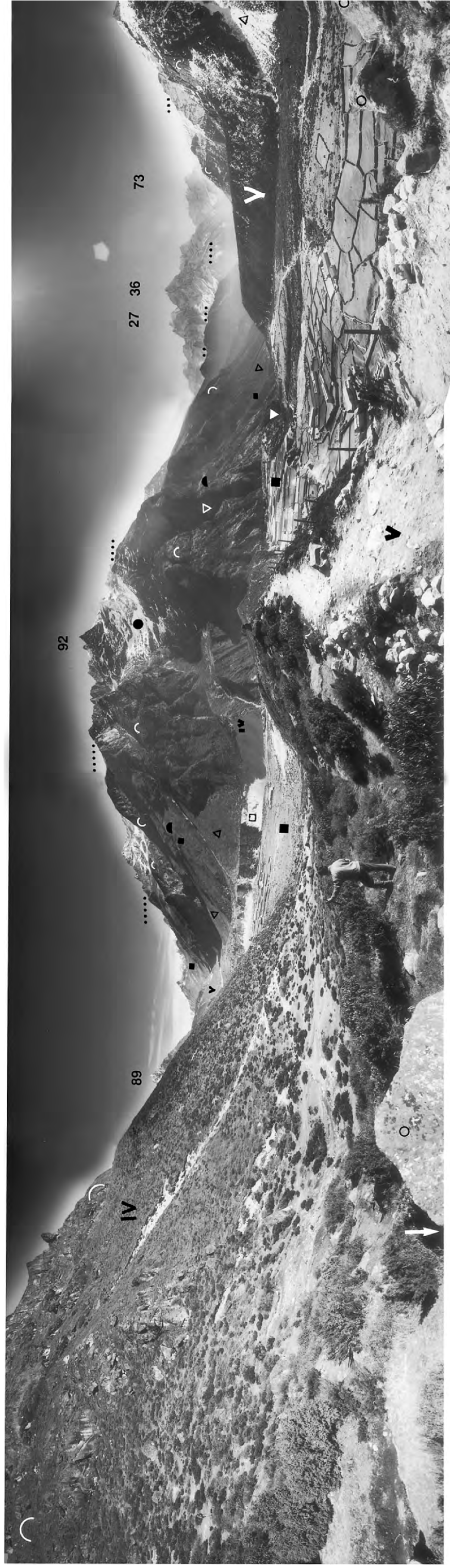
↑Photo 197. Panorama photo from the exit of the highest orographic left side valley at the valley head of the Arabtsen Drangka at 4780 m a.s.l. (Figure 3, Panorama 197) into the head of this side valley, from facing WNW (left margin) via facing NNW (centre of the panorama) up to facing ENE (right margin). (X, X-XI and X-XII) are historic end moraines and youngest glacier positions (Table 1) of the short hanging glaciers visible from this viewpoint, which flow down to the S (No. 84) to the SE (X, X-XI) and from the 6180 m-peak to the S (No. 88) (X-XII) (cf. Figure 3 below No. 88). (IV) is a late Late Glacial moraine remnant of the Sirkung Stage (Table 1); (V) are neoglacial moraine bodies of the Nauri Stage. (■) mark High Würmian to Holocene remnants of ground moraine, which chronologically are not to be classified in more detail. (▲) are debris cones fed by fresh crumbly debris. (●) show glacigenically polished-back mountain spurs, for the last time abraded during the Würmian ice stream network. (...) from left to right) are the Würmian ice stream network. (M. Kuhle, 09/11/1982).



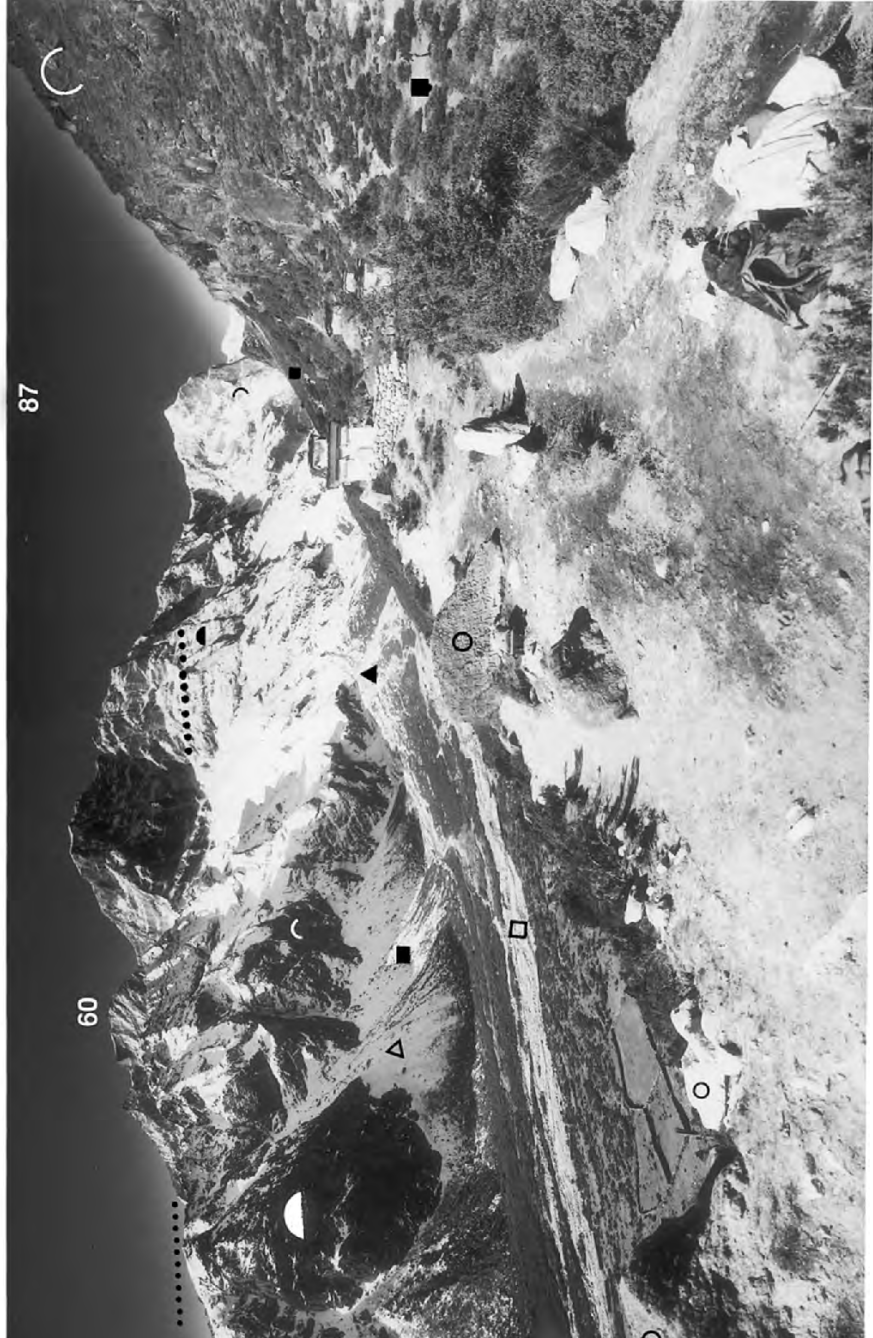
↑ *Photo 198.* Panorama photo from the orographic left slope of the lower Arabisen Drangka at 4240 m a.s.l. (Figure 3, Panorama 198) from facing NNE (left margin) along the orographic left flank of the Arabisen Drangka and into the left flank of the Bote Koshi Drangka in the background, via facing NE to Kabsale (No. 92, 5583 m), via facing ENE to the 5761 m-high Khumbui Yul La (No. 74) and the summit of the 6856 m-high Amat Dablang (No. 20), via facing W down the Nangpo Tsangpo Drangka and to the 6779 m-high Kang Taiga, up to facing SE into the orographic left flank of the Nangpo Tsangpo Drangka (right margin), (□) is the current glaciofluvial gravel floor of the Arabisen Drangka river; (■) on the left below No. 52 is the end moraine of a contemporaneous cirque glacier; the rest of the (■) are covers of ground moraine on the valley bottom and the flanks of the Arabisen Drangka (■ below on the very left, on the very right and in the middle below); (■ somewhat right below No. 20) are covers of ground moraine on the orographic left slope of the Nangpo Tsangpo Drangka main valley reaching up to a height of 4100 m a.s.l. (■ white; cf. Figure 36). (V) are the neoglacial end moraines of the Nauri-Stage (Table 1), fringing the tongue basin with the Thame settlement. (V black) shows the sampling locality of Figure 85 (see also Figure 37, No. 44). (IV) is a remnant of a ground moraine pedestal of the late Late Glacial Sirkung-Stage (Table 1), for the last time reshaped by the meltwater of the neoglacial Kabsale SW-cirque glacier during the Nauri-Stage. (O) is a High Würmian to Late Glacial cirque in the catchment area of the Kabsale SW-hanging valley. (∇) are debris cones, which further below pass into debris flow cones and fans. At some places of the catchment area very coarse to coarse-blocky debris of crumblings is visible (∇ black). (∇) are further crumblings, orientated according to ice-marginal and subglacial hollow forms of drainage; (∇ white) is a subglacially developed Late Glacial drainage tube, i.e. ravine, which due to crumblings has been extended since the deglaciation. (○, ∩, ∪) are glaciogenic abrasions on the faces of gneiss bedrock preserved between the crumblings. (...) is the High Würmian (Stage 0, Table 1) glacier trim-line, reconstructed according to the ground moraine covers and upper limits of abrasion. It runs from (...) on the very left at ca. 5000 m (Figure 35 left side), via 4400 m (...) on the right below No. 74; Figure 36 on the left) down to 4000 m a.s.l. (...) on the left below No. 27; Figure 52 left side). Analogue photo M. Kuhle, 08/11/1982.



← *Photo 200*. Picture taken at 3640 m a.s.l. from the orographic left flank of the lower Bote Koshi-i.e. Nangpo Tsangpo Drangka from down-valley of the confluence with the Arabitsen Drangka (below No. 85) W of the Samde settlement (Figure 3, Photo 200) facing W up the Bote Koshi- (on the right) and the trough-shaped Arabitsen Drangka (on the left) on to the 6500 m-high Teng Kangpoche (No. 87) and the 6718 m-high Pigpherago Shar (No. 85). (♢) is the Bote Koshi river, which cuts into the ground moraine pedestal of the late Late Glacial Sirkung Stage (IV); (■) on the right below IV) is moraine material *in situ*, which recently and to an increasing extent has been fluvially undercut by the outburst of the moraine lake of the Langmoche glacier (Dig Tsho) in 1985. (▽ black) are cones and slopes of the moraine material tipped over since that time. (○) are faceted moraine boulders, exposed by the stream in the talweg; (□) are edged moraine boulders up to the size of a hut consisting of gneiss and granite. (V) shows an orographic left end moraine of the Arabitsen glacier, which during the Nauri Stage (Table 1) has been thrust across the ground moraine pedestal of Stage IV. (■) are ground moraine covers, in part superficially reshaped by debris cones (the two ■ white below No. 87). The highest occurrences have been observed at 4800 m a.s.l. (■ black, small, on the very top). (●) is a glacially back-polished mountain spur and triangular-shaped slope; (○, ◐) are glacial forms of abrasion in the rock. The upper limit of all these forms, i.e. their polish line (...), provide evidence of the High Würmian (Stage 0) valley glacier level. It has run at about 5800 m (... on the right below No. 87) and has fallen away to the inflow of the Arabitsen Drangka at ca. 4500 m (on the left below No. 87). Above the orographic right main valley flank the ice level has run at about 5300 m a.s.l. (the two ... on the right). Analogue photo M. Kuhle, 07.04.2003.

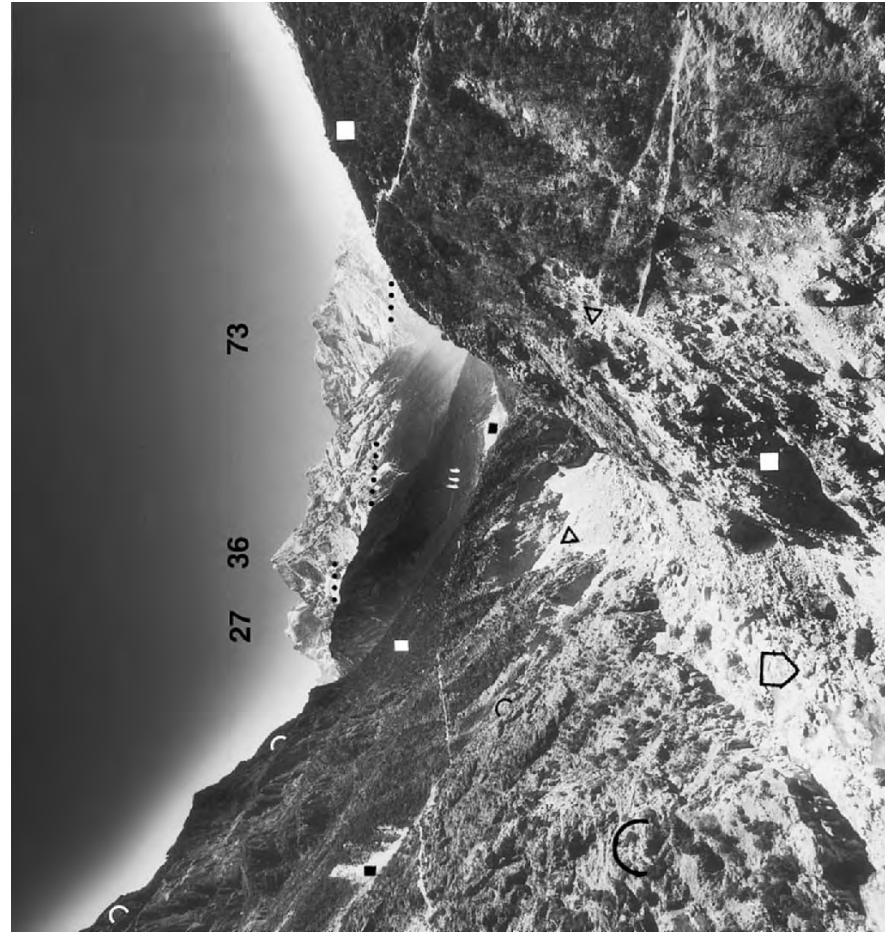


↑ *Photo 199*. Panorama photo taken from the orographic left slope of the lower Arabitsen Drangka at 3910 m a.s.l., 110 m above the Arabitsen Drangka talweg (□ on the right) (Figure 3, Panorama 199), from facing NNW (left margin) along the orographic right flank of the Bote Koshi Drangka on to the 5967 m-peak (No. 89), up the main valley into the left flank of the Bote Koshi Drangka in the N, via facing NE to Kabsale (No. 92, 5583 m), via facing ESE to the 6779 m-high Kang Taiga (No. 27), the 6608 m-high Tramserku (No. 36) and the 6369 m-high Kusum Kanguru (No. 73), down the Nangpo Tsangpo, i.e. lowest Bote Koshi Drangka, via facing S to the 6187 m-high Kongde Ri (No. 60), via facing WSW to the 6500 m-high Teng Kangpoche (No. 87), up the Arabitsen Drangka, up to facing W into its left flank (right margin). (●) is the sampling locality of Figure 85 (see also Figure 37, No. 44) in the late Late Glacial (Stage IV) material of a ground moraine pedestal (also ■ on the right) with a peripheral modification by a neoglacial orographic left lateral moraine of the Arabitsen tributary glacier (V black in the foreground) of the Nauri Stage (see Table 1). (V white) is the corresponding right lateral- to end moraine. (○) are edged to round-edged gneiss- and granite boulders up to 3 m in length (person for scale). (V black, small) is a neoglacial end moraine in the confluence area of the Langmoche Drangka. (IV large) is the correspondingly old ground moraine core of a ground moraine pedestal, reshaped by the meltwater of the neoglacial Kabsale SW-cirque glacier. (■) are further ground moraine pedestals on the valley bottoms (■ large, half-left and half-right below No. 92) and mantlings of the slope by ground moraine; (V black) are cone forms modifying the ground moraine covers; they have a morainic core. (▲ black) is an active debris flow fan. (□) are Holocene to contemporaneous glaciofluvial accumulations of gravel. (▼ white) shows a current fluvial cut by backward erosion of the Arabitsen river into the ground moraine plate on which the Thame settlement is situated. (●) are glacially back-polished mountain spurs and triangular-shaped slopes in the rock, for the last time abraded during the Würmian ice stream network; (○, ○, ○) are clearly preserved glacialic roundings of abrasion on the faces of gneiss rock. (...) is the High Würmian (Stage 0, Table 1) glacier trim-line reconstructed according to the ground moraine covers and upper limits of abrasion. It runs from (...) on the very left) from ca. 5300–5000 m (Figure 35 on the left), via 4600–4400 m (...) on the right below No. 92 and on the right below No. 73; Figure 36) down to 4200–4000 m a.s.l. (...) on the right below No. 36; Figure 52 on the left side) and from ca. 5800 m a.s.l. (...) on the right) down to ca. 4700–4500 m (on the left below No. 60). (●) is an Ice Age to neoglacial cirque. (▽ white) marks a sharp wall cut without a catchment area, developed as a subglacial meltwater ravine. Analogue photo M. Kuhle, 06/04/2003.





← *Photo 201*. Picture taken at 3590 m a.s.l. (Figure 3, Photo 201) from the ravine-like talweg of the lower Bote Koshi Drangka, set in decimetres-deep, in the confluence area of the Arabtsen Drangka E of the Thame Og settlement looking up-valley facing NW. (Δ) is an avalanche cone, which has reached the Bote Koshi river and shortly dammed up. (○ black) are potholes and pothole-walls, still annually reached and reworked by the high water. (○ white) are bowl-shaped remnants or parts of potholes in dimensions of 1–4 m, 6–8 m above the stream. (▼) marks a 3×3×1.9 m extended niche of crumbings in the outcropping massive, i.e. very coarse-bedded mica gneiss (6b). (○, ◐) are glacial rock polishings, roughened by weathering, and glacialic roundings of abrasion. Analogue photo M. Kuhle, 25/03/2003.



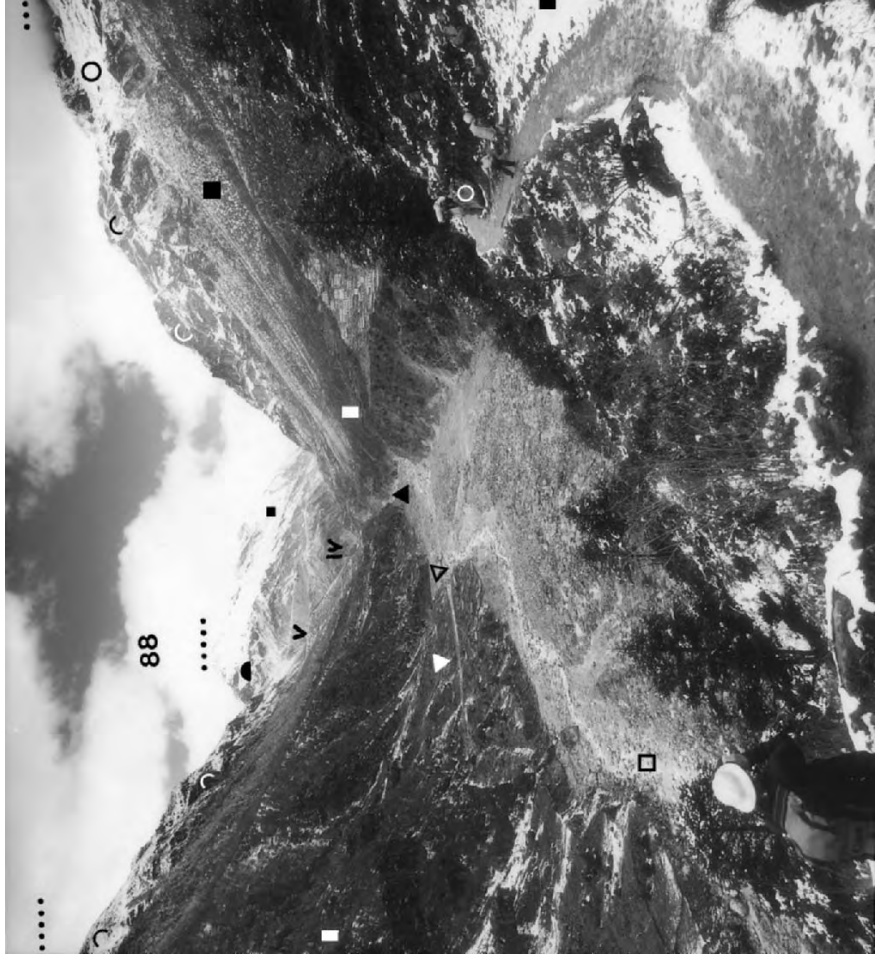
↑ *Photo 203*. Picture taken at 3650 m from the ground moraine pedestal (■ large) at the exit of the Arabtsen Drangka E of the Thame Og settlement (Figure 3, Photo 203) facing ESE on to the 6779 m-high Kang Taiga (No. 27), the 6608 m-high Tramserku (No. 36) and the 6369 m-high Kusum Kanguru (No. 73), down the Nangpo Tsangpo, i.e. lower Bote Koshi Drangka. (◐) is the main valley river, the bed of which has recently been widened due to the increasing fluvial lateral erosion, caused by the flood wave of the outburst of the moraine lake of the Langmoche glacier (Dig Tsho) in 1985. (▽) are slight breaks of landslips, cones and slopes, made up of the ground moraine material, which at the same time has been tipped over. In November 1982 the author has still walked the two trails (▽ on the right), which are broken off now. (◐, ◑) are glacialic abrasion forms of the orographic left flank, in part mantled by remnants of ground moraine covers (■ small) (Figure 36). (III) is the Dhampu Stage (Table 1) end moraine of the orographic left tributary valley glacier, the Kyajo glacier. (...) on the right below No. 27) shows the High Würmian glacier level about 4240 m a.s.l. on the mountain ridge between the Kyajo Drangka and the Khumde settlement beyond. (...) on the right below No. 36) is the course of the glacier trim-line in the confluence area of Imja- and Nangpo Tsangpo about 4300–4200 m (Figure 32) and (...) below No. 73) at ca. 4100–4000 m in the area where the Kyashar Khola joins the Dudh Koshi Nadi (Figure 52). Analogue photo M. Kuhle, 06/04/2003.



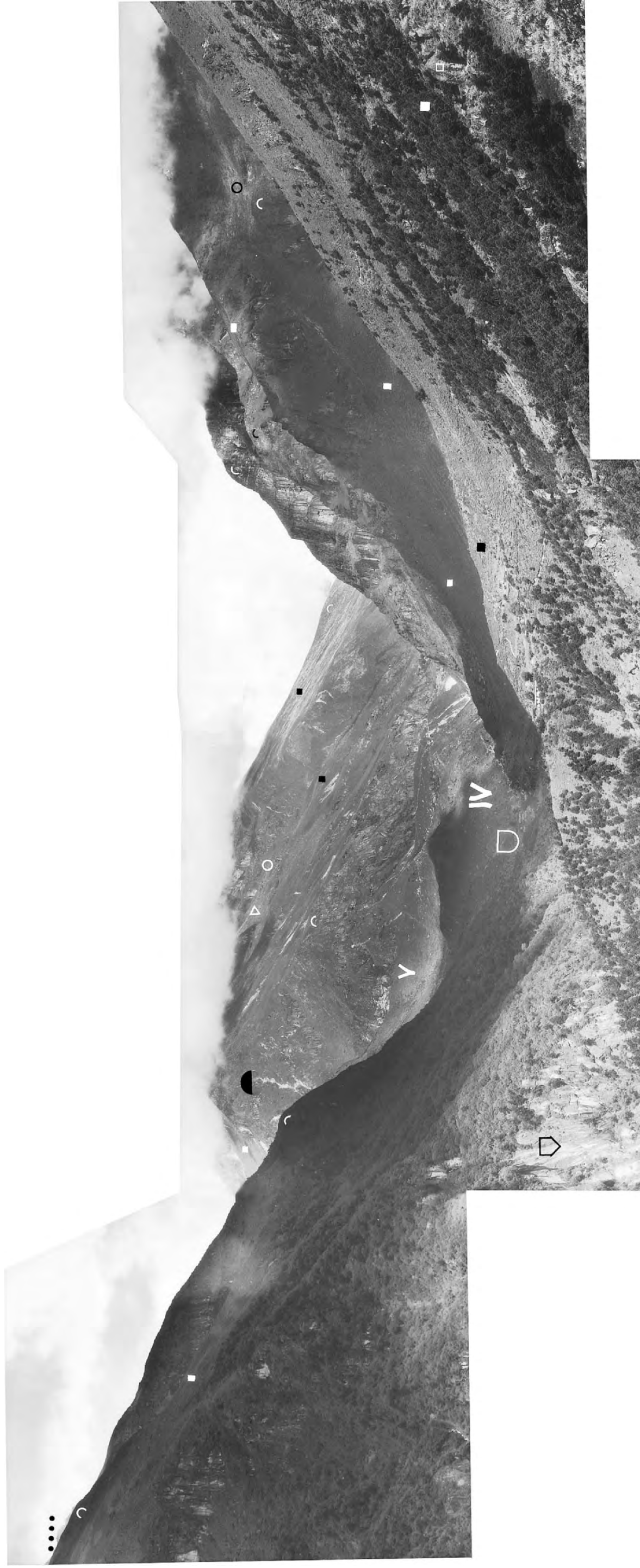
← *Photo 202*. Picture taken at 3640 m a.s.l. (Figure 3, Photo 202) from the ground moraine pedestal (■) at the exit of the Arabtsen Drangka, E of the Thame Og settlement, facing NNE into the orographic left flank of the lower Bote Koshi Drangka. (○) is one of many well-rounded erratic granite boulders (person for scale) of the ground moraine pedestal (■), lying on a glacially polished and rounded rock bottom (◐ small) of the outcropping valley underground. On the abraded gneiss wall (◐ large) remnants of subglacial potholes, in size 2–6 m, are situated (▼). They are very freshly preserved as half-hollows up to at least 50 m above the current river (▼ black) (Figure 3 on the right of Photo 202), (▽) is a collapse of a rock face ca. 40 m² in size. As can be recognized by the light colour, this crumbling has taken place just recently. (◐) is the lower elongation of a subglacially developed meltwater ravine to gully (Photo 199 ▽ white), through which snow avalanches nowadays come down, reaching the Bote Koshi river (Photo 101 Δ). Analogue photo M. Kuhle, 25/03/2003.



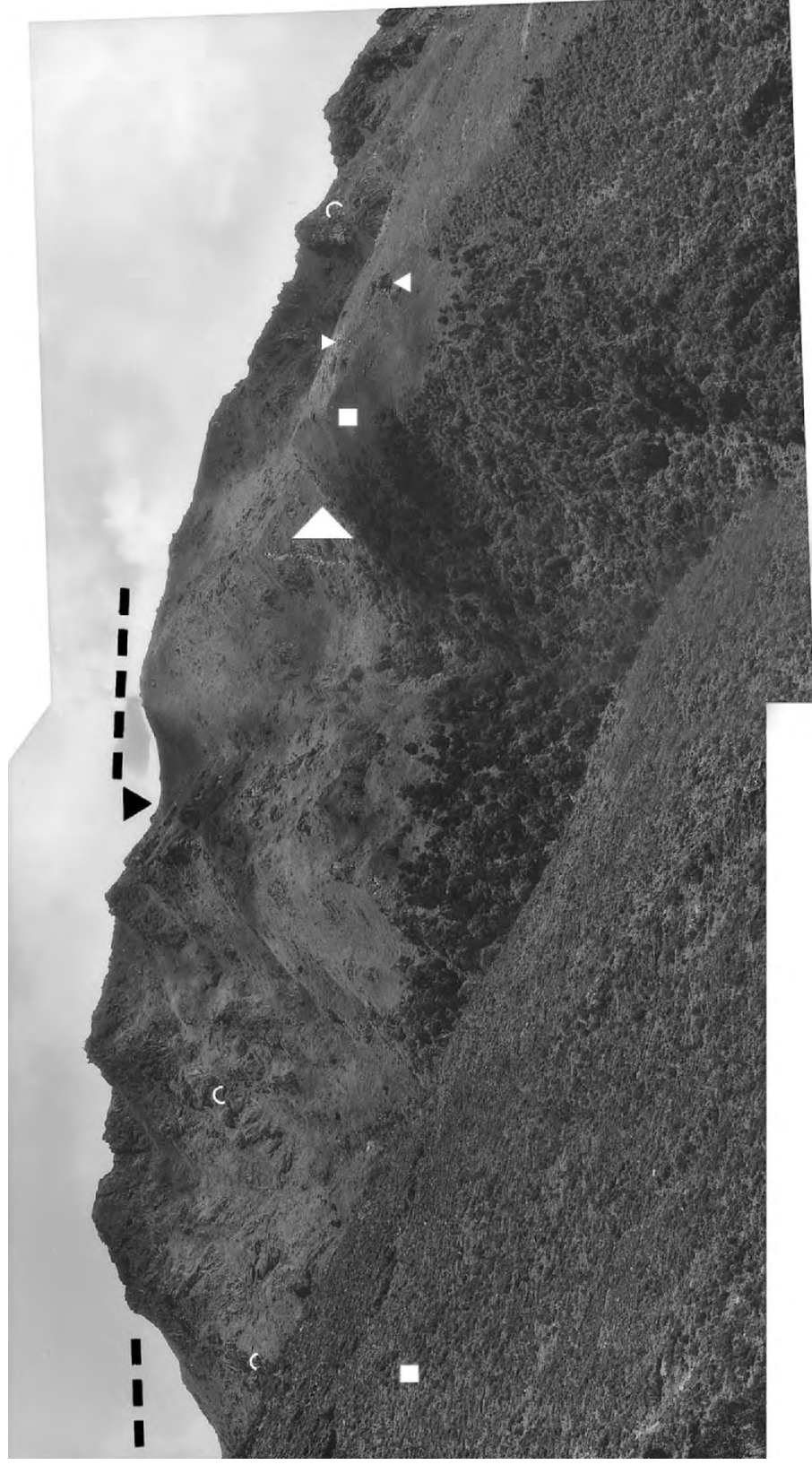
↑ *Photo 204*. Picture taken at 3670 m a.s.l. (Figure 3, Photo 204) from the orographic left flank of the Nangpo Tsangpo, i.e. lower Bote Koshi Drangka N above the Thomde settlement (□ white), ca. 200 m above the talweg (□ black), facing SE down the Nangpo Tsangpo, i.e. lower Bote Koshi Drangka. (■) are ground moraine covers recognizable in this valley section up to at most 4200–4300 m a.s.l. (■ on the very top and second from the right) (Figure 32), (■ large) are the mantlings with ground moraine on the trough flanks in Profile 26 (Figure 36, see Figure 3), (↑) is the sampling locality of Figure 86 (see also Figure 37, No. 45), (○) are ground moraine pedestal and faceted granite boulders, 'swimming' in the fine material matrix. (□ white) shows a remnant of the ground moraine pedestal on which the Thomde settlement is situated, glaciofluvially flattened since the Late Glacial deglaciation. It corresponds with the level of ground moraine (■ white on the very right) on the right valley side. (▽) is a current debris flow fan, which has been – and still is – built-up of dislocated moraine from the orographic right valley slope. (III) is the orographic right lateral- to end moraine of the Dhampu Stage (Table 1) of the orographic left tributary valley glacier, the Kyajo glacier, which at that time has reached the main valley. (▼) is an outer slope of the Bote Koshi river in the older ground moraine material, i.e. in the underlying bed of this end moraine. It has been increasingly undercut by the flood wave due to the outburst of the moraine lake of the Langmoche glacier (Dig Tsho) in 1985, so that fresh slides and crumbings have taken place as far as into the deposits of end moraine in the hanging layer. (●) is a glacially back-polished mountain spur and triangular-shaped slope (Figure 3 on the right below Photo 84); (○, ○) are glacial abrasion forms in the rock. Due to their upper limits, i.e. the polish lines developed (...), all these forms provide evidence of the High Würmian (Stage 0) valley glacier trim-line; it runs (... on the left) about 4240 m a.s.l. on the mountain ridge between the Kyajo Drangka and the Khumde settlement beyond (... centre on the left) in the confluence area of the Imja- and Nangpo Tsangpo about 4300–4200 m (Figure 32) and (... centre on the right) at ca. 4100–4000 m in the area, where the Kyashar Khola joins the Dudh Koshi Nadi (Figure 52); on the orographic right side (... on the right) the glacier trim-line runs at ca. 4200 m a.s.l. Analogue photo M. Kuhle, 25/03/2003.



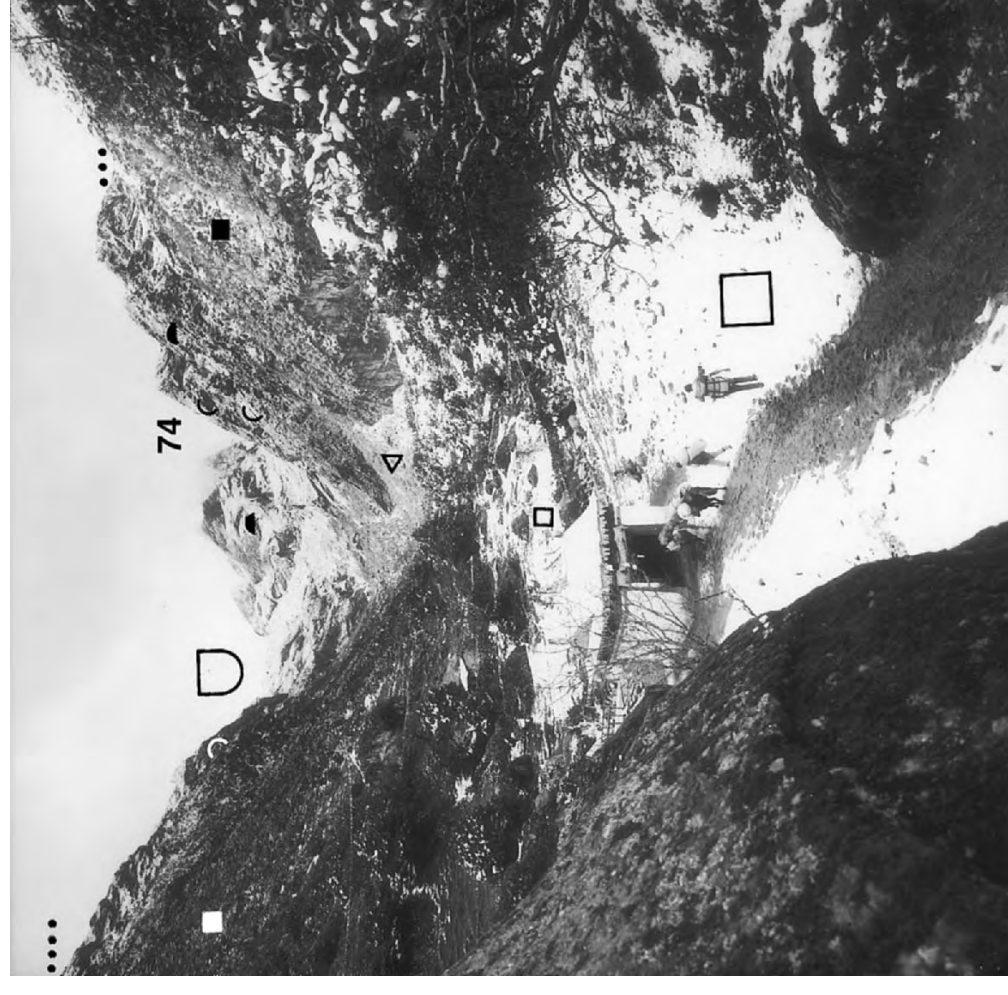
↑ *Photo 206*. Picture taken from the orographic left flank of the Nangpo Tsangpo Drangka between the Dramo (on the right of the right white ■) and Gonggha settlements at 3550 m a.s.l. (Figure 3, Photo 206), ca. 120 m above the talweg (□) facing WNW up the Nangpo Tsangpo valley via the valley chamber of Dramo on to the 6180 m-peak (No. 88). (▽) is an alluvial fan derived from a channel on the orographic right side of the slope, adjusted to the gravel floor of the valley (□). (▼ white) is a debris flow cone of dislocated ground moraine from the orographic right valley slope. (▲ black) is the course of a glacial ravine with an overlay of ground moraine. (IV) marks the remnant of a late Late Glacial ground moraine pedestal (Sirkung Stage; Table 1); (V) is a neoglacial end moraine complex (Nauri Stage), thrust across by the Arabisen glacier. (■) are covers of ground moraine with a thickness of decametres. Owing to this, they cannot be confused with covers of weathering- and slope debris. (○ white) is one of the boulders in size of metres up to that of a hut (person for scale) from which the moraine covers are built up. (●) is a classic, glacially triangular-shaped slope (Figure 3 on the left above Panorama 198). (○, ○) are rock ribs, piercing through the ground moraine covers. They show glacial abrasions, which have rounded the gneiss bedrock. (...) is the Würmian (Stage 0, Table 1) surface height of the valley glacier verified according to the upper limits of abrasion: (... on the left and right) has run at 4400–4300 m a.s.l. (Figure 36), (... below No. 88) is the glacier trim-line at ca. 5300 m a.s.l. (○ black) is an Early- to Late Glacial cirque depression, flatly set into the orographic left valley flank. Analogue photo M. Kuhle, 25/03/2003.



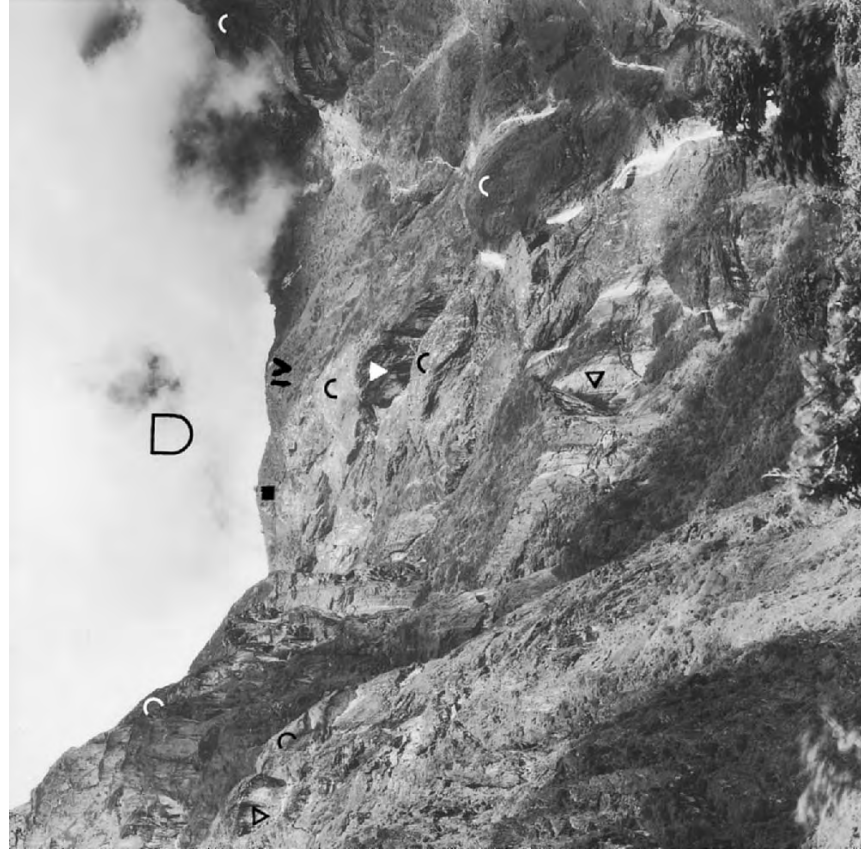
† Photo 205. Panorama photo at 3500 m a.s.l. from the orographic left slope of the lower Bote Koshi, i.e. Nangpo Tsangpo Drangka S of the Mende settlement (Figure 3, Panorama 205), from facing SW into the right valley flank (left margin), via facing WNW up the trough valley (D), up to facing NNW into the orographic left valley flank (right margin). (D) is a rock threshold in the Lower Tibetan gneiss (6b), i.e. here a trough threshold, dividing the valley by a trough basin, which has been subglacially-glaciofluvially dissected. The wall of the ravine-like incision shows current crumbings (ψ ; the light rock faces). (IV) is the remnant of a decametre-thick late Late Glacial ground moraine pedestal (Sirkung Stage; see Table 1); (V) is a neoglacial end moraine complex, thrust across the ground moraine pedestal by the Arabtsen glacier. (C) are flat, Early- and Late Glacial cirque forms (karoids). (V) is current debris below the back-wall of a cirque. (■) are small-scale ground moraine covers on the trough valley flanks (Figure 36), reaching 4600 m a.s.l. (■ in the centre above) and 4700 m (■ on the left of ■). Down the slope they are linearly furrowed in many places. (□) are moraine boulders in size of metres up to that of a hut, in part erratic. (C, C, C) are rock ribs, piercing through the covers of ground moraine. They show glacial abrasions, which have rounded the gneiss bedrock. (●) is a classic, triangular-shaped slope (Figure 3 on the left above Panorama 198), the form of which is due to a truncated spur. (...) is the High Würmian glacier level at ca. 4300 m a.s.l. reconstructed according to an abrasion limit (Figure 36, Profile 26 on the right side). Analogue photo M. Kuhle, 01/09/1982.



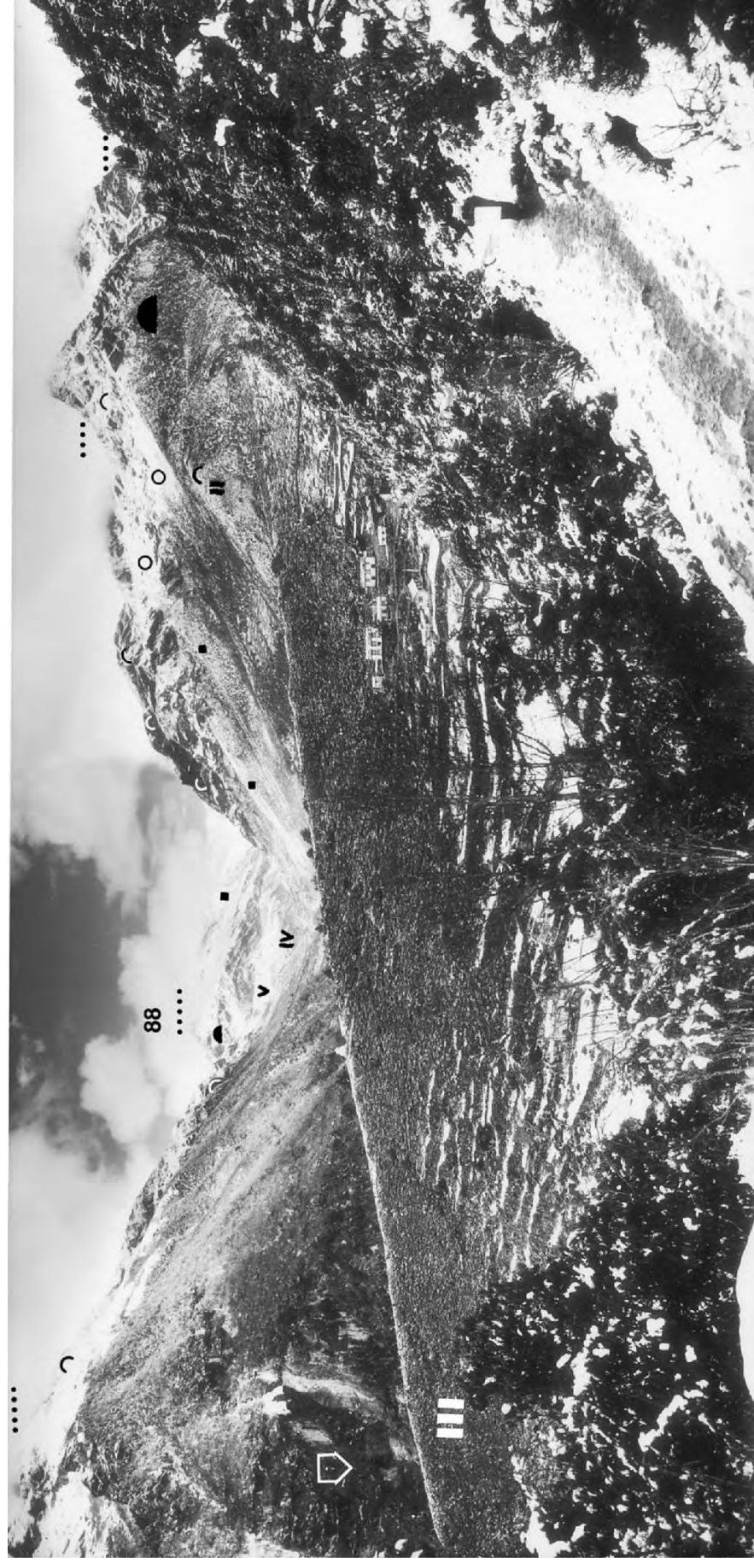
↑ *Photo 207.* Panorama photo from the orographic right side at the exit of the Kyajo Drangka S of the Mende settlement taken at 3500 m a.s.l. (Figure 3, Panorama 207) facing ENE (centre of the panorama) on to a mountain spur, which belongs to the orographic left flank of the exit of the Kyajo Drangka as well as to the orographic left slope of the Nangpo Tsangpo Drangka (main valley). (▼ black) is the sampling locality of Figure 63 (see also Figure 37, No. 30) on the mountain ridge behind which the Khumde settlement is situated. (○, ◊) are small-scale abrasion roundings in relatively thin-stratified gneiss (6b); (■) are decimetre-thick covers of ground moraine up to an altitude of 3900 m a.s.l.; (● on the right) shows the place where a very thick accumulation of ground moraine has developed an iron-shaped, even remnant, covered by several boulders in size of a hut up to that of a house (▼▲ white). (♠) marks a saddle between the outcropping mountain slope and an accumulation of ground moraine. (---) is the High Würmian glacier trim-line about at least 2240 m a.s.l. Analogue photo M. Kuhle, 01/09/1982.



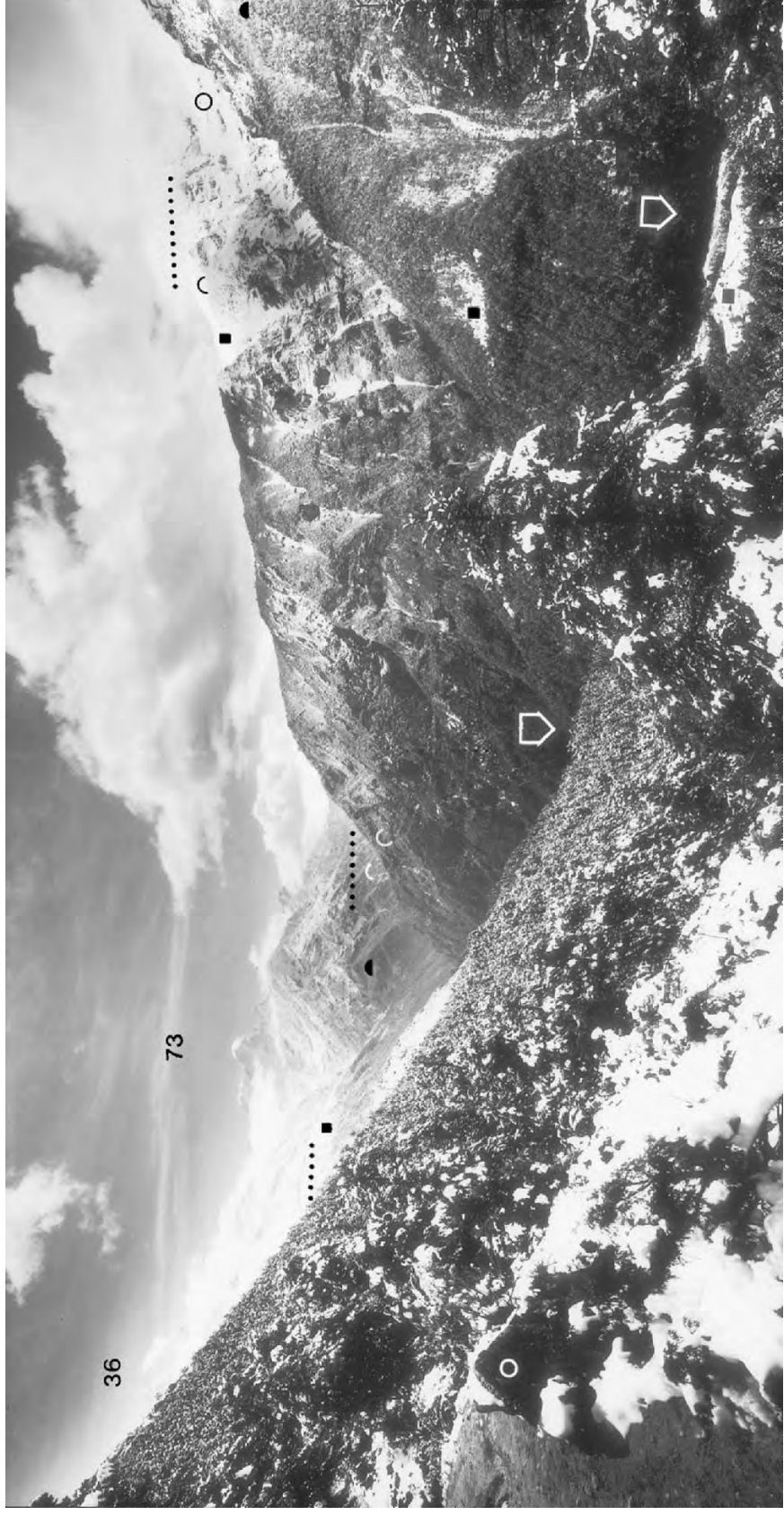
↑ *Photo 208.* Picture from the orographic left side of the exit of the Kyajo Drangka taken at 3440 m a.s.l. (Figure 3, Photo 208) facing NNE up the trough-shaped (D) Kyajo Drangka on to the 5761 m-high massif of Khumbui Yul Lha (No. 74). The valley has a steep step (below D) (Photo 209), which in the cross-profile is flatly and broadly developed. (□ small and large) are the youngest accumulations on the valley bottom from glaciofluvially reshaped ground moraine with a cover of gravel and debris flow fans. (▽) marks a debris cone, which has been – and still is – built up of rock crumbings and dislocated ground moraine (■ black). (●) are High Würmian to Late Glacial (Stages 0-II; Table 1) covers of ground moraine on the valley flanks. (○, ◊) are rock ribs, piercing through the ground moraine covers. They show glacial abrasions, which have rounded the bedrock gneiss. (●) are truncated spurs, back-polished by the glacier ice. (...) is the corresponding High Würmian glacier trim-line at ca. 4300–4400 m a.s.l. Analogue photo M. Kuhle, 25/03/2003.



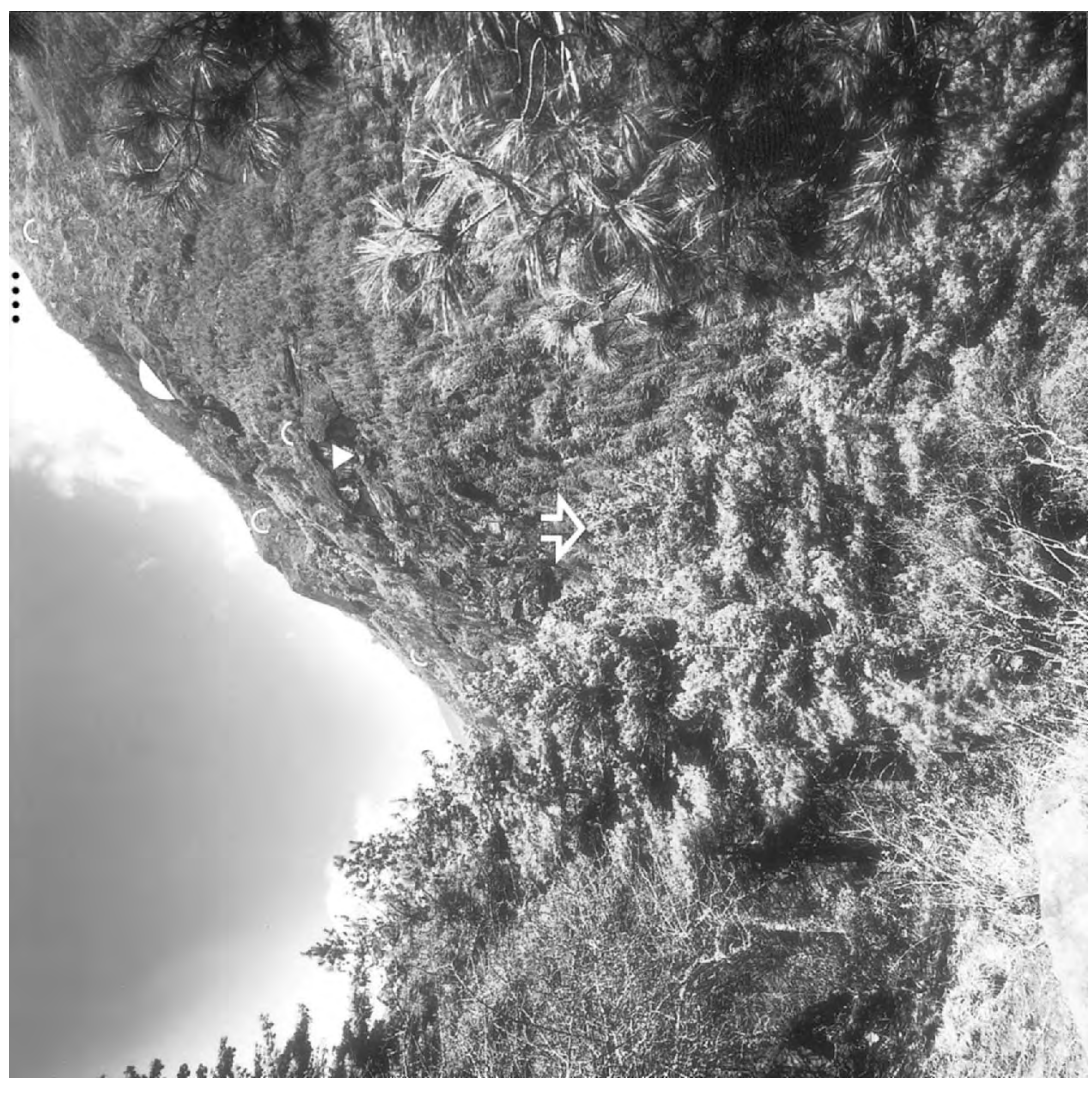
↑ *Photo 209*. Picture taken from the orographic left side of the exit of the Kyajo Drangka at 3440 m a.s.l. (Figure 3, Photo 209) facing N up the trough-shaped (D) Kyajo Drangka onto a steep step in its longitudinal course on which moraine material is situated (■), deposited by the Kyajo glacier of the late Late Glacial Sirkung Stage (IV). The classically glaciogenic polish form of the bottom of the flatly abraded rock of this steep step in the gneiss rock (6b: Lower Tibetan gneiss), shows forms of roches moutonnées (∩ below IV and on the right below IV); one of them has a characteristic steep fall on the lee-side, i.e. a break off (▼), which might have been subglacially developed by regelation. The old age of this break-off can be recognized by its dark colour due to water stripes. (∩, ∩ on the right) are clear traces of abrasion by flank polishing on the rock faces of the trough flanks. (∇) are Holocene to historical-recent niches of crumbings, still sharp-edged and light, which have been developed orientated according to the banking structure of the gneiss. Analogue photo M. Kuhle, 01/09/1982.



↑ *Photo 210*. Panorama photo from the orographic left side in the Nangpo Tsangpo Drangka and at the same time also from the orographic left at the exit of the Kyajo Drangka from NW of the Gonglha settlement taken at 3340 m a.s.l. (Figure 3, Panorama 210) from facing WSW (left margin) with the orographic right flank of the Nangpo Tsangpo, via facing WNW up the trough-shaped main valley (Figure 36) on to the 6180 m-peak (No. 88), via facing NW into the orographic left Nangpo Tsangpo Drangka flank and the junction with the Kyajo Drangka (▲ large), up to facing NNW (right slope) on to a ground moraine slope. (III) is the end moraine of the Kyajo glacier, deposited during the Dhampu Stage (Table 1). On its inner slope several field terraces and new houses can be observed. (II) marks a remnant of lateral or ground moraine, the level of which has been reached and reworked by the joint Bote Koshi (Nangpo Tsangpo-) and Kyajo glaciers for the last time during the Late Glacial Taglung Stage. (IV) is the remnant of ground moraine at the exit of the Arabtsen Drangka across which the neoglacial end moraine of the Arabtsen glacier (∇) has been thrust. (■) are ground moraine covers, reaching here up to 4800 m (■ on the right below No. 88) and in many places covering the glaciogenic flank abrasions (∩, ∩, ∩) on the very left and ∩ (cf. Figure 36). (...) below No. 88) marks the High Glacial glacier ice and developed to glaciogenically triangular-shaped slopes. The highest flank abrasions reach up to 4300 m a.s.l. (∩ on the left and ∩) (cf. Figure 36). (...) below No. 88) marks the High Würmian glacier surface about 5300 m and ca. 4300 m a.s.l. (the rest of ...). (∩) are flatly inset, bowl-shaped erosional forms of small Late Glacial hanging glaciers, which could be genetically classified as cirques. (∅) is the orographic right wall of a subglacially developed ravine, set off with a crumbling edge against the much flatter, orographic right through valley flank (see also Photo 211). Analogue photo M. Kuhle, 25/03/2003.



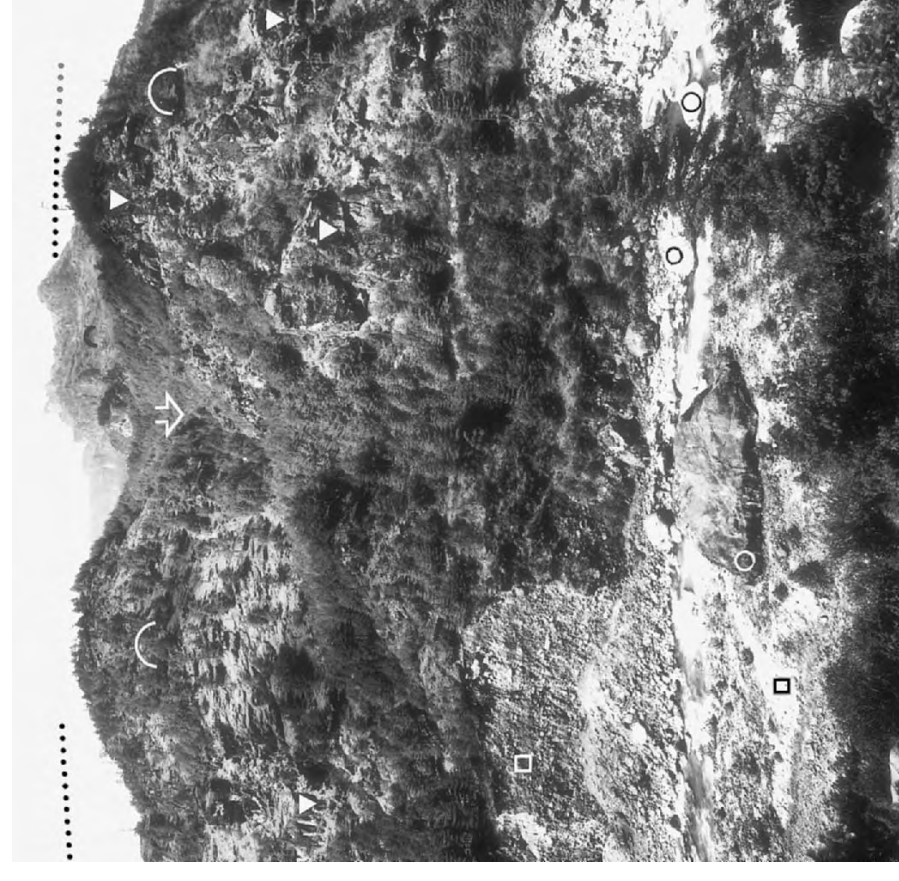
↑ *Photo 211.* Panorama photo taken at ca. 3560 m a.s.l. (Figure 3, Panorama 211) from the orographic left flank of the Nangpo Tsangpo (lower Bote Koshi-) Drangka down-valley of the junction with the Kyajo Drangka, half-way between the Gonglha and Namche Bazar settlements, from facing ESE (left margin) along the orographic left flank, down the Nangpo Tsangpo Drangka with the 6608 m-high Tramserku (No. 36), via facing SE to the 6369 m-high Kusum Kanguru (No. 73), via facing SW (right margin) into the orographic right main valley flank. (■) are ground moraine covers, here reaching a height up to 4300 m (■ on the left below No. 73) and covering the glacialic flank abrasions at many places (○, ◐, ◑ on the right below) is an early Late Glacial (Stages I and II; Table 1) remnant of a ground moraine pedestal. (○ white) are gneiss- and granite boulders metres in size, which have also built-up the ground moraine cover on the orographic left slope. (●) are glacialic triangular-shaped slopes developed by flank abrasion. (...) on the very left and very right) indicate as uppermost limits of glacier polishing the High Würmian glacier trim-line at ca. 4300 m a.s.l. (Figure 32, Profile 22 on the left side); (...) on the right below No. 73) is the orographic left polish line in the main valley of higher order continuing down-valley, the Dudh Koshi Nadi, at ca. 4000 m a.s.l. (Figure 52, Profile 28 on the left side). (○ black) is a NE-exposed early-, High-, Late- to neoglacial cirque form WNW of the Kongde alpine pasture in the Kongde Ri-massif. (♁) mark the subglacially developed ravine-like meltwater gorge cut into the very wide main valley bottom, which in many places is trough-shaped (Figure 36). Analogue photo M. Kuhle, 25/03/2003.



↑ *Photo 212.* Picture taken at 3050 m a.s.l. from the spur between the left flank of the Nangpo Tsangpo- and the right flank of the Imja Drangka from the area where the two valleys join to form the Dudh Koshi (Figure 3 and 4 Photo 212), facing NE looking into the orographic left flank of the Imja Drangka. (●) is a glacialic triangular-shaped slope, developed from a back-polished mountain spur. (○, ◐) are glacialic flank abrasions and polishings on the gneiss bedrock, which in part are perfectly preserved. Since the deglaciation these polishings on the rock roundings have only slightly splintered off and, accordingly, grown dull. The upper limit of these forms reaches up to 4300 m a.s.l. and marks the Würmian glacier trim-line (...). (▼) shows one of the crumbings which in the meantime have developed in many places, thus selectively destroying the flank polishings. (♁) is the upper margin of the glacial gorge which from here has been set into the bottom of the glacier valley (Figure 3; see also Photo 213). It exceeds a depth of 100 m and has already been laid out subglacially. Analogue photo M. Kuhle, 7/4/2003.

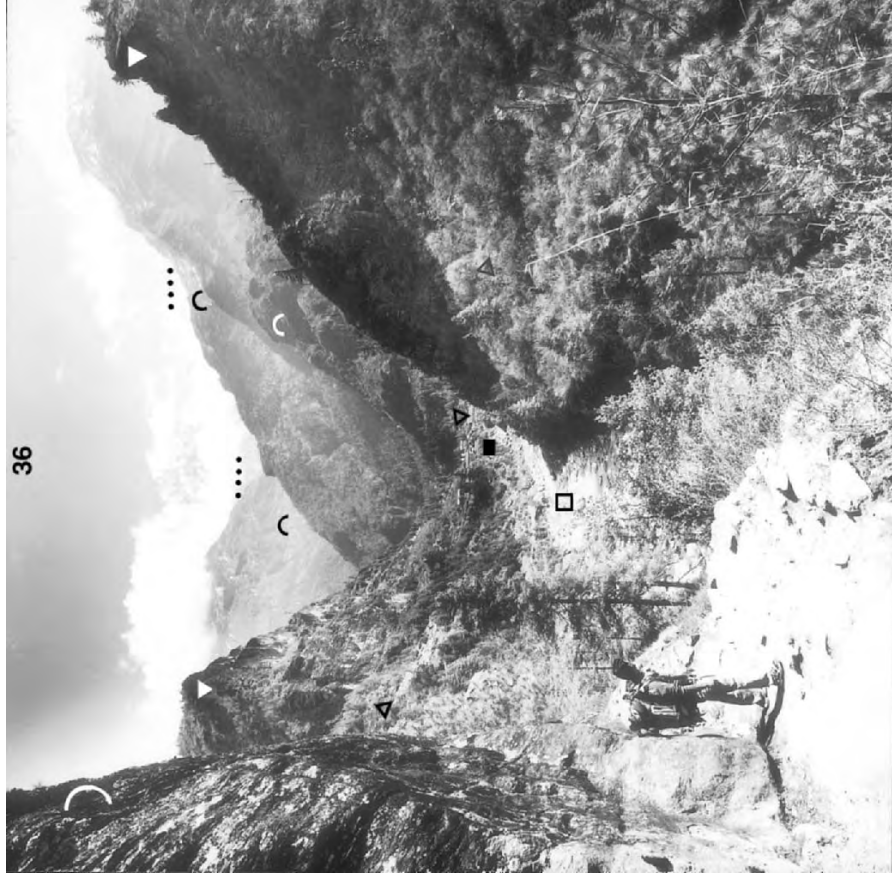


← Photo 213. Taken at 2950 m a.s.l. in the confluence area of the Nangpo Tsangpo- and Imja Drangka at the source of the Dudh Koshi Nadi, in the left flank of this main valley of the highest order (Figure 3 and 4 Photo 213) facing NNW on to two forms of potholes (○). They are several metres in diameter (persons for scale; the sticks are 1.6 m-long) and are situated on a rock ledge in the vertical wall of the subglacial gorge (⇩), ca. 50 m above the current gravel floor of the Dudh Koshi river. Analogue photo M. Kuhle, 7/4/2003.

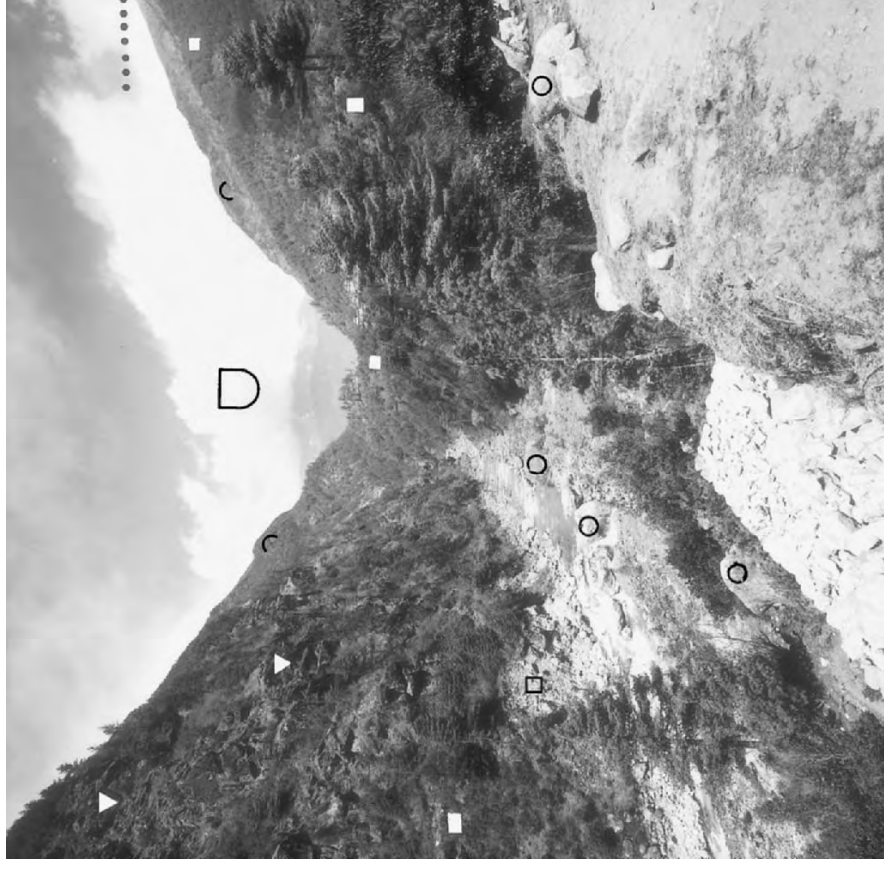


← Photo 214. Taken at ca. 3000 m a.s.l., 120 m above the talweg, from the orographic left flank of the Dudh Koshi Nadi halfway between the Jorsale and Monjo settlements (27°47'08" N/ 86°43'15" E; Figure 4, Photo 214), facing NNW looking up-valley. (△ white) is an angular grey mica gneiss boulder (6b) in size of a hut, moulded as a mani-stone, which as a crumbled boulder belongs to the local moraine. (□) marks a terrace of round-edged to rounded polymict boulders in size of metres, deriving from glaciofluvially condensed ground moraine. (○, ◊) are glacialic flank abrasions, testifying to a slightly trough-shaped-concave, i.e. glacially polished out valley cross-profile. This trough form (□) reaches down to the bends of the profile (▽, ▽ black); below, the box-shaped, steep cross-profile of the subglacial meltwater gorge sets in. (▼) are postglacial rock crumbings, which, due to their lighter colour, can in some places be diagnosed as being historical to recent. (...) is the High Würmian glacier trim-line (Stage 0, Table 1) about 4200–4100 m a.s.l. (■) are the Late Glacial terraces of a ground moraine pedestal in the confluence inset of the Nameche settlement about 3500 m a.s.l. (Figure 3, 1 on the left of Photo 84). Analogue photo M. Kuhle, 10/3/2003.

↑ Photo 215. Picture taken at ca. 2870 m a.s.l., 80 m above the talweg and the gravel floor (□ black), from the orographic left flank of the Dudh Koshi Nadi near the Monjo settlement (27°46'15" N/86°44'25" E; Figure 4 Photo 215), facing WNW looking into the orographic right valley flank. (○ white) is a gneiss (metamorphic) boulder in size of a house; (◊ black) are far-travelled granite boulders. (□ white) is material of a debris flow cone or -fan, undercut by the Dudh Koshi river, i.e. by the surge of the outburst of the moraine lake of the Langmoche glacier (Dig Tsho) in 1985. (⇩) is a subglacial meltwater channel laid out as a bottom line in the valley flank from which the debris flow material (□ white) of displaced ground moraine was transported. (◊) are glacialic flank abrasions with forms of rounded knobs, and band polishings of outcropping edges of the stratum in the grey mica gneiss bedrock the upper limit of which provides evidence of a High Würmian ice level (...) at 4100–4000 m a.s.l. (Figure 52). (▼) are postglacial rock crumbings roughening the flank abrasions. Analogue photo M. Kuhle, 10/3/2003.



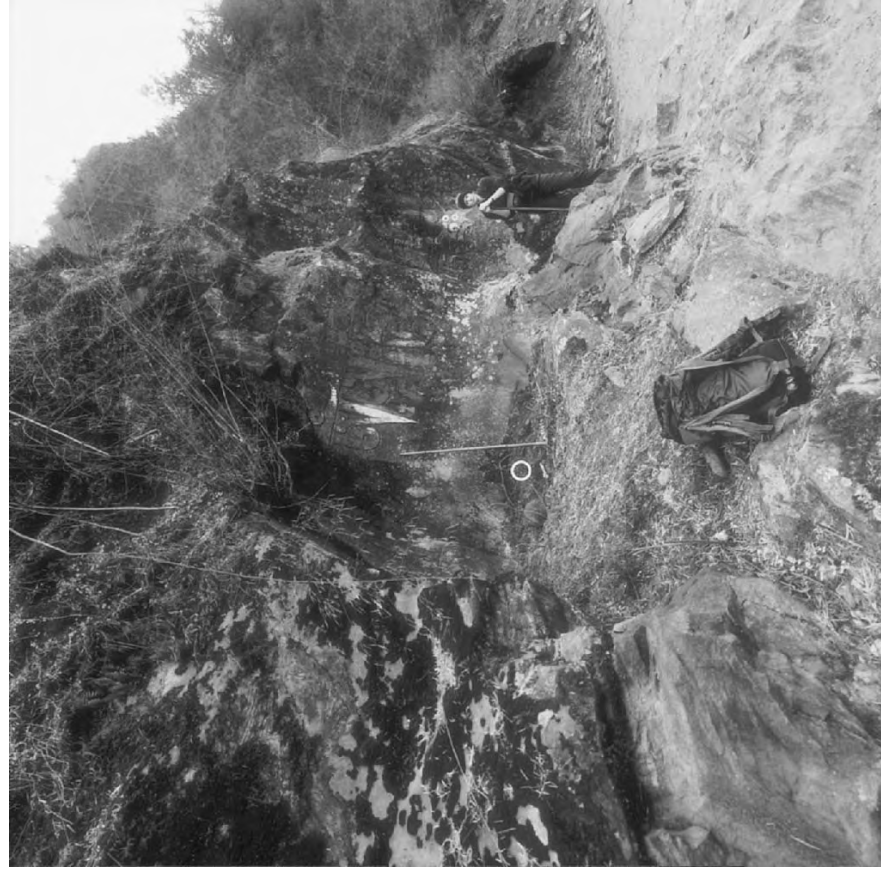
← *Photo 216.* Picture at ca. 2810 m a.s.l., ca. 140 m above the talweg and the gravel floor (□), taken from the orographic right flank of the Dudh Koshi Nadi S of the Bengkar settlement (above ■) (27°45'45" N/86°43'18" E; Figure 4, Photo 216), facing NE up-valley looking on to Tramsertku (No. 36, 6608 m). (■) is a ground moraine remnant the surface of which has been glaciofluvially reworked, and (▽) on the right above) a glaciofluvial terrace with a great density of large boulders which from this ground moraine level have been glaciofluvially condensed by the removal of the matrix. (□) is the current gravel floor of the Dudh Koshi river, which, due to the flushing out of moraine, presents a further condensation of the morainic portion of coarse boulders at a 10 m lower level. (△ on the left and right) are two cones of moraine debris, i.e. debris flow, built up of ground moraine, which has been dislocated down-slope. (○, ◌) mark glaciogenic flank abrasions in the Lower Tibetan grey mica gneiss (6b; Nepal Geological Map 1:125,000, 1985; Sheet No. 721-B) reaching up to 4400-4300 m a.s.l. (... on the left; Figure 32) and 4000 m (... on the right; Figure 52), thus indicating the High Würmian glacier trim-line. (▼) are postglacial rock crumbings, which are the characteristic reshaping of glaciogenically oversteepened trough valley flanks worldwide. Analogue photo M. Kuhle, 10/3/2003.



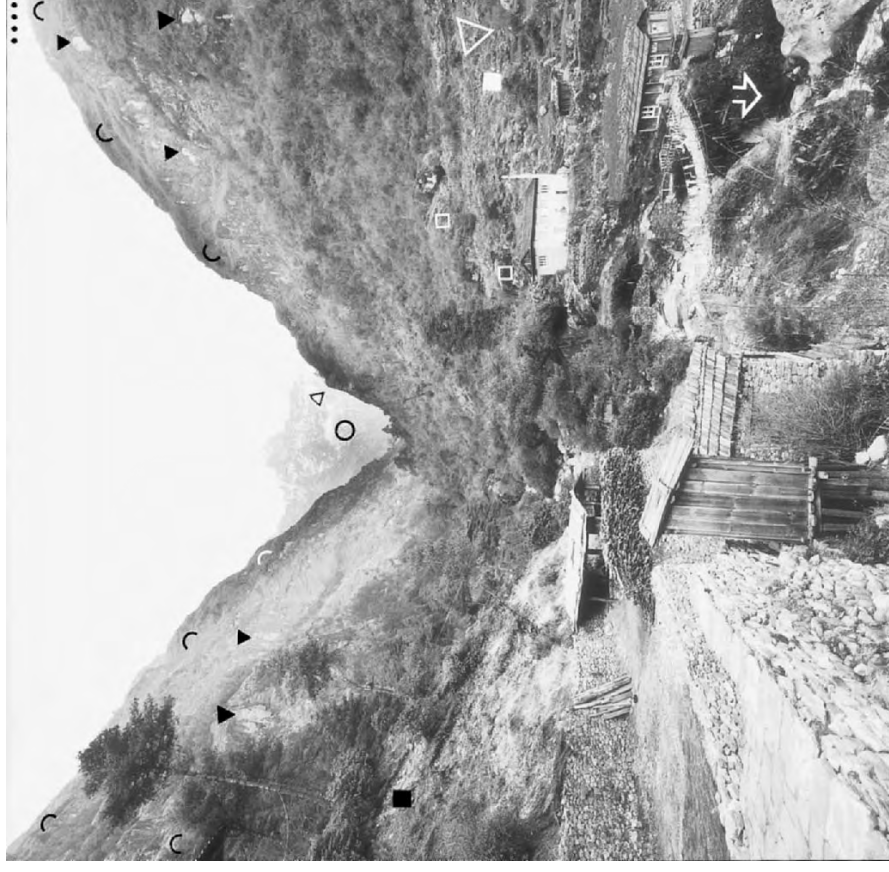
↑ *Photo 218.* Picture at ca. 2810 m a.s.l., ca. 140 m above the talweg and gravel floor (○ on the left above), taken from the orographic right flank of the Dudh Koshi Nadi N of the Toktok settlement (on the right below ◇) (27°45'45" N/86°43'18" E; Figure 4, Photo 218) facing S down-valley. (■ on the left) is a fluvial ground moraine remnant, secondarily flattened on its surface; (□) marks a glaciofluvial terrace remnant from which the clay and silt portions of the original, dislocated moraine material have been flushed out. Sands, pebbles and fine to medium-sized gravel components have been displaced during the Tertiary, whilst the very large moraine boulders in size up to a hut have been left and condensed approx. on the spot. (○ on the left above) are boulders of local gneiss and erratic tourmaline granite in size of a hut, flushed free in the current gravel floor and only occasionally dislocated by several metres down-valley along the talweg because of surges of outbursts of glacier lakes, as e.g. the outburst of the moraine lake of the Langmoche glacier (Dig Tsho) on August 4th, 1985. (○ below and on the right) are 1.5-3 m long erratic, in part faceted granite-tourmaline boulders on the orographic right ground moraine slope. (■ on the right) show further ground moraine covers on the orographic right valley slopes; (■ below ◇) is a Late Glacial (Stages I and II?) remnant of a ground moraine pedestal. (○, ◌) are glaciogenic flank abrasions which testify to the slightly trough-shaped concave (○), i.e. glaciogenic polishing of several valley cross-profiles (Figure 53, Pro. 29 on the left above the Dudh Koshi river). (...) is the High Glacial glacier trim-line about 3700 m a.s.l. (▼) are postglacial rock crumbings making holes in the abrasion roundings and interrupting them by sharp breaking edges. Analogue photo M. Kuhle, 10/3/2003.



← *Photo 217.* Picture taken at ca. 2790 m a.s.l., ca. 150 m above the talweg of the Dudh Koshi Nadi N of the Toktok settlement (27°45'35" N/86°42'57" E; Figure 4, Photo 217), facing W, showing a classic roche moutonnée (○) on the orographic right valley flank. Part of it is covered and surrounded by a ground moraine cover (■) containing far-travelled erratics of tourmaline granite, superimposed on outcropping Lower Tibetan grey mica gneiss (6b). Glacier polishings and glacier striae are still preserved on the gneiss surface of the roche moutonnée. These characteristic forms occur on the marginal rock faces which, due to flushing, have only recently been cleared of the loamy ground moraine cover. Analogue photo M. Kuhle, 10/3/2003.



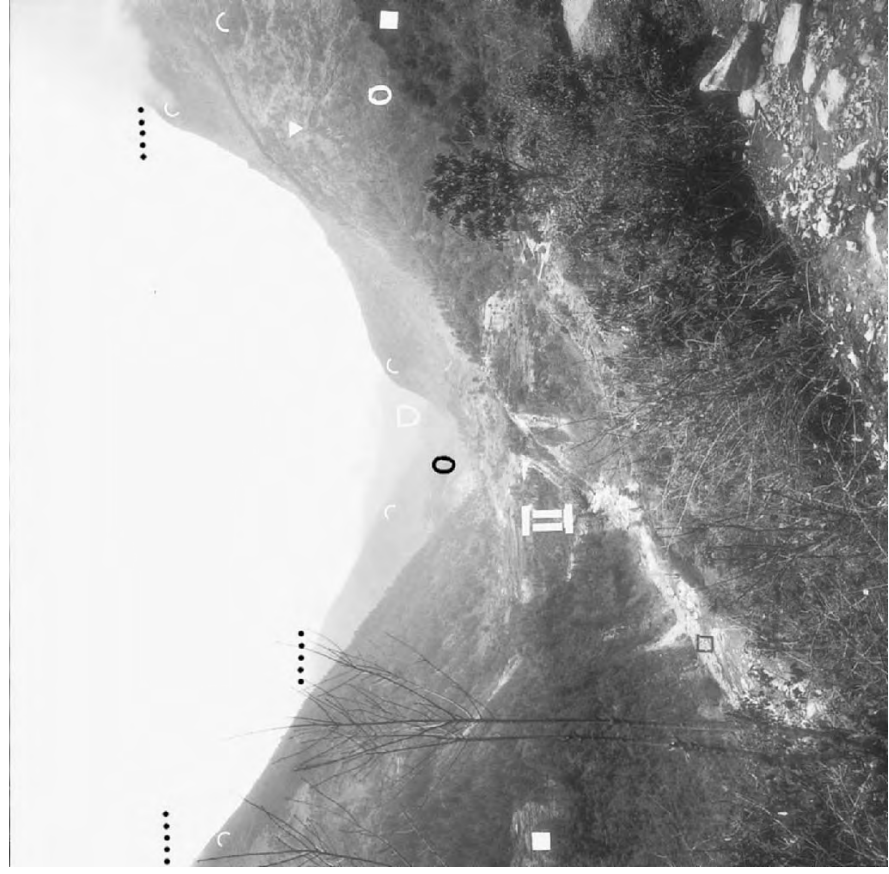
↑ *Photo 219.* Taken from the orographic left flank of the Dudh Koshi Nadi at 2680 m a.s.l. (27°44'25" N/86°43'25" E; Figure 4, Photo 219) close to the Dukdingma settlement, facing SSE down-valley. The picture shows one of three parts of pothole forms (○); it is ca. 3 m in diameter (person for scale; the stick is 1.5 m-long) and is situated on a rock ledge in the bedrock gneiss in the steep face of a subglacial gorge stretch, ca. 50 m above the current Dudh Koshi river. Into the surface of the pothole, which is still smooth, one has engraved "Om mani padme hum" with letters in size of decimetres to metres. Analogue photo M. Kuhle, 10/3/2003.



↑ *Photo 220.* Picture taken at ca. 2630 m a.s.l., ca. 25 m above the talweg running in a glacial gorge (♣), from the orographic right valley side (27°43'18" N/86°43'37" E; Figure 4, Photo 220) with the Thado Koshi Gaon settlement, facing ENE up the Thado Koshi Khola. Below the ca. 5800 m-high mountain at the valley head, a cirque-like polish floor is situated (○) from where the Würmian Thado Koshi glacier – as a left side valley component of the Dudh Koshi parent glacier – has started. (■) is ground moraine on the basal valley slopes, in many places covered by debris cones and fans (▽ white) as well as angular boulders of rock fall (□) reaching the size of a house (for scale see the 2 1/2-storied house in front of it). The rock falls are crumbly which have taken place since the deglaciation up to nowadays. In many places their break-out scars (▼) have damaged the glacial abrasion roundings (○, ◐). Some of the roundings have still been preserved on the boulders of the rock falls, so that these show a one-sided rounding with the old surface (e.g. on the right above □ on top). Despite the flank abrasions (◐, ◑), the valley shows a gorge-like V-profile; only toward below near to the talweg its end is trough-shaped (below ▽ black). Accordingly, it can altogether be systematized as a gorge-like trough (Kuhle, 1982). Analogue photo M. Kuhle, 10/3/2003.

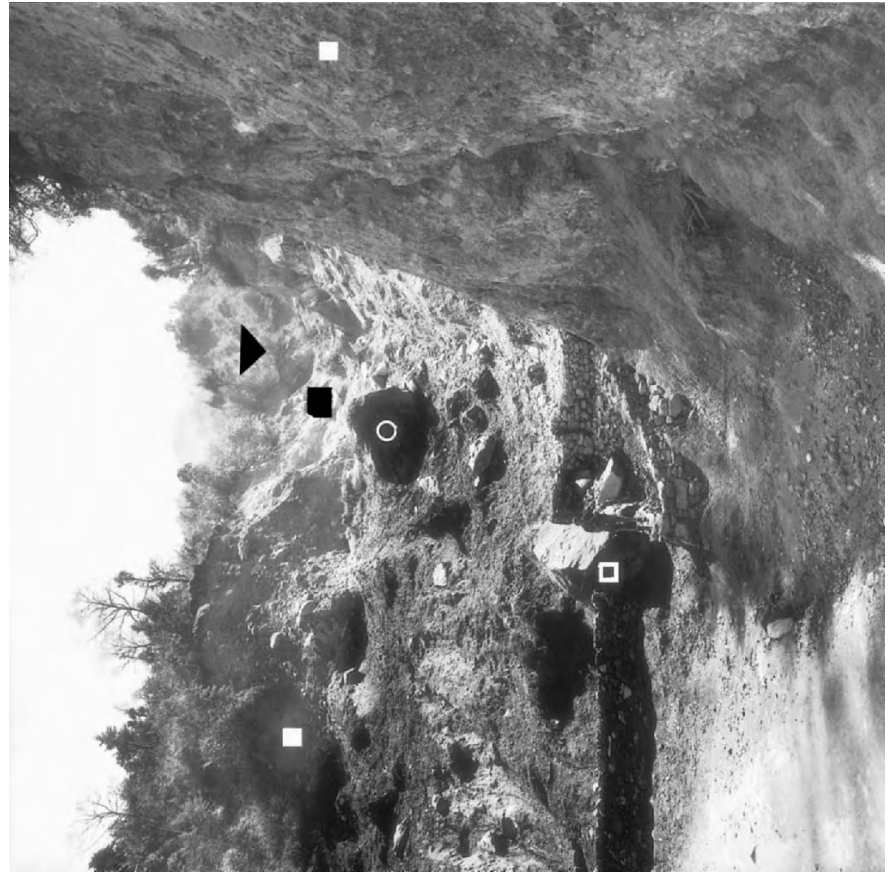


↑ *Photo 221.* View taken at ca. 2540 m a.s.l., ca. 30 m above the talweg (below □ white) of the Dudh Koshi Nadi from the orographic left valley side (27°42'58" N/86°43'23" E; Figure 4, Photo 221), ca. 0.8 km S of the Thado Koshi Gaon settlement, facing SSW down-valley into the orographic right valley flank; (◐) are High Würmian to early Late Glacial (Stages 0 and I, Table 1) glacialic flank abrasions on the orographic right side. They are trough-like concavely polished out and have a ground moraine overlay (■). (II) is a Late Glacial remnant of end moraine of the Taglung Stage (Table 1; cf. Photo 227 II). (□ black and white) are glacialimnic sands compressed by the glacier tongue (↔) of this stage (see Figure 87), which thus have become a pushed end moraine and can be addressed as accompanying remnants of a front moraine (Figure 11 II on the left below No. 73). (▽ and ▼) are remnants of a 5–6 m-thick glaciofluvial gravel overlay, covering the truncated surface of the push moraine (stratigraphic unconformity, discordance). Analogue photo M. Kuhle, 30/8/1982.



← *Photo 222.* View taken at ca. 2720 m a.s.l., ca. 200 m above the talweg (□) of the Dudh Koshi Nadi from the orographic left valley side (27°42'56" N/86°43'33" E; Figure 4, Photo 222), ca. 1 km S of the Thado Koshi Gaon settlement facing N up-valley looking across the Thado Koshi Khola-junction (on the right of II). (II) is a ground moraine pedestal, for the last time covered by a glacier tongue of the Dudh Koshi parent glacier during the Taglung Stage (Table 1). (This tongue has come to an end in the area of the end moraine shown in Photo 221; cf. Figure 11 II on the left below No. 73 and Photo 227 II). (■ on the left) is a remnant of a ground moraine pedestal belonging to the Late Glacial Ghasa Stage (Table 1 D). (■ on the right) marks the W margin of the orographic left ground moraine pedestal, which has to be classified as being from the High Würmian glacier cover (Stage 0). (0) are two further High Würmian terrace-remnants of a ground moraine pedestal at the corresponding level about 300–400 m above the current talweg of the main valley (□). (0 black) is the orographic right ground moraine pedestal in the valley chamber of the Ghat settlement; (0 white) is the ledge of the ground moraine pedestal on which the Thado Koshi tributary glacier has joined the Dudh Koshi parent glacier. (○, ◐) are glacialic flank abrasions roughened by several postglacial rock crumbings (▼); they have created valley cross-profiles with a typically concave course of the rock slopes so that trough-like valley cross-profiles have developed (□). The upper polish lines run between 4000 (... centre; cf. Figure 52), 3700 (... on the right) and 3600 m a.s.l. (... on the left; cf. Figure 53). Analogue photo M. Kuhle, 9/3/2003.

→ *Photo 223.* Picture taken at ca. 2720 m a.s.l. from approx. 200 m above the talweg of the Dudh Koshi Nadi on the orographic left valley side (27° 42' 39" N/86° 43' 50" E; Figure 4, Photo 223; Photo 227 between 0 and 0 above), ca. 1.2 km S of the Thado Koshi Gaon settlement, facing E up-slope through an active erosion gully with spring erosion and slides (▼) in a High- to Late Glacial (Stages 0-I; see Table 1) ground moraine pedestal (■). (○ and □) are 3–5 m-long (person for scale) in part round-edged (○) to edged polymict boulders; smaller boulders, which also 'swim' isolated from each other in a fine material matrix (see Figure 88) (on the right of ■ on the left), are sometimes faceted and a little better rounded. Analogue photo M. Kuhle, 8/4/2003.



← *Photo 224.* Panorama from the orographic left flank of the Dudh Koshi Nadi, on the right side of the Handi Khola-exit in the Lukia settlement, taken at 2840 m a.s.l., ca. 840 m above the talweg of the main valley (◊) (27° 41' N/86° 44' 47" E; Figure 4, Panorama 224) from facing WNW (left margin) via NW with the 6611 m-high Karyolung (No. 16) in the background, via the 5885 m-high Nupla (No. 17) up to facing NNW (right margin) looking across the orographic right flank of the Dudh Koshi Nadi as far as up-valley. (■ large in the foreground and 0-I) is the High Würmian ground moraine pedestal on which the Dudh Koshi glacier flowed during its greatest extension. It has been truncated by glaciofluvial activities and, during the Late Glacial Ghasa Stage (I, Table 1), covered by a partly thin gravel overlay on the orographic right side of the Handi Khola tributary glacier joining the main glacier. (0) is a corresponding remnant of a ground moraine pedestal on the orographic right main valley flank. (◊) is the probably syngenetically, i.e. subglacially developed cut of the meltwater gorge through the ground moraine pedestal down to the outcropping rock ground (cf. Figure 54), then shaped by the current Dudh Koshi river. (■ small in the background) are High Würmian remnants of ground moraine cover on the orographic right main valley flank. (▽) is a debris flow cone in which the ground moraine material, dislocated down-slope on the valley flank, has been re-sedimentated since the deglaciation. (▼ white) are slope rills cutting the ground moraine covers. (○ and ◐) are glacialic flank abrasions and smoothings in the grey mica gneiss bedrock (6b). The mountain flank has been polished back to such an extent that even truncated spurs and the resulting glacialicly triangular-shaped slopes have been developed (▲). (▼ black) are larger, fresh crumbings currently destroying the rock roundings. (...) is the polish line running from ca. 4100 m a.s.l. (... on the right) down to 3400 m (... on the left) (see also Figures 52 and 53). Analogue photo M. Kuhle, 14/11/1982.





← *Photo 225.* Picture taken from the orographic left flank of the Dudh Koshi Nadi, on the right side of the Handi Khola-exit in the Lukla settlement at ca. 2800 m a.s.l., approx. 800 m above the talweg of the Dudh Koshi Nadi (27° 41' 02" N/86° 44' 45" E; Figure 4, Photo 225), facing E, showing a 2 m-deep excavation exposure of ground moraine in the High Würmian ground moraine pedestal. The exposed moraine material (■) consists of more or less round-edged and faceted augengneiss boulders up to extensions of 1.5 m (○), embedded into a strongly condensed matrix, which is rich in clay and associated with edged, less metamorphic components of schist. Analogue photo M. Kuhle, 9/3/2003.

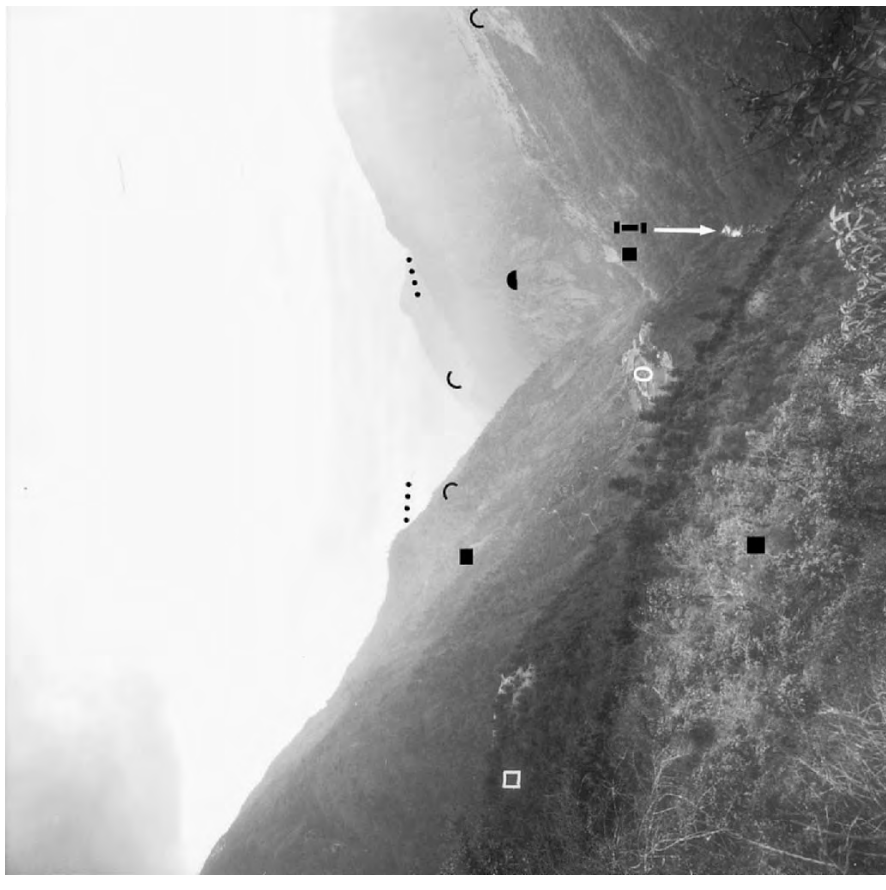
↓ *Photo 226.* Panorama picture from the orographic left flank of the Dudh Koshi Nadi, on the right side of the Handi Khola-exit SW below the Lukla settlement at ca. 2770 m a.s.l., taken from ca. 770 m above the talweg of the main valley (below ■ small) (27° 40' 50" N/86° 44' 10" E; Figure 4, Panorama 226) from facing SE (left margin) up the Handi Khola, via S (I) down the main valley and on to the orographic left lateral moraine of the Handi Khola glacier of the Late Glacial Ghasa Stage (I, Table 1), up to facing W into the orographic right main valley flank (right margin, background). This lateral moraine (I) is situated on the High Würmian surface of the ground moraine pedestal (O) about 2700 m a.s.l. (■ large) is the corresponding orographic right inner slope of the Handi Khola tributary glacier moraine of the Ghasa Stage (cf. Figure 89). (○) is an outcropping rock head, abraded and polished like a roche moutonnée. (⤴) marks a subglacially created fluvial cutting which since the deglaciation has undergone a further subaerial development. (○) are orographic left High Würmian flank abrasions the upper limit of which (——) testifies to a glacier trim-line of the Handi Khola tributary glacier between 4000 and 3800 m a.s.l. (—) was the contemporaneous surface of the Dudh Koshi parent glacier between (...) on the right) 3200 and 2700 m a.s.l. (...) on the left) (Figure 54). (■ small) is a ground moraine cover and (●) a truncated spur on the orographic right main valley flank. Analogue photo M. Kuhle, 9/3/2003.



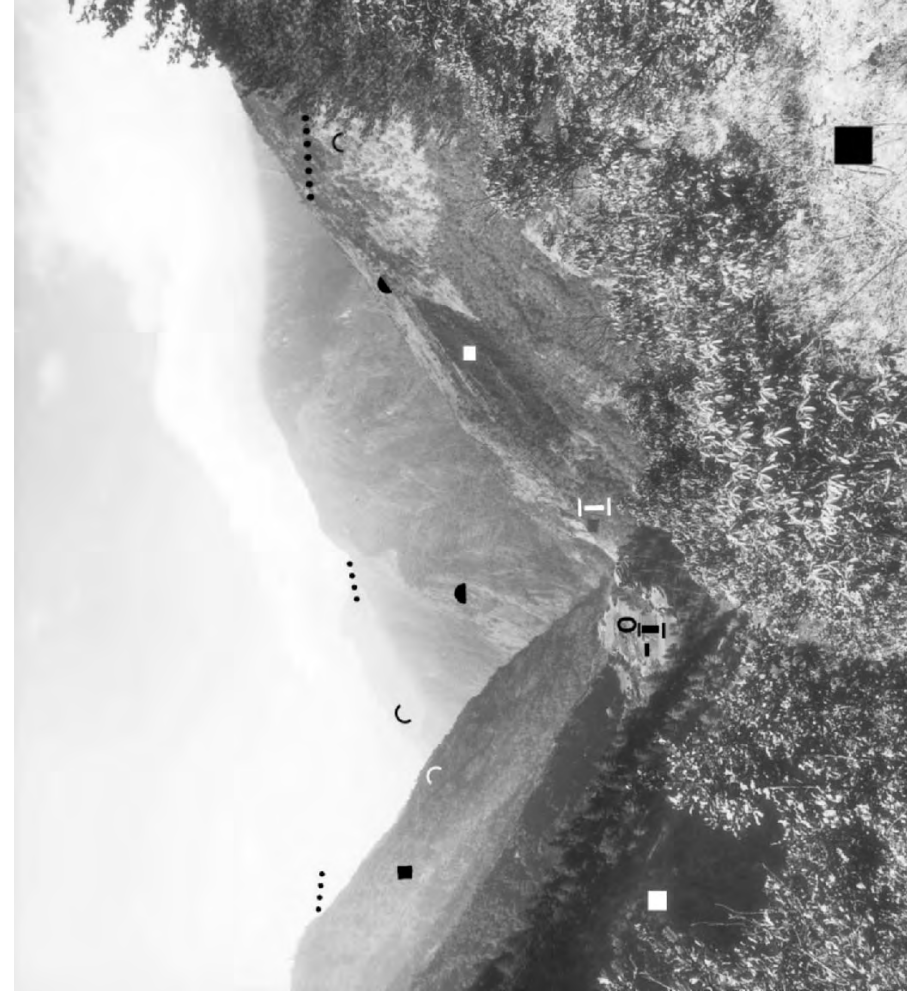


← *Photo 228.* Taken at ca. 2500 m a.s.l., N below the Pakhepani settlement, from the orographic left flank of the Dudh Koshi Nadi, ca. 650 m above the talweg (27° 40' N/86° 43' 37" E; Figure 4, Photo 228), facing NNE up-valley. (0-I) is the terrace of the ground moraine pedestal with the Surke settlement, the core of which was accumulated during the High Würmian period (Stage 0, Table 1) and was still reached and modified by the Dudh Koshi glacier tongue of the early Late Glacial Ghasa Stage (cf. Photo 127 0-I below). (0) are further High Würmian remnants of a ground moraine pedestal, reshaped by the Dudh Koshi river (♂) in the valley ground since the deglaciation. (♂) mark remnants of a ground moraine cover, left behind by the High Würmian valley glacier on the left valley flank. In places they alternate with glaciolimmic deposits of an early Late Glacial small lateral valley (Stages 0-1) on the slope surface. (○, ◻) are glaciogenic flank abrasions, roughened by several postglacial rock crumbings (▼). The upper limits of the abrasions provide evidence of a course of the glacier trim-line running from ca. 4000 m (third ... from the left) in the background (Figure 52), via 3600 m (second ... from the left and on the very right) (Figure 53), down to ca. 3400 m a.s.l. (left margin) in the middleground. At (◻) in the background, the valley cross-profiles are most trough-like (Figures 52 and 53). (▽) is a debris flow fan with boulders of rock avalanches, adjusted to the remnant of the ground moraine pedestal (0 white below). Analogue photo M. Kuhle, 8/3/2003.

← *Photo 227.* Picture taken from the 2945 m-high Chutok La, S above the Pakhepani settlement, from the orographic left flank of the Dudh Koshi Nadi, ca. 1200 m above the talweg of the Dudh Koshi Nadi (27° 39' 27" N/86° 43' 33" E; Figure 4 Photo 227) facing N up-valley. Due to its filling with the then ground moraine pedestal up to 400 or even 500 m above the talweg, the remnants of which are preserved (0 and 0-I), the Dudh Koshi showed a trough form (◻) during the Würmian period (Stage 0). (♂) are further remnants of this ground moraine pedestal. It has been – and still is – cut by the Dudh Koshi river (♂). (△) are debris cones and debris flow fans of dislocated moraine, small rock avalanches and crumbings, laid down on the surface of the ground moraine pedestal since the deglaciation. (◻) are glaciolimmic deposits in the area of a Late High Würmian to Early Late Glacial (Stages 0-I) orographic left lateral sander, sedimentated into a lateral valley between valley glacier and valley flank (Figure 90). (○, ◻) are glaciogenic flank abrasions, roughened by several postglacial rock crumbings (▼); the flank abrasions reach up to ca. 3600 (Figure 53) to 3400 m a.s.l. and provide evidence of a correspondingly high course of the High Würmian glacier trim-line (---). (I above) is the terrace of the ground moraine pedestal of the Late Glacial Ghasa-Stage (Table 1) in the confluence area of Nangpo Tsangpo- and Imja Drangka. (II) is the lowest ice margin position of the Late Glacial Dudh Koshi Nadi during the Taglung Stage, situated at c. 2500 m a.s.l. (Photo 221). Analogue photo M. Kuhle, 29/8/1982.

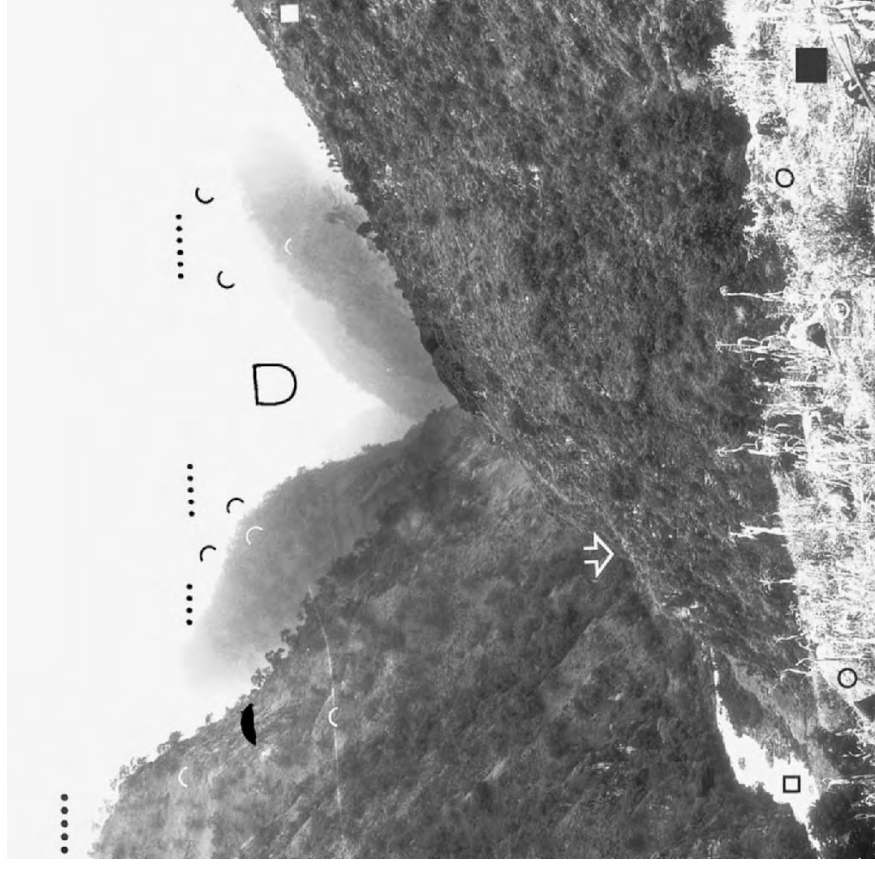


↑ *Photo 229.* View taken at ca. 2530 m a.s.l., ca. 700 m above the talweg of the Dudh Koshi Nadi and down-valley of the Handi Khola exit, from the orographic left flank of the Dudh Koshi Nadi (27° 40' 31" N/86° 43' 49" E; Figure 4 Photo 229), facing S down the main valley. (♂) is the Dudh Koshi river about 1800 m a.s.l., which has cut the ground moraine pedestal near the Surke settlement (0 and I); it was built-up by the High Würmian Dudh Koshi valley glacier and overthrust and modified by the glacier tongue as late as the early Late Glacial Ghasa Stage (Table 1). (♂) are ground moraine remnants (Figures 91 and 95) and (◻) are glaciolimmic sediments of lateral formation (Figure 90), deposited during a High Würmian (Stage 0) to early Late Glacial (Ghasa Stage I) lateral valley between the glacier and the orographic left valley flank (Photo 227 ◻). (♂) shows a truncated spur in the junction area of the Lumding Khola where the High Würmian Lumding glacier – as the lowest tributary glacier – was connected with the Dudh Koshi parent glacier (Figure 4 and 11 on the right below No. 16). (○, ◻) are remnants of glaciogenic flank abrasions in the outcropping Lower Tibetan augen mica gneiss (6b), which, in accordance with their upper limit, provide evidence of a High Würmian glacier trim-line (...) with an orographic left polish line at ca. 2700 m a.s.l. (... on the left) (Figure 54) and an orographic right one at a correspondingly minor altitude (... on the right). Analogue photo M. Kuhle, 9/3/2003.

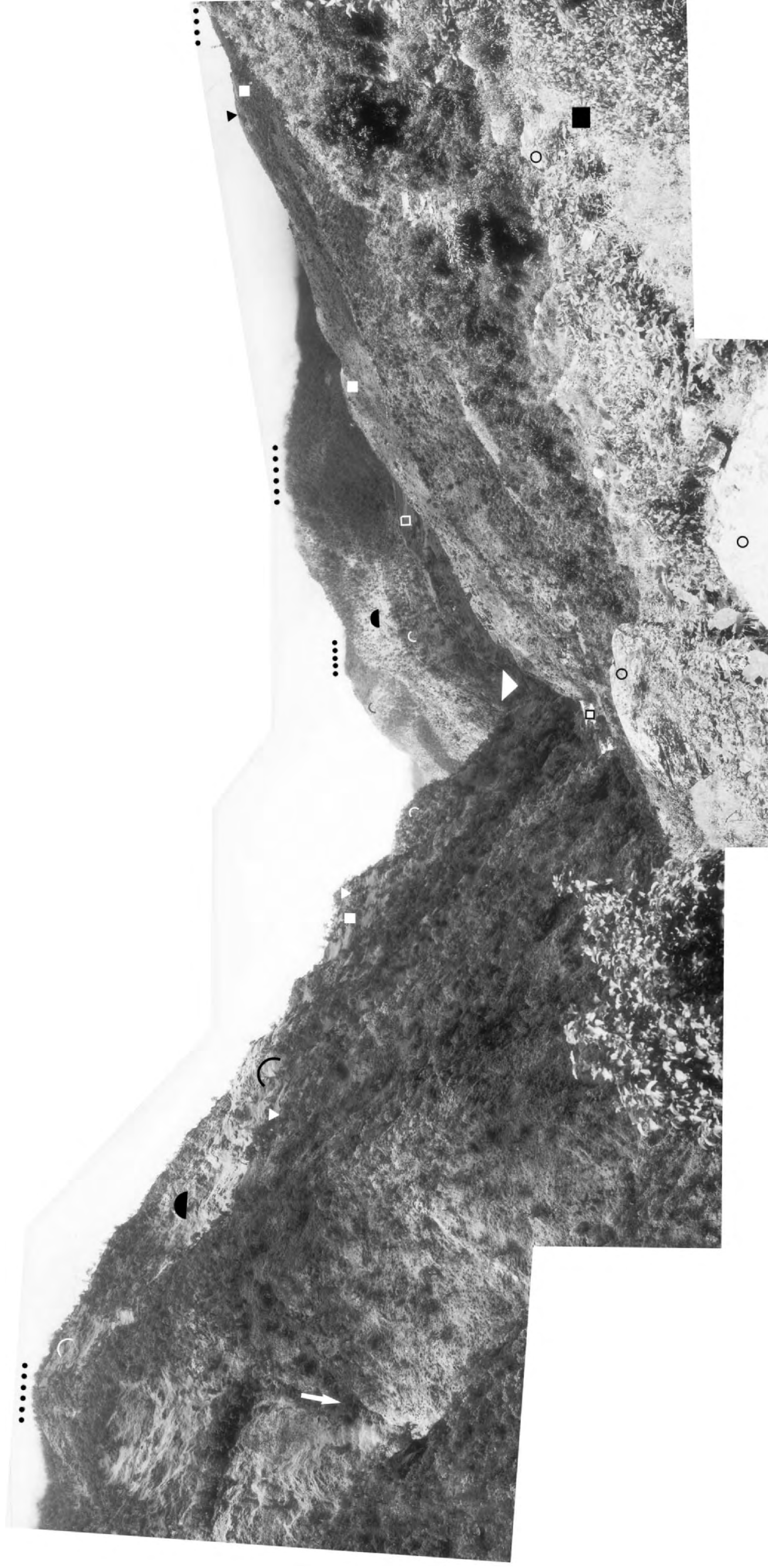


← *Photo 230.* Picture taken at ca. 2470 m a.s.l. N, above the Surke settlement (0-I), from the orographic left flank of the Dudh Koshi Nadi, ca. 670 m above the talweg of the Dudh Koshi Nadi (27° 40' 25" N/86° 43' 48" E; Figure 4, Photo 230), facing SSW down the main valley. (0-I and ■ I) are remnants of a ground moraine pedestal the core of which is of High Würmian age (Stage 0). During the first Late Glacial Stage (Ghassa Stage I, Table 1) it was reshaped by the valley glacier tongue – coming to an end somewhat down-valley – and fluvially undercut during the postglacial period. (■) are remnants of ground moraine (Figure 94); (■ on the left above), situated at an altitude of about 2650 m (on the left above), is of a High Glacial age (Figure 95). (▲●) are glacially reworked triangular-shaped slopes; (○, ◐, ◑) are flank abrasions damaged by crumbings. (...) shows upper limits of abrasion, which, according to their bends similar to polish cavettos, are recognizable as indicators of the highest past glacier level (...) on the left, cf. Figure 54). Analogue photo M. Kuhle, 9/3/2003.

→ *Photo 232.* Picture at ca. 1800 m a.s.l. in the junction area of the Khari Khola and the Dudh Koshi Nadi, from the orographic left flanks of the two valleys, taken from ca. 250 m above the talweg of the Dudh Koshi Nadi (27° 36' 47" N/86° 42' 15" E; Figure 4, Photo 232), facing N up the main valley. (■) are ground moraine remnants, the thickness of which at a corresponding relief small-scale reaches one decametre (■ black), but mostly only a few metres (■ white); (○) are round-edged boulders, 1–2 m in size. (◐, ◑, ◒) are glacially reworked abrasions in the mica garnet gneiss (background) and mica schist (foreground), roughened by crumbings; due to the gorge fog, at this altitude the break-out scars have been covered with grasses and lichens within a few years so that they cannot be distinguished by their colour. (▲) is a truncated spur. The outcropping rock banks incline with 27° to the NNW so that the Dudh Koshi Nadi has an obsequent course; due to the subsequent small tributary valleys and glacial gorges, developed in the minor-resistant mica schist, the abraded, convex rock spurs protrude (◐, ◑, ◒). The valley shows a two-part cross-profile: an upper, wide, trough-shaped one (◐) and a lower, narrow, gorge-like one; (◑) is a gorge-like, subglacial cut of meltwater, typical of the Himalaya. (◒) is the Dudh Koshi river completely covering the bottom of the glacial gorge (◑). (...) marks the High Würmian (Stage I) glacier trim-lines, running from ca. 2700 m (the two ... from the right) (Figure 54) down to ca. 2300 m a.s.l. (...) on the very left). Analogue photo M. Kuhle, 27/8/1982.



← *Photo 231.* Panorama taken from N of the Chutok La (pass) at ca. 2790 m a.s.l. from the Pakhepani hamlet, from the orographic left flank of the Dudh Koshi Nadi, ca. 1000 m above the talweg of the Dudh Koshi Nadi (27° 39' 45" N/86° 43' 40" E; Figure 4, Panorama 231), facing W (left margin) into the orographic right flank of the Lumding Khola, via facing NW on to the 6611 m-high Karyolung (No. 16), via facing NNW to the 5885 m-high Nupla (No. 17), facing N up the Dudh Koshi Nadi; on to the 5761 m-high Khumbui Yul Lha (No. 74), up to facing NE (right margin) into the orographic left flank of the main valley. (■) are remnants of ground moraine the thickness of which increases from the valley flanks (Figure 94) down to the valley bottom, forming ground moraine pedestals (0 and ■ below 0 above up to ■ I). (0 and ■ I) are remnants of a ground moraine pedestal, overridden and modified by the early Late Glacial Dudh Koshi glacier as late as Stage I. Below (I black), the lateral moraines of the Handi Khola glacier are situated, overlying the High Würmian ground moraine pedestal (0 above) (Figure 11, far below No. 73 I; Photo 226). (◐) are glaciofluvial to glaciolimitic sands, heaped up in an orographic left lateral valley (Figure 90). (▲) are glacially triangular-shaped slopes developed from truncated spurs. (◐, ◑, ◒) mark flank abrasions (▼), which have been damaged by crumbings; their upper limit proves the High Würmian glacier trim-line (—); it runs on the left below No. 74 at about 4200–4000 m (Figure 52), below No. 17 and on the right below No. 74 at about 3900–3600 m (Figure 53), on the very right and below, below No. 16, at about 2800 m, and below No. 16 above up to below on the very left in the Lumding Khola, from ca. 5000 down to 2700 m a.s.l. Analogue photo M. Kuhle, 9/3/2003.



↑ *Photo 233*, Panorama taken at ca. 1700 m a.s.l. from the Jubing hamlet down-valley of the Khari-junction (□ white) and up the confluence of the Deku Khola and the Dudh Koshi Nadi, from the orographic left flanks of the main valley from ca. 200 m above the talweg of the Dudh Koshi Nadi (27° 36' 27" N/86° 41' 50" E; Figure 4, Photo 233) from facing WNW (left margin) via facing up the main valley, up to facing NE (right margin). (□ black) is the Dudh Koshi river flowing out of a subglacially developed gorge-stretch (◄). (□ white) is an orographic left lateral kame, which from the Khari Khola has been accumulated against the down-melting tongue of the Dudh Koshi glacier. (●) are metre- to decametre-thick remnants of ground moraine, mainly situated on the flatter orographic left valley slopes; (▼ black) indicates an erosion gully, cutting and exposing a ground moraine head. (○) are up to 3 m-long gneiss boulders, which, isolated from each other, stick in a clayey matrix, (●) are glacially truncated spurs, and (◌, ◌) are rock roundings on the flanks created by glacial abrasions. Since the deglaciation they have been roughened by crumblings (▼ white). Due to the monsoon-specific climate, nearly all the damages by crumblings are covered with grass. (↓) is a meltwater tube subglacially developed between the valley glacier flank and the valley face. (...) marks the Würmian (Stage D) glacier trim-line approx. reconstructed at ca. 2500 m (second ... from the left) down to ca. 2250 m a.s.l. (... on the very left) (Figure 55). Analogue photo M. Kuhle, 27/8/1982.

deposition. Their hydrothermal decay in the bedrock must have been less or the process of displacement in the course of the glacier transport was different, etc. Already the difference with regard to the condition of the boulders at one and the same place disproves the possibility of age determination of moraines by the dating of boulder surfaces (Section 3.8.2). Additionally, in the research area fresh local boulders of rock falls have been observed on moraines, upon which the one-sided past rounding of the rock face from which they have fallen, has been preserved (e.g. Photo 220). The age which can be determined by the rounding, is the integral age of the surface of the rock face before the rock fall; whilst the age which is determinable by the other boulder faces, is that of the rock avalanche. However, none of these age data have to do with the age of the moraine.

5.3. The snow-line depression as climate indicator (Figure 11)

The cirque level and the Würmian (Stage 0) height of the snow-line derived from it, lie about 3650 m (Sections 2.4.7 and 3.9). According to a mathematical method, the depression of the snow-line in the sense of the equilibrium line (ELA-depression) and past equilibrium line (Si), both in m a.s.l., are calculated as follows:

$$Sdepr = (tp - ti)/2 \quad (1)$$

(Sdepr = equilibrium line depression (ELA-depression), tp = recent terminus of the glacier tongue; ti = past terminus of the glacier tongue).

The current lowest glacier terminus in the catchment area of the Würmian Arun glacier (tp), that of the Lower Barun glacier, is situated at 4500 m a.s.l. (tp = 4500) (Section 2.1); the Würmian glacier terminus of the Arun glacier (ti) lay at ca. 500 (450) m a.s.l. (ti = 500) (Sections 2.4.5 and 2.4.7). $4500 - 500 = 4000$; $4000:2 = 2000$. Accordingly, the ELA-depression in the S-slope of the Khumbakarna Himal was 2000 m.

The medium lowest current glacier terminus in the catchment area of the Würmian Dudh Koshi glacier (tp), like that of the large Ngozumpa glacier, is located at 4600 m a.s.l. (tp = 4600) (Figures 3 and 19) (Section 3.6); the Würmian glacier terminus of the Dudh Koshi glacier (ti) lay at ca. 900 m a.s.l. (ti = 900) (Section 3.9.2). $4600 - 900 = 3700$; $3700:2 = 1850$. Accordingly, the ELA-depression in the S-slope of the Khumbu Himal was 1850 m. In correspondence, the ELA-depressions of the Late Glacial glacier Stages I,II,III and IV, which in the Dudh Koshi Nadi, i.e. Ngozumpa- or Nangpo Tsangpo Drangka were located at 1800(I),2500(II),2750(III) and about 3300(IV) m a.s.l., amounted to 1400, 1050, 925 and 650 m.

At a methodically different calculation of the snow-line, the areal relation of glacier feeding- to ablation area has to be considered. Experience has shown that in the high mountain valley area concerned it is ca. 2:1. This corresponds to an AAR (accumulation area ratio)

of 0.66. In the relief of the Khumbu Himal described, a High Würmian ELA-depression of only 1200 m (see Figure 17) at an AAR of 0.66, already leads to an ice margin at 610 m a.s.l. in the lower Dudh Koshi Nadi (see Figure 17). That is a 300 m lesser altitude above sea-level than the ice margin at 900 m a.s.l., which has been made empirically probable (Sections 5.1 and 3.9.2). Checking this snow-line calculation according to a method which considers the medium altitude of the crest fringe of the catchment area

$$Si = (pha - ti)/2 + ti \quad (2)$$

(Si = past equilibrium line; pha = past height of an accumulation area; ti = past terminus of the glacier tongue)

Si = 4300 (m); pha = 7990 (m); ti = 610(m); $7990 - 610 = 7380$; $7380:2 = 3690$; $3690 + 610 = 4300$, i.e. at the empirically lowest ice margin with ti = 900 (m): $7700 - 900 = 6800$; $6800:2 = 3400$; $3400 + 900 = 4300$, then the past height of the accumulation area is pha = 7700 m a.s.l. In consideration of the medium heights of the summits (Table 5) and the resulting medium altitude of the crest fringe of the catchment area, this is a value which is too high. Consequently, for the Würmian climate estimation of the Khumbu-Khumbakarna Himal an approximate average value of all the applied calculation-methods of snow-lines and snow-line depressions (see Section 2.4.7) will be considered, which for the entire area mediates between the local differences of the ELA (e.g. Sections 2.4.7 and 3.9). This means that in the central region of the research area the Würmian Ice Age snow-line (Stage 0) has run at ca. Si = 3870 m a.s.l. ($3650 + 3650 + 4300 = 11600:3 = 3866.7$) (Figure 11) and the snow-line depression according to

$$Sdepr = Sp - Si \quad (3)$$

(Sdepr = equilibrium line depression (ELA-depression); Sp = recent equilibrium line; Si = past equilibrium line) was ca. sdepr = 1630 m (Sp = 5500; Si = 3870; $5500 - 3870 = 1630$).

In the adjacent Kangchendzönga massif (Figure 2 No. 5) 140 km to the E, a Würmian snow-line depression of ca. 1660 m has been calculated (Kuhle, 1990, p. 419/420) and in the Dhaulagiri Himalaya 320 km further W (Figure 2 No. 4) it was ca. 1530 (1430–1634) m (Kuhle, 1982, p. 151/152). At a comparable method, considering the areal relation of the feeding- to the ablation area (AAR = 0.6), the lowest glacier tongue on the S-slope of the Dhaulagiri group has reached down to 1219 m (Figure 18) and during the High Würmian (Stage 0) a Himalaya ice stream network has existed comparable to that of the Khumbu Himalaya (cf. Figure 17 with 18; Figure 2 No. 1 with Nos. 4 and 5).

The climatic interpretation of the snow-line depression of 1630 m allows the following statement as to the Khumbu-Khumbakarna Himalaya to be made: At a decrease in temperature of 0.5 °C/100 m (that is the current value) the average annual temperature during

the Würmian Ice Age (Stage 0) would have dropped by ca. 8 (8.15) °C; at a more arid gradient of 0.6 °C/100 m by ca. 10 (9.78) °C. The snow-line altitudes and ELA-depressions of the Late Glacial-, Neoglacial- to Historical glacier stages are presented in Tables 1, 3 and 4 and summarized in Section 5.2.

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