GeoJournal 17.4 615–624

The Petrography of Southern Tibet

Results of Microscopic and X-Ray Analyses of Rock Samples from the 1984 Expedition Area (Transhimalaya to Mt. Everest N Slope)

Heydemann, Annerose, Dr., University of Göttingen, Institute of Sedimentary Petrography, Goldschmidtstraße 1, 3400 Göttingen, FR Germany,
Kuhle, Matthias, Prof. Dr., University of Göttingen, Geographical Institute, Goldschmidtstraße 5, 3400 Göttingen, FR Germany

During the 1984 expedition to S Tibet more than 100 rock samples were collected from the country rocks and morainic components. Some of these samples were examined in thin section by microscopy and X-ray diffraction. 24 of these samples of glacial geological interest are chosen for treatment here. These deal mainly with far-travelled erratics deposited on country rocks of another type.

Kuhle (cf. pp. 459–469, this issue) has executed a glaciological treatment of certain petrographic analyses from the Transhimalaya and Tibetan Himalaya (Fig 1, samples 24. 8. 1984/1,2; 31. 8. 1984/1–2c). The remainder treated here (Fig 1,2 samples 2. 10. 1984/1–4, 23. 10. 1984/1–9, 2. 11. 1984/1–3) are from the immediate Mt. Everest N slope. Because 50 days of detailed work was possible there, the density of such samples is greatest on the Mt. Everest N slope. These mineralogical researches provide here a short account of the petrography and tectonic influences found in this highest part of the earth.

Other samples (not represented here) were obtained from the upper surfaces of moraines to investigate the intensity of weathering and for the determination of ages by differences in iron hydroxide occurrence. These include samples from other groups of mountains of S Tibet e.g. the Shisha Pangma N slope.

Samples from the Transhimalaya North of the Tsangpo
(Samples 24. 8. 1984/1–2; Fig 1)

Chalamba La is an E–W pass at 5300 m 150 km W of Lhasa. The location of samples 24. 8. 1984/1+2 lies 400 m below the N–S trending ridge at Chalamba La. Sample 1 is from a dissected bench (29°42'N 90°14'E). This is a rhyolitic rock with albite-oligoclase phenocrysts in a fine-grained groundmass (Fig 3). Partial chloritisation and carbonatisation indicates hydrothermal alteration. All the surrounding summits and peaks up to 6138 m are also formed of rhyolitic rocks.

Sample 2 is an erratic derived from the same place as Sample 1. It is a granitic rock with tectonic features (Fig 4). There are many large light-coloured and well-rounded granite blocks (with long axes up to 1 m long) transported here by valley glaciers at least 1200 m thick from the E (components of a network of ice streams). This spread of granite blocks occurs both in the saddle of the Chalamba La and up to 200 m on the slope above it.

Samples from the Tibetan Himalaya i.e. the Ladake Shan South of the Tsangpo
(Samples 31. 8. 1984/1–2c; Fig 1)

Although the N slope of the Latzu massif is formed of phyllites the Lulu valley (28°44' –54'N 87°10' –25'E) is incised into basalts in its S slopes. These basalts are clearly stratified, flat-lying and with no columnar texture at right angles to the cooling surface. Sample 1, from this area, is a much-decomposed basaltic rock in which the pyroxenic components are hydrothermally chloritised and carbonatised (Fig 5).

A glacial till with large blocks extends from 5200 m in the Lulu valley down to its outlet at 4300 m into the Lulu basin. It lies as a far-travelled erratic-bearing layer above the basalt country rocks. Its fine-grained matrix contains light-coloured rounded granite blocks up to 3 m long which lie in the valley floor and up to 170 m above it on the valley slopes (Samples 2, 2a, 2b, 2c). Erratics 2a and 2c are tectonically modified biotite-granite (Fig 7

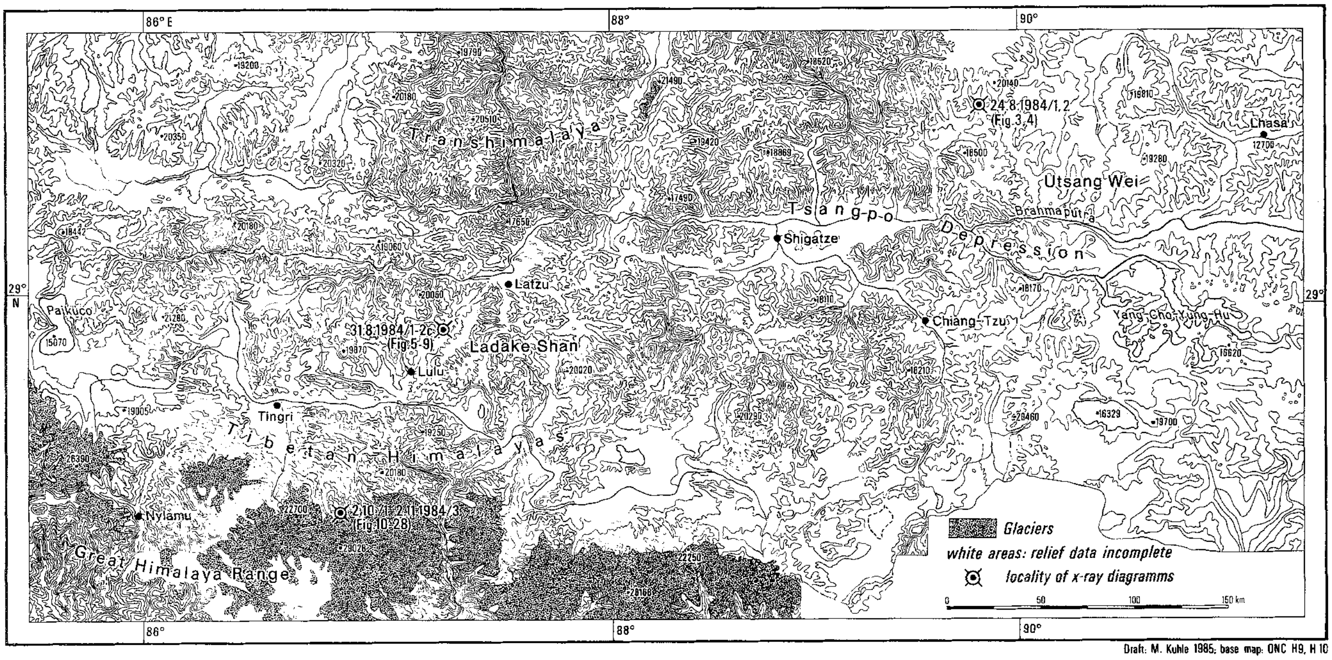
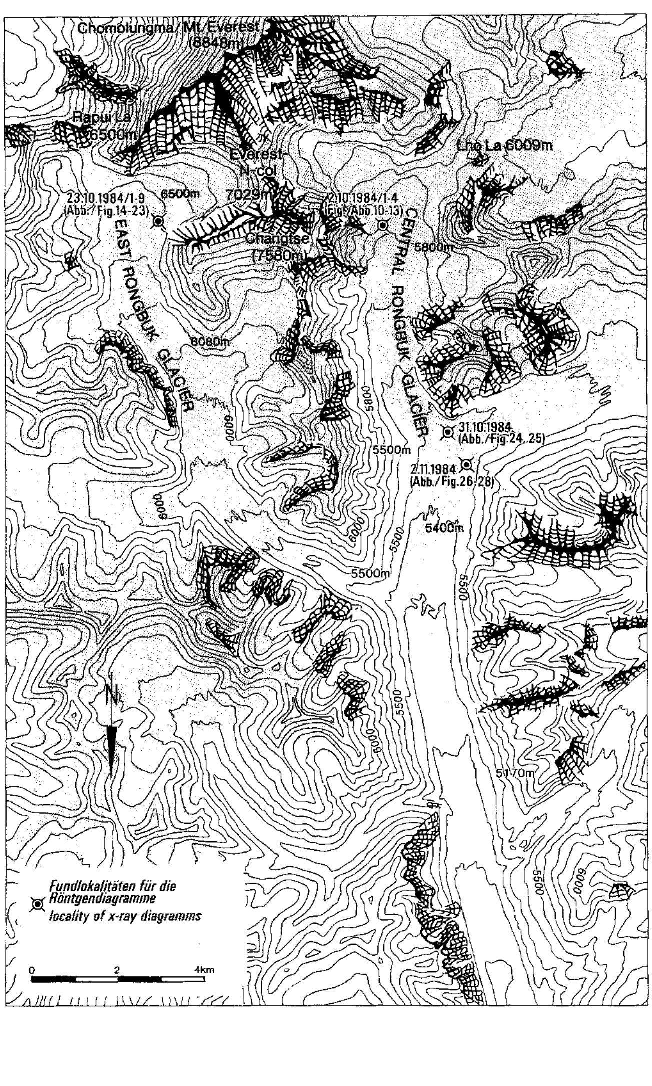


Fig 1 Localities at which the S Tibetan rock samples were collected

Fig 2 Rock sample localities on the N slope of Mt. Everest



and 9) and erratics 2 and 2b are similarly modified two-mica granite with varying muscovite-biotite relationships. In Sample 2 part of the biotite is already chloritised (Fig 6 and 8).

Samples from the Source Basin of the Rongbuk Glacier in the North Slope of Mt. Everest

27°58' –28°10'N 86°45' –87°E (Samples 2. 10. 1984/1–4; Fig 1 and 2

Rock samples from the Mt. Everest area were mainly investigated to provide further information on the petrography of the highest part of the earth. It is well known from the High Himalaya belt that it is made up of a number of irregularly spaced plutons emplaced at the top of the Tibetan slab into sedimentary series up to the Cretaceous (Deberon, F. et al.: Geol. Rundschau 74, 229–236 (1985).

Samples 2. 10. 1984/1–4 are from the medial (surface) moraine exactly where it thaws out at 5800 m. This medial moraine derives from the true right side lateral moraine of the central Rongbuk glacier below the 1800 m high NW wall of Changtse. Thus, the four samples provide information of the petrography of the peak of Changtse. Surface observations have already shown that granite intrusions occur here within a sedimentary series. The naked eye can detect a red contact metamorphism and schists show migmatisation. Sample 1, a fine-grained biotite schist, is certainly derived from this sediment series (Fig 10).

The three other samples are granitic materials. Sample 2 (Fig 11) is from a tectonically modified two-mica granite with hardly any chloritisation of the biotite.

Fig 3

South Tibet and Mt. Everest
X-ray diagramm: 24.8.1984/1; 5300 m, Chalamba La
rhyolithic rock (solid)
A. Heydemann and M. Kuhle

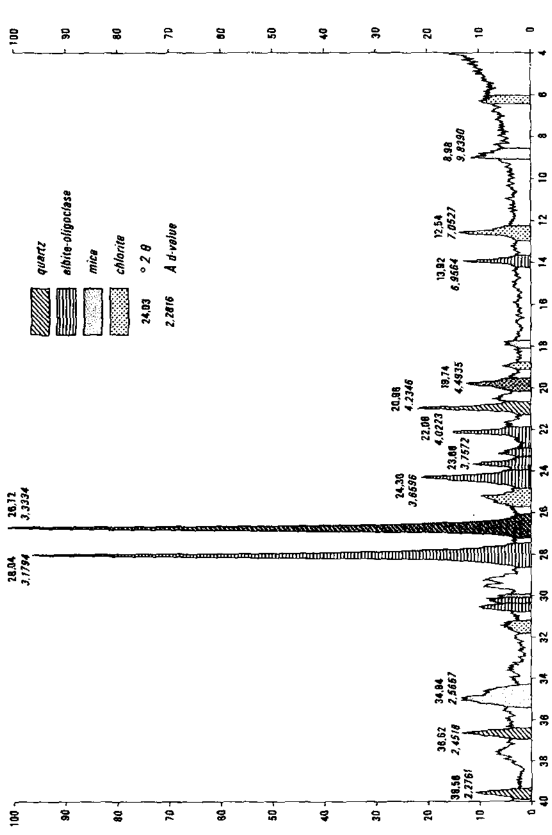


Fig 4

South Tibet and Mt. Everest
X-ray diagramm: 24.8.1984/2; 5300 m, Chalamba La
Erratic clast: Granite (tectonometamorphic)
A. Heydemann and M. Kuhle

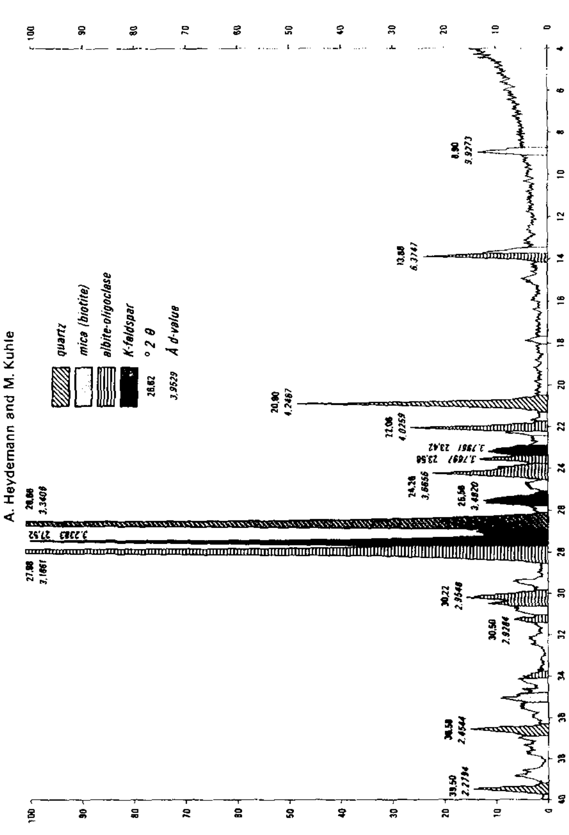


Fig 5

South Tibet and Mt. Everest
X-ray diagramm: 31.8.1984/1
Decomposed basaltic bedrock 4,950 m a.s.l. Latzu massif, Lulu valley
A. Heydemann and M. Kuhle

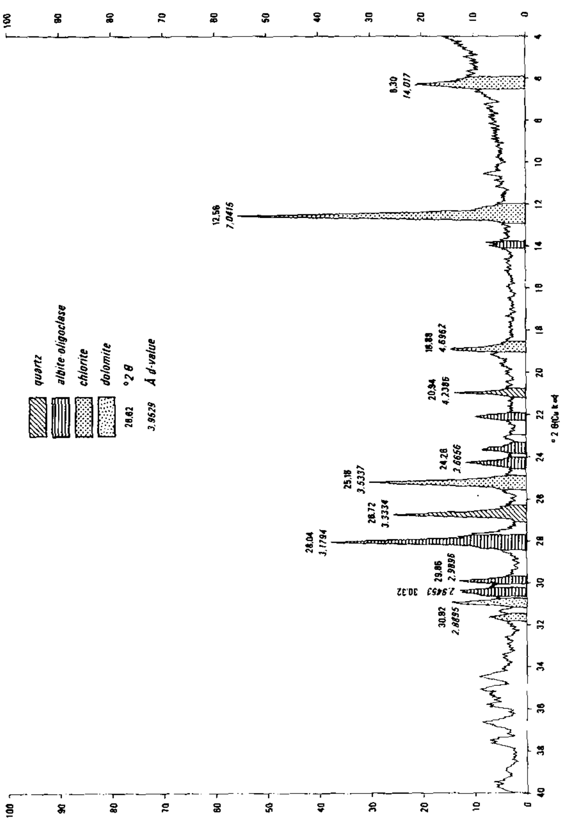


Fig 6

South Tibet and Mt. Everest
X-ray diagramm: 31.8.1984/2
Erratic clast: Two-mica granite, 4,950 m a.s.l. Latzu massif, Lulu valley
A. Heydemann and M. Kuhle

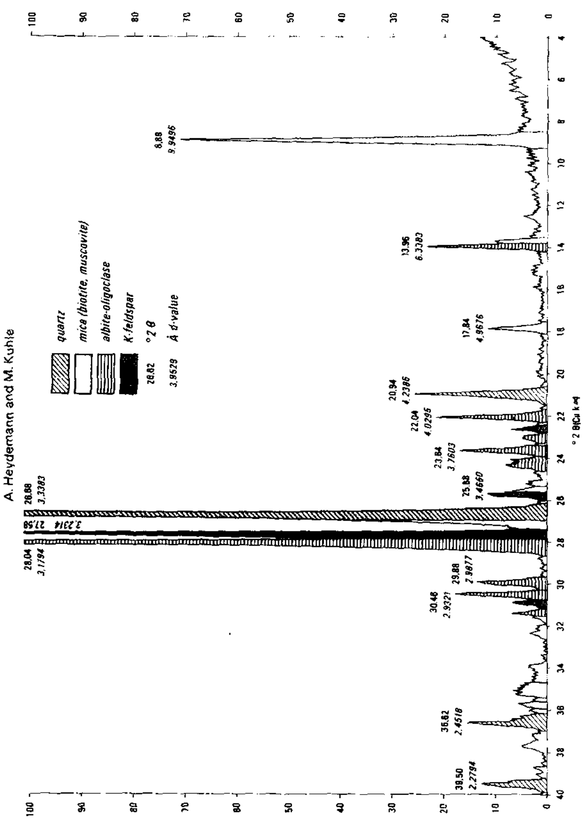


Fig 7

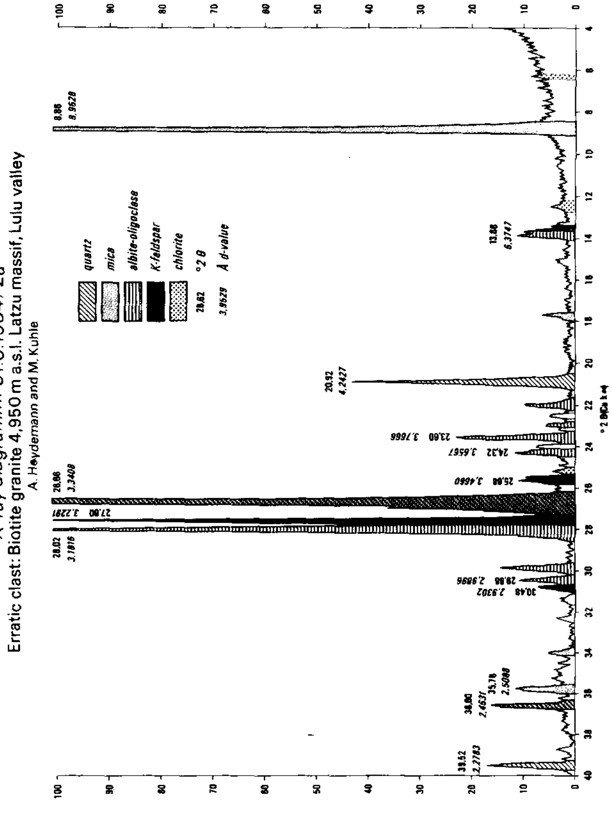


Fig 8

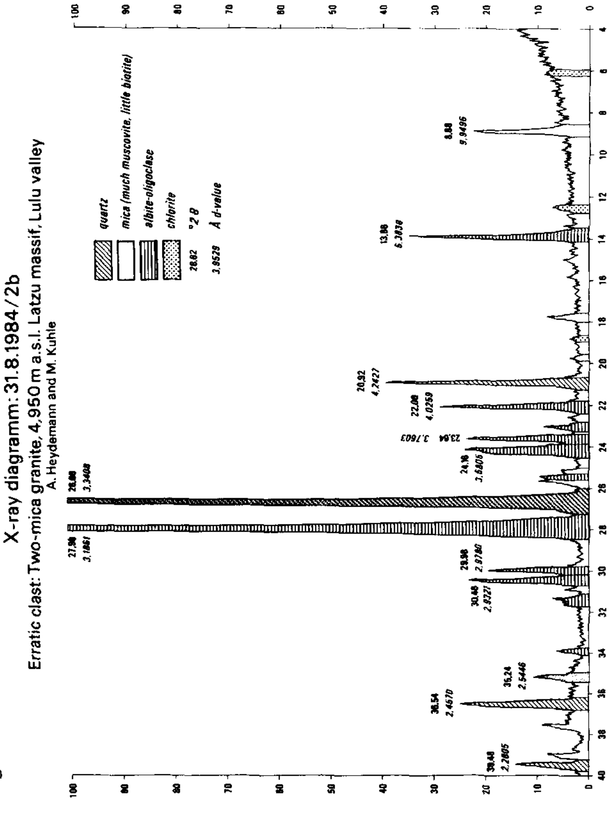


Fig 9

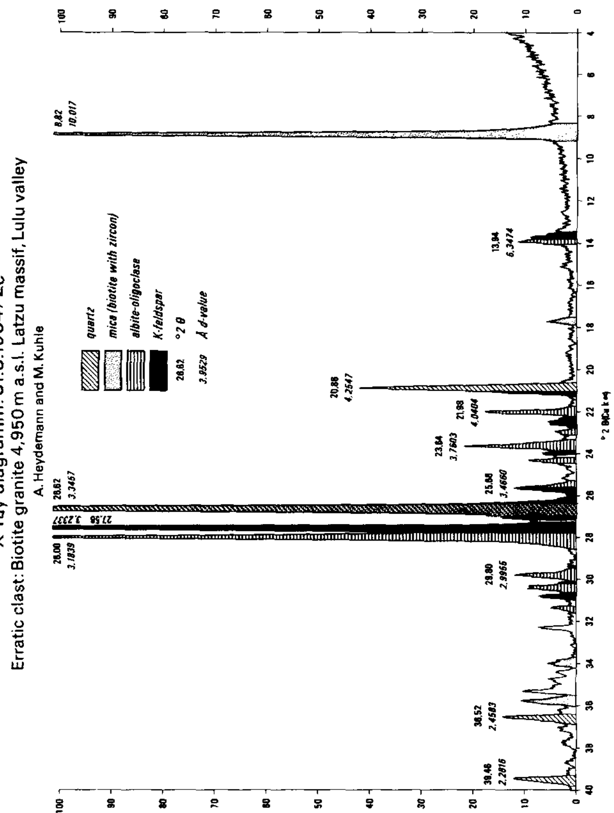


Fig 10

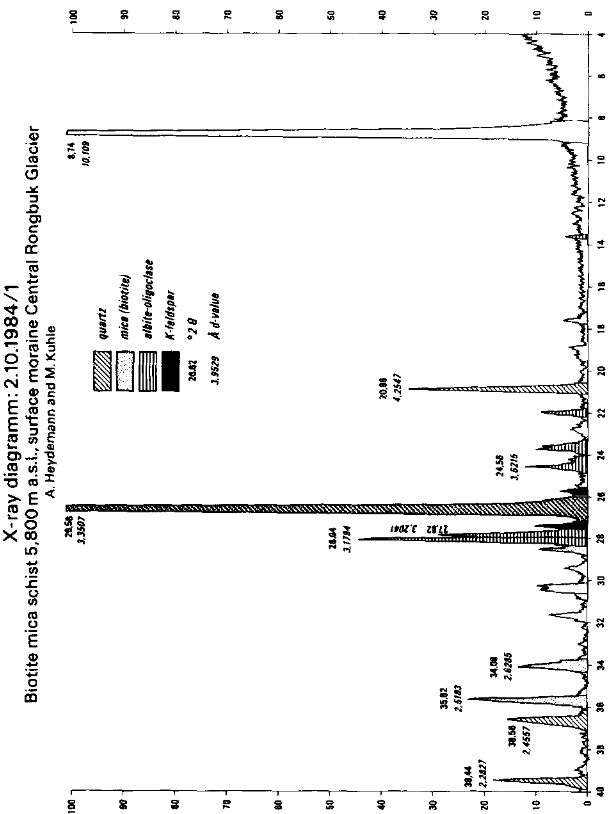


Fig 11

South Tibet and Mt. Everest
X-ray diagramm: 2.10.1984/2, Central Rongbuk Glacier, medial moraine
Two-mica granite
A. Heydemann and M. Kuhle

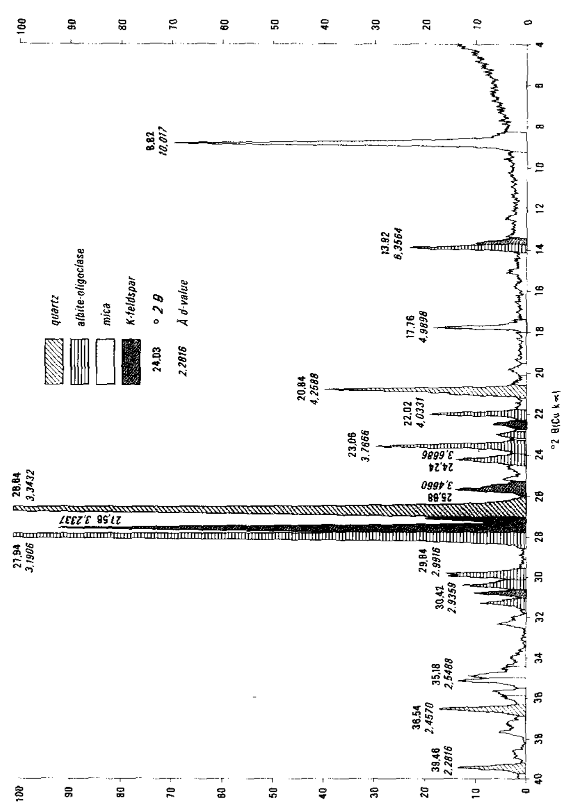


Fig 12

South Tibet and Mt. Everest
X-ray diagramm: 2.10.1984/3
Makalu-Granite
Central Rongbuk Glacier, medial moraine
A. Heydemann and M. Kuhle

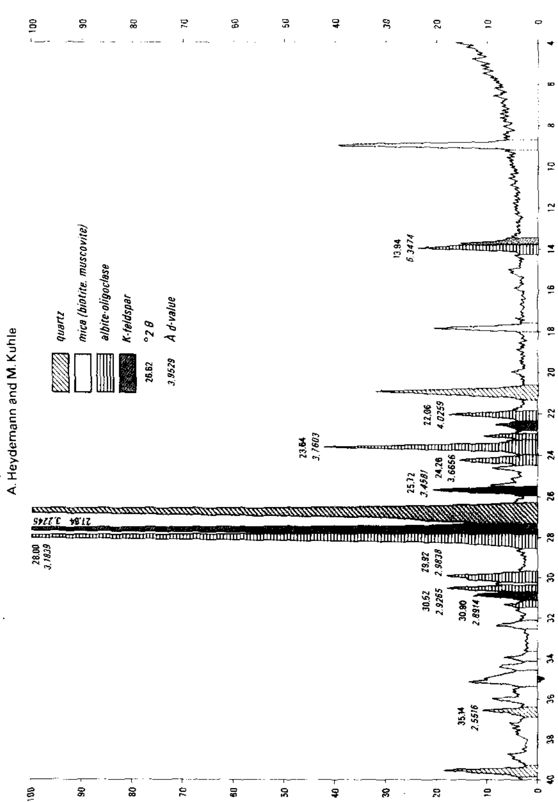


Fig 13

South Tibet and Mt. Everest
X-ray diagramm: 2.10.1984/4, Central Rongbuk Glacier, medial moraine
Granite (without K-feldspar)
A. Heydemann and M. Kuhle

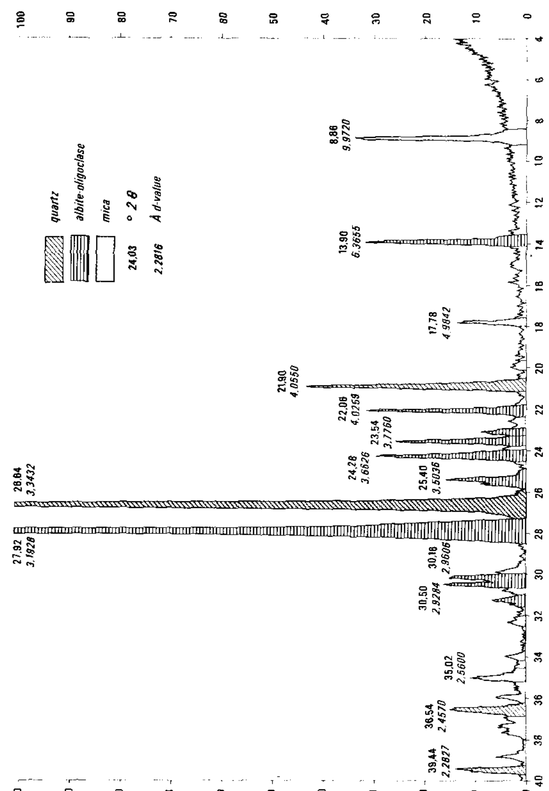


Fig 14

South Tibet and Mt. Everest
X-ray diagramm: 23.10.1984/1
quartz-containing marble
A. Heydemann and M. Kuhle

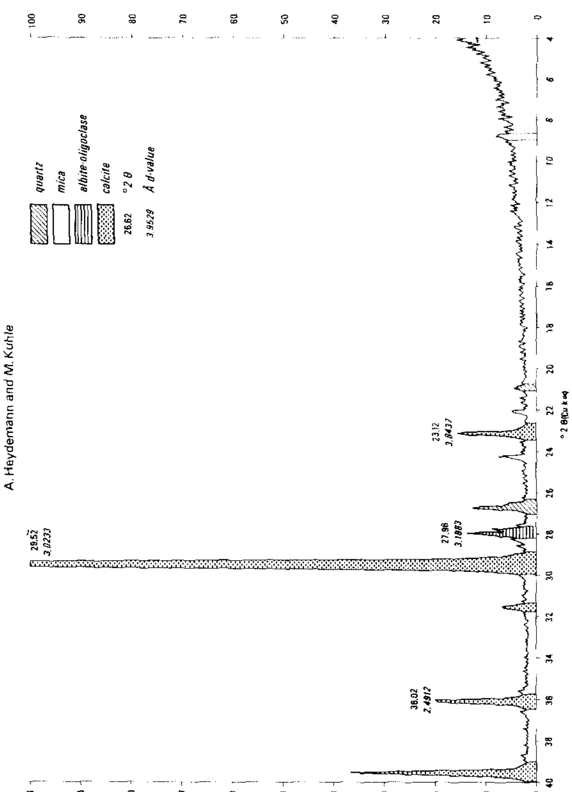


Fig 15

South Tibet and Mt. Everest
X-ray diagramm: 23.10.1984/2
limestone mylonite
A. Heydemann and M. Kuhle

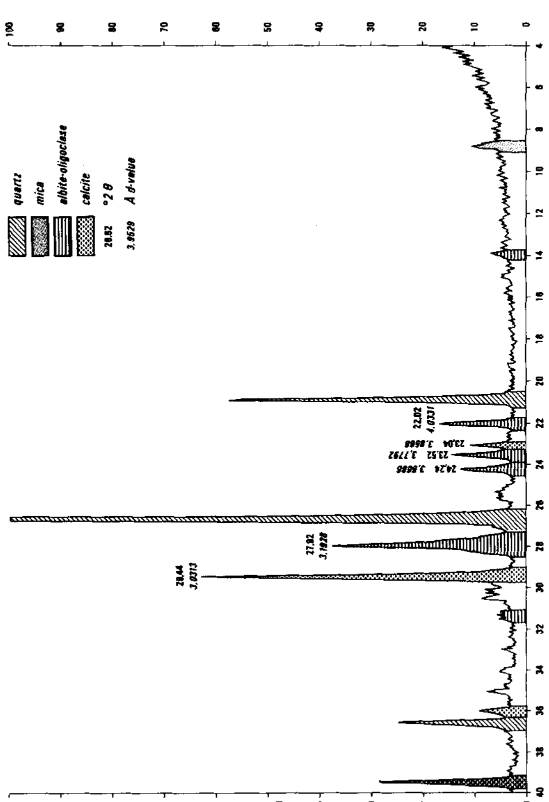


Fig 17

South Tibet and Mt. Everest
X-ray diagramm: 23.10.1984/4
Granite (tectonometamorphic)
A. Heydemann and M. Kuhle

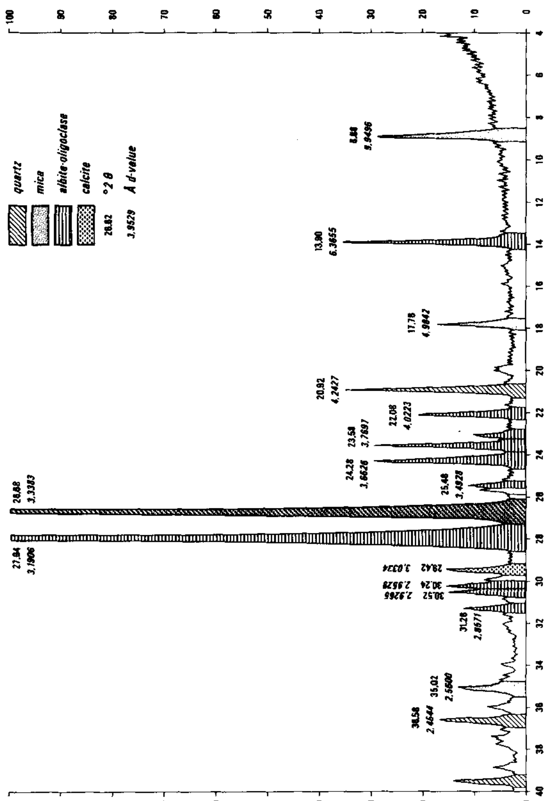


Fig 16

South Tibet and Mt. Everest
X-ray diagramm: 23.10.1984/3
Calcite marble
A. Heydemann and M. Kuhle

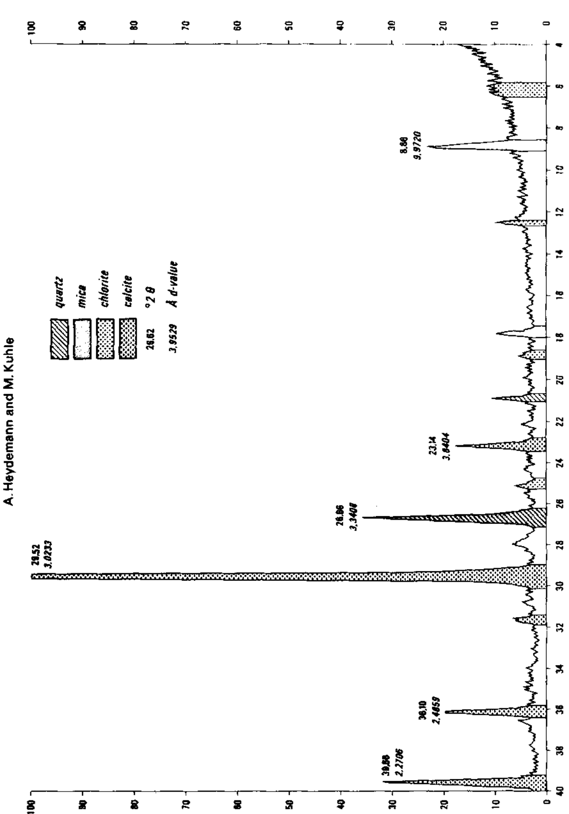


Fig 19

South Tibet and Mt. Everest
X-ray diagramm: 23.10.1984/5, East-Rongbuk Glacier, left lateral moraine; 6,500 m a.s.l.
Cataclasite (sillimanite)
A. Heydemann and M. Kuhle

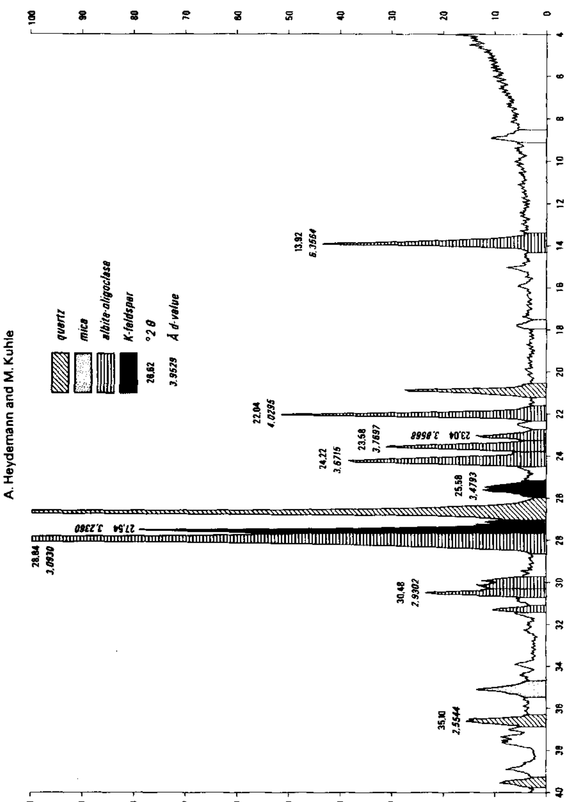


Fig 20

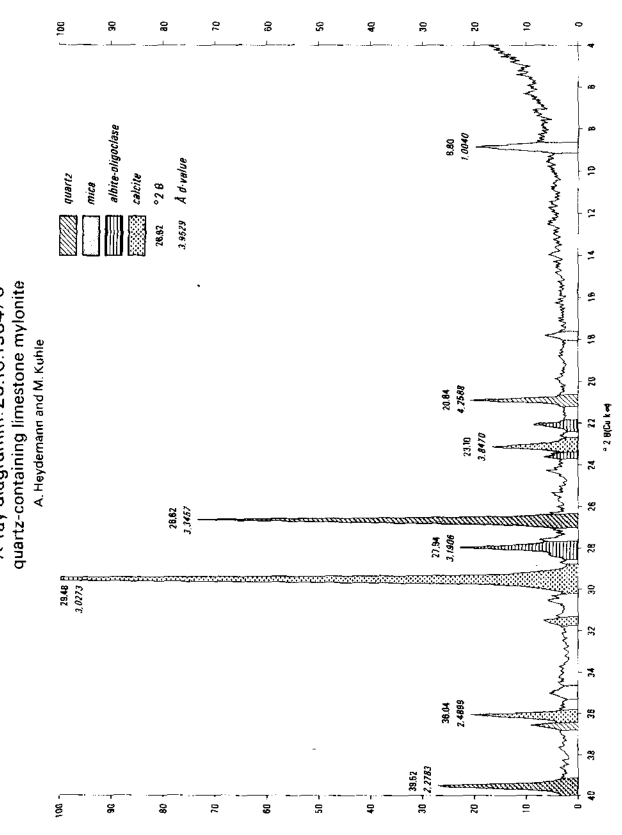


Fig 21

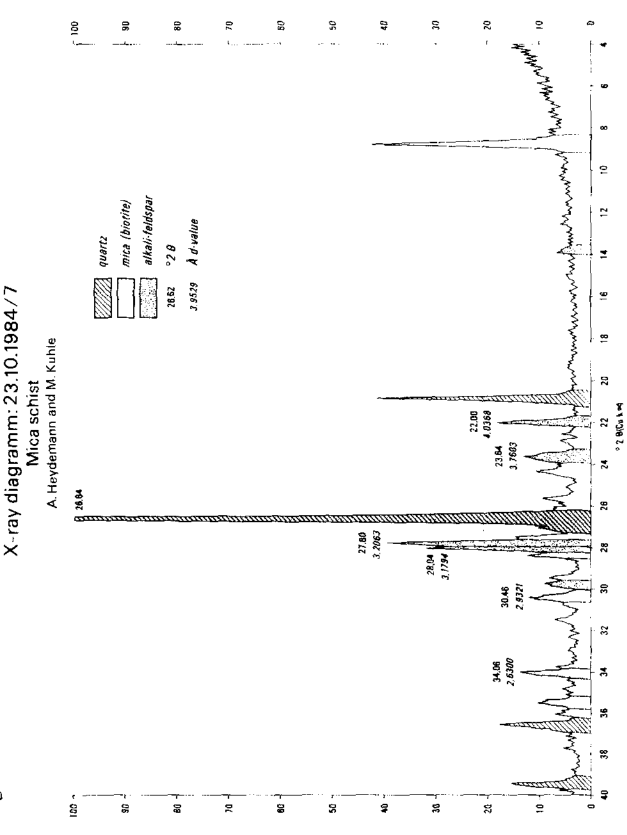


Fig 22

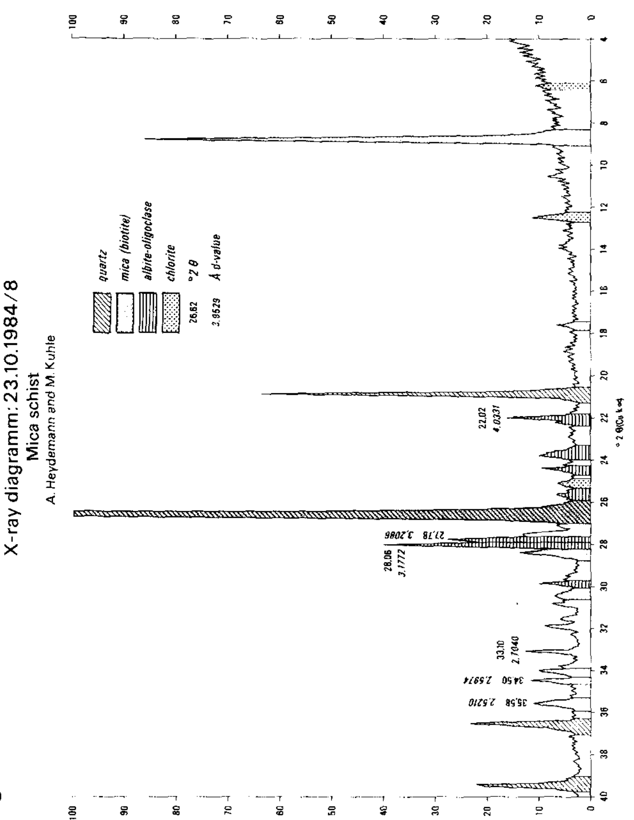
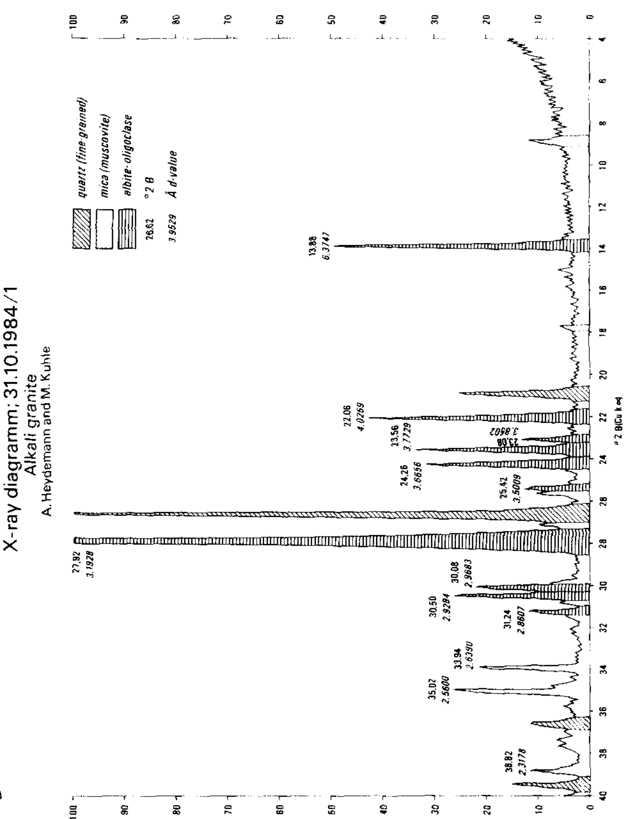


Fig 24



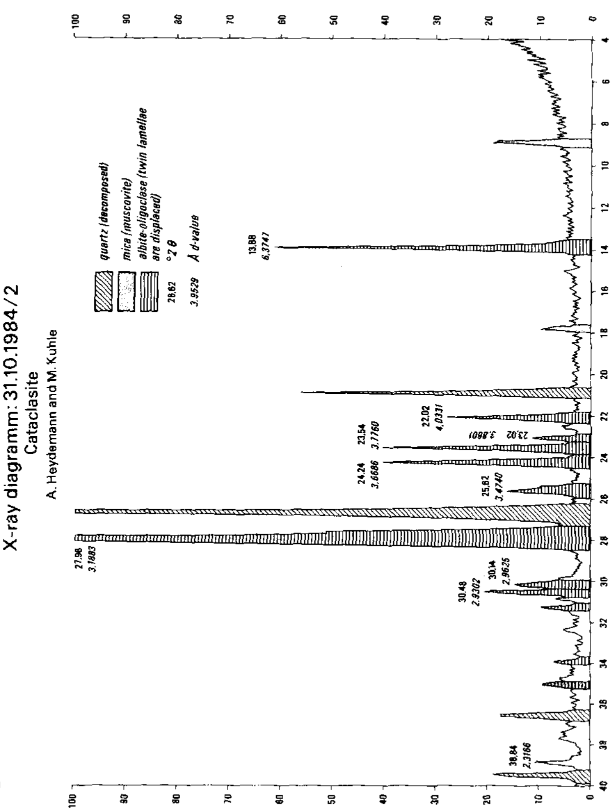


Fig 25

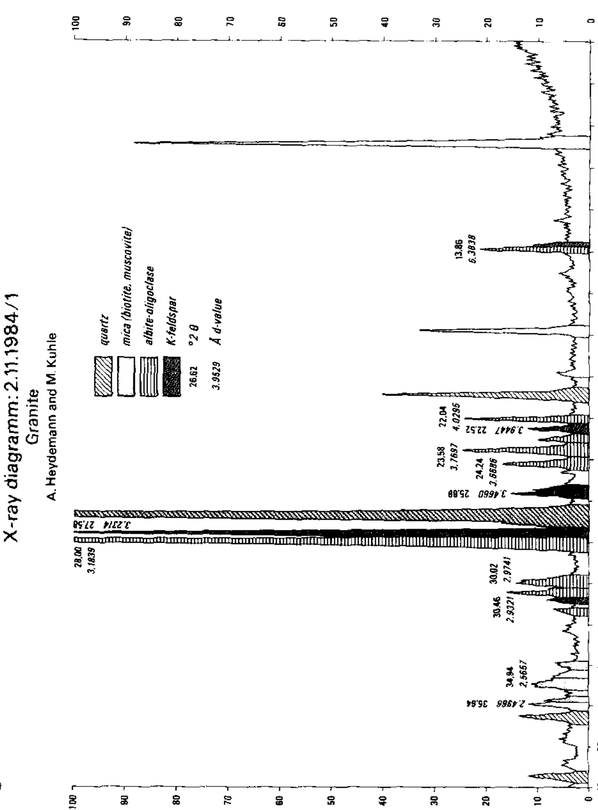


Fig 26

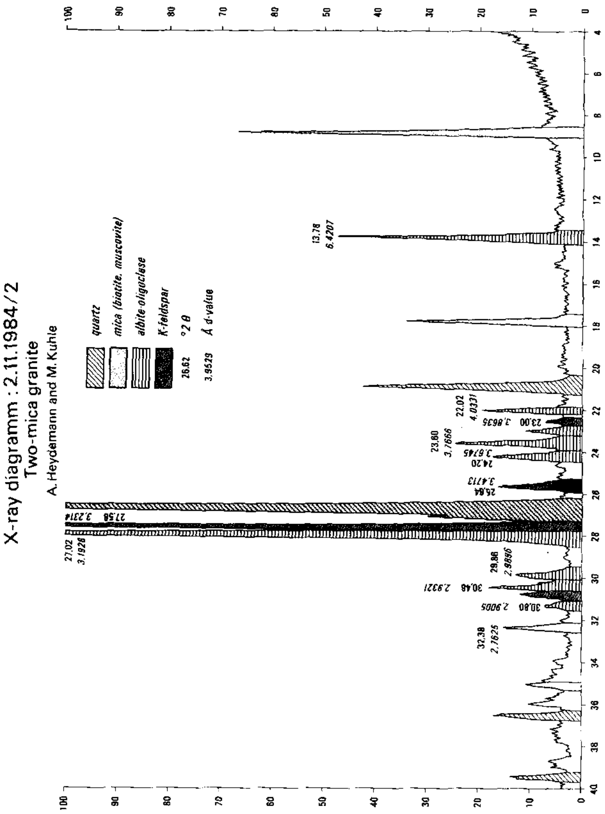


Fig 27

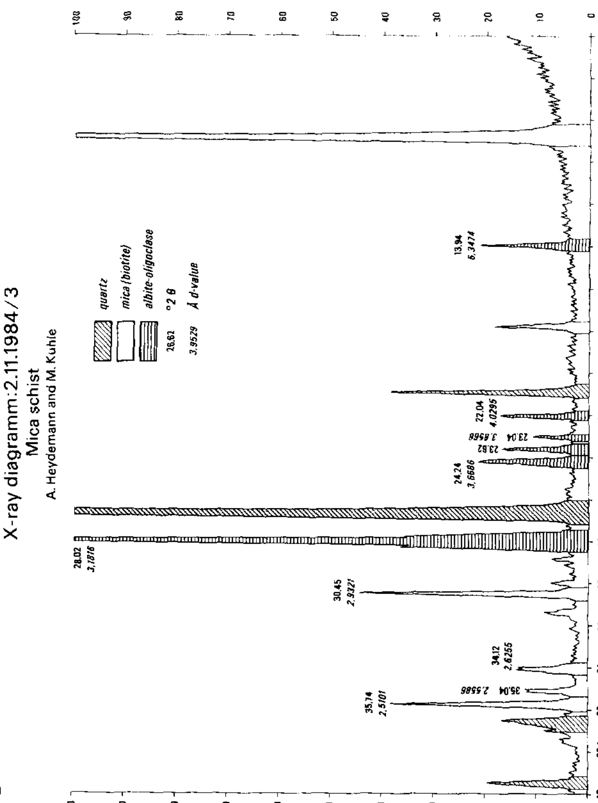


Fig 28

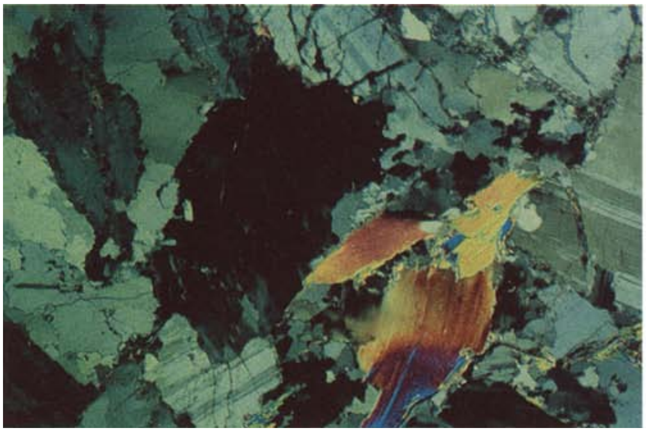


Fig 18 Thin section of a strongly tectonically modified granite. (Sample 23. 10. 1984/4; see also Fig 17). An excerpt with crossed nicols (photo 2.7×4.1 mm). The quartz here occurs partially as tectonically broken crystals with a wavey extinction and partially as the result of stress factors they are interdigitated as clearly distinguishable minute crystals of various orientations. The feldspars, easily recognised by their twinning laminations, are also broken up, the fragments juxtaposed and the fracture lines partly rewelded. The micaceous components, here recognisable by the vivid interference colours, also show pressure effects with distorted bundles of mica.

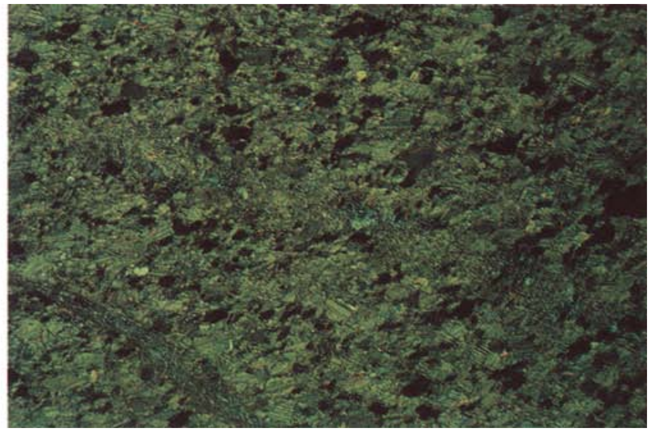


Fig 23 Thin section of a tectonically modified calcite-marble (Sample 23. 10. 1984/9). An excerpt with crossed nicols (photo 2.7×4.1 mm). The calcite crystals of the fine-grained marble all show pressure twinning. The quartz crystals are very small ($< 100\ \mu$) and well rounded and only part of them show wavey extinction. The slightly diagonal cleavage line shows broken and rubbed calcite crystals, appearing now as microcrystalline phases. The quartz components are recrystallised and appear here partly as linearly ordered aggregates formed of minute, variously ordered and interdigitated crystals.

Sample 3 is a similar two-mica granite with rare biotite and dominant muscovite (Fig 12). It is noticeable that tourmaline is subsidiary, and dissolved garnets are recognisable in the thin section. In the Everest area these tourmaline-bearing granites are known as Makalu granites where further to the SE they form the 8481 m peak of Makalu. Sample 4 (Fig 13) is a tectonically modified granitic rock showing recrystallisation phenomena. X-ray analysis shows no potash feldspar but only albite-oligoclase. This thin section also contains relicts of dissolved garnets.

Samples from the Source Basin of the E Rongbuk Glaciers of the Mt. Everest N Slope

(Sample 23. 10. 1984/1–9; Fig 1 and 2).

Samples 23. 10. 1984/1–9 are derived from the glacier-upwards true left bank lateral moraines of the N col of Mt. Everest between the N wall of Mt. Everest and the SSE wall of Changtse at 6500 m. These portions of rock have been carried by snow- and ice-avalanches from the two rock walls (1800 m and 1000 m high) and the summit pyramids and thus provide petrographic information on the summit region.

Samples 1–3, 6 and 9 must be attributed to series of carbonate rocks. Samples 1–3 and 9 are quartz-bearing calcite marbles modified tectonically and metamorphosed; they contain subsidiary soda-feldspar, mica, chlorite and epidote. In sample 9 some phlogopite occurs subsidiary to muscovite and chlorite (Fig 14, 16, 23).

Samples 2 and 9 represent calcite-mylonites, quartz rich resp. quartz-bearing. The calcite forms the 'lubricant' medium between the quartz grains; albite and mica are also subsidiary here (Fig 15, 20).

Sample 4 (Fig 16 and 18) is a granite almost modified to a kataklasite by tectonic modification. The thin section shows the fragmented quartz crystals (with wavey extinction) and similarly broken and rewelded feldspar crystals.

Sample 5 is a true kataklasite. Its quartz and feldspar crystals are broken, aligned and sheared. Tourmaline is a notable component of this kataklasite (Fig 19).

Samples 7 and 8 are also from a sedimentary series. They are fine-grained biotite mica-schists with biotite partly chloritised; green hornblende, epidote and traces of apatite are subsidiary here (Fig 21, 22).

Samples from the Confluence of the Central and Western Rongbuk Glaciers on the North Slope of Mt. Everest

(Samples 31. 10. 1984/1, 2 and 2. 11. 1984/1–3; Fig 1 and 2).

Samples 31. 10. 1984/1 and 2 were collected at 5740 m from the medial moraine of the Rongbuk glacier beyond the confluence ridge. They provide information about the rocks in situ in the 1000 m high steep slopes of this spur which rises to 6480 m. Sample 1 is a tourmaline-bearing alkali-granite which is fine-grained, metamorphosed and tectonically altered (Fig 24). Sample 2 is a kataklasite of granitic composition, also tourmaline bearing (Fig 25).

Samples 2. 11. 1984/1–3 are from the medial moraine of the W Rongbuk glacier where it debouches on to the main stream; this shows they originate from the true left valley sides of the W glacier. Samples 1 and 2 are tectonically modified two-mica granites with residual garnet.

Sample 3 is again a representative of a sedimentary series, a fine-grained tourmalinised biotite schist (Fig 28).

Summary: Mineralogical investigations of rock samples from the Transhimalaya and Tibetan Himalaya allow the conclusion that during the last glaciations in this area there was long distance glacial transport. The samples from the Mt. Everest group, the highest region of the continental crust, provide an account of the petrological data collected from this area. They depict a juxtaposition of sedimentary series and granitic intrusive bodies and also extreme tectonic action deep into their crystalline structure.