RESULTS OF THE KYOTO UNIVERSITY
SCIENTIFIC EXPEDITION
TO THE KARAKORAM AND HINDUKUSH, 1955, Vol. VII

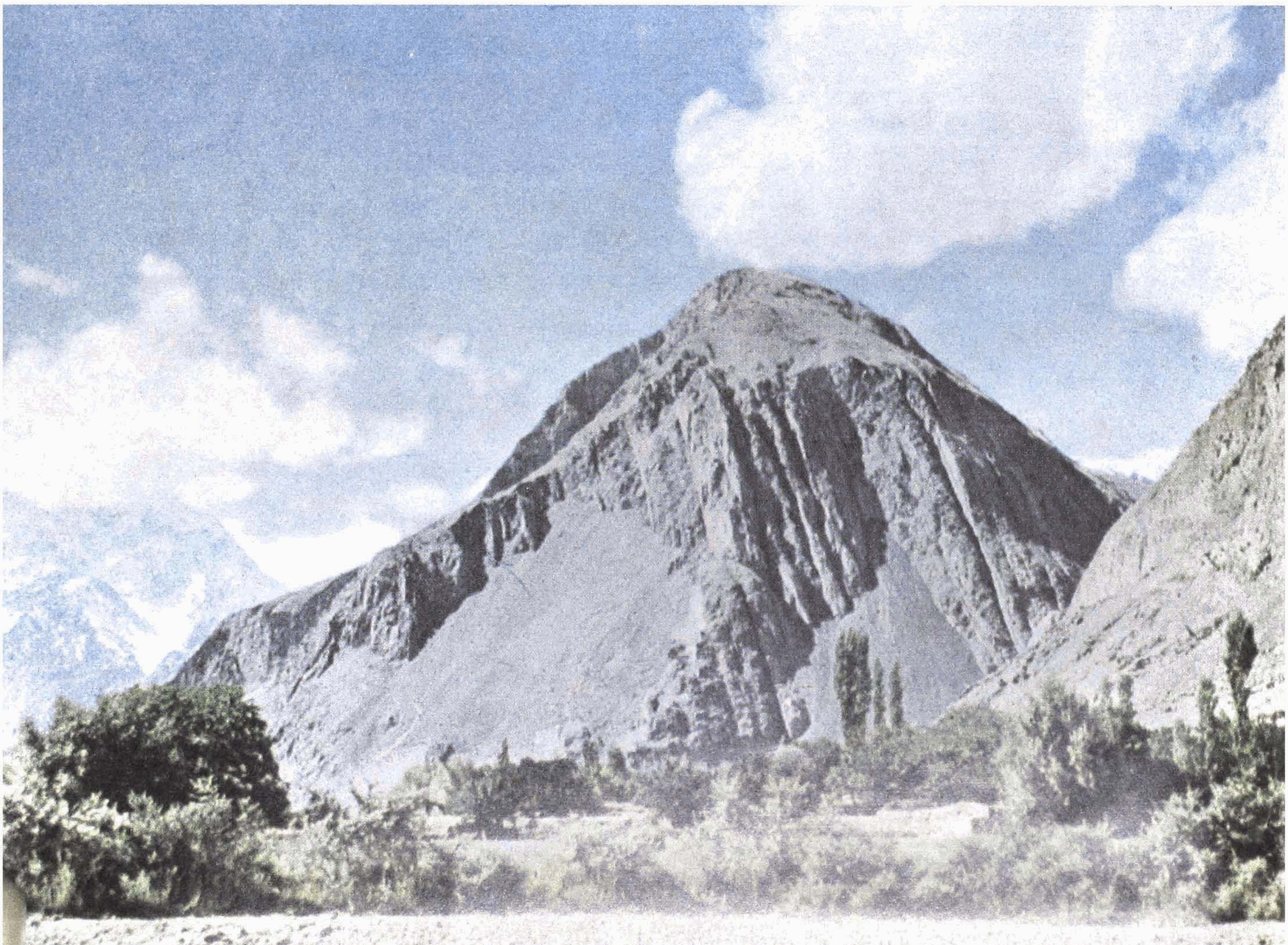
GEOLOGY OF THE KARAKORAM AND HINDU KUSH

Edited by

SUSUMU MATSUSHITA AND KAZUO HUZITA

THE COMMITEE OF THE KYOTO UNIVERSITY SCIENTIFIC
EXPEDITION TO THE KARAKORAM AND HINDUKUSH

KYOTO UNIVERSITY
1965



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1) Green Series:

The entrance of the western side of the Ganga (or Ganto) La (pass) crossing the eastward extension of the Haramosh mountain range. The gate-rock is a thick crystalline limestone almost vertically dipping. The vicinity of the pass is composed of the alternations of limestones and black phyllites which may be assigned to the Green series.

2) Darkot Group:

Looking southwestwards from Barkulti village in the middle course of the Yasin river. The alternation of sandstones and phyllitic slates composing the frontal peak belongs to the Palaeozoic Barkot group. (See Fig. 3-4).

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EDITORIAL NOTE

THE present volume makes the sixth publication of the results of the Kyoto University Scientific Expedition to the Karakoram and Hindukush, 1955. The volumes of the series so far published are as follows:

Volume II. Flora of Afghanistan, 1960
Volume VI. Zirni Manuscript, 1961
Volume V. Personality and Health in Hunza Valley, 1963
Volume IV. Insect Fauna of Afghanistan and Hindukush, 1963
Volume III. Plants of West Pakistan and Afghanistan, 1963

The Editorial Board is indebted to the Fauna and Flora Research Society which, through the financial assistance from the Asahi Press, has taken the trouble of preparing the manuscripts for the publication.

Kyoto
February 28, 1965 A. O.

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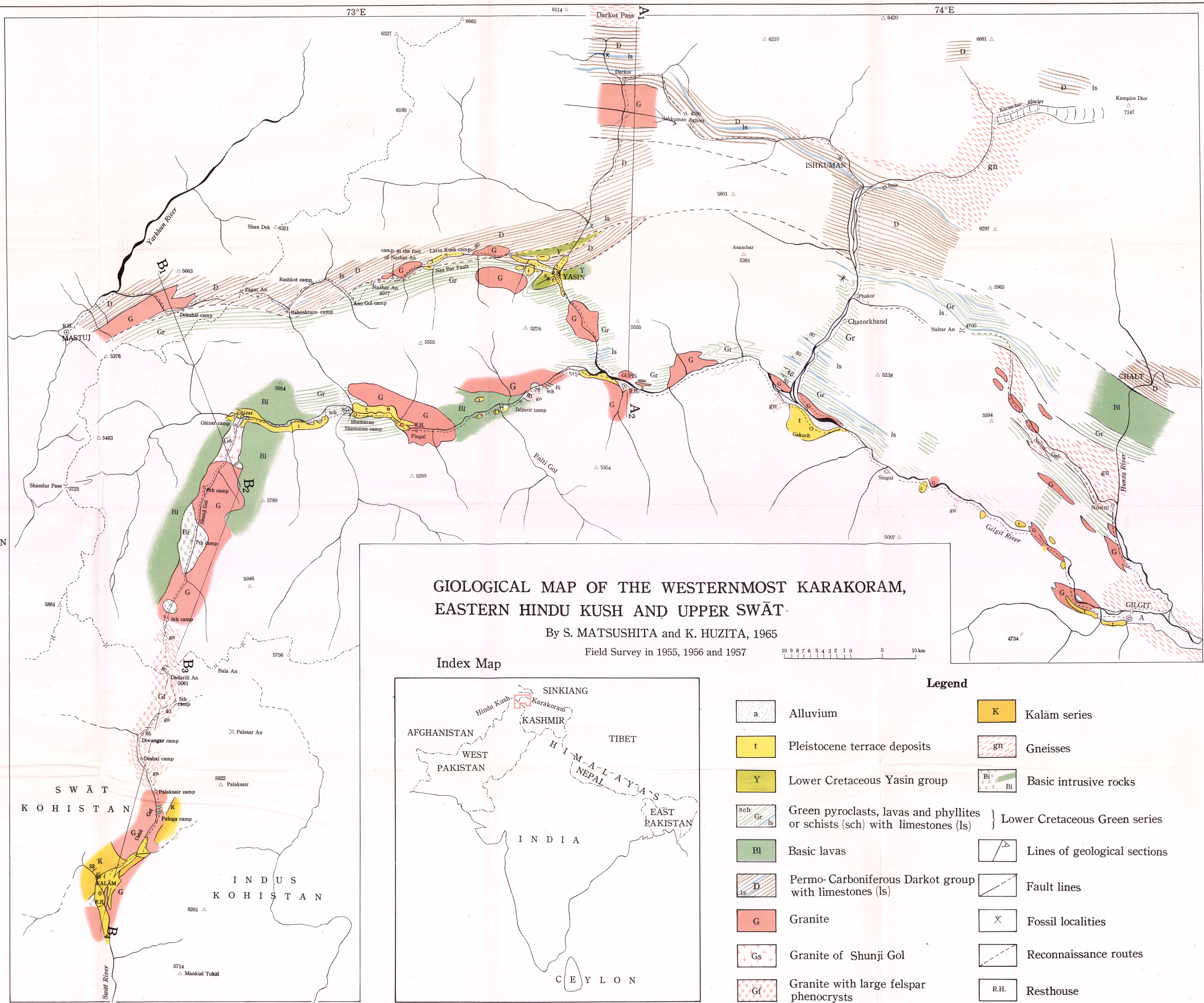
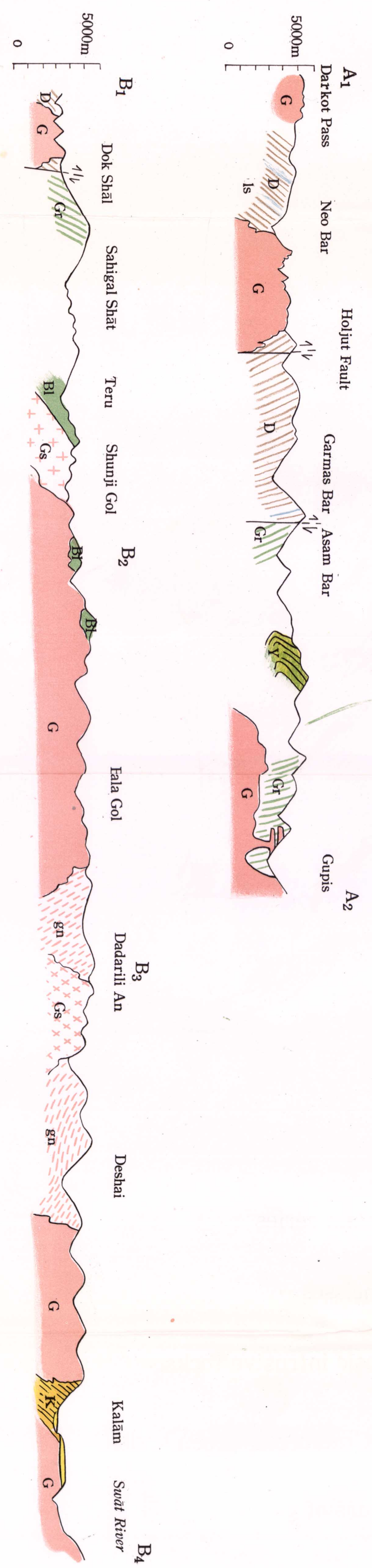


Geological Sections



1. Preface

In this volume are contained the results of our studies on the geology of the Western Karakoram and the Eastern Hindu Kush. We two participated in the Karakoram team of the Kyoto University Scientific Expedition to the Karakoram and Hiudu Kush 1955 in which we carried out in the period from early June to late August a reconnaissance survey along the following route: Gilgit—Indus river—Istak (Stak)—Istak La—Tormik river—Ganga La—Basha river—Braldu river—Askole—Baltoro glacier—Askole—Biafo glacier—Hispar pass—Hispar glacier—Nagar—Hunza—Hunza river—Gilgit.

In the next year, 1956, taking part in the First Kyoto University-Panjab University Joint Scientific Expedition, K. HUZITA engaged in the geological surveying in the Gilgit-Ishkuman-Yasin area from early September to late October.

In the following year, 1957, in turn, as a member of the Second Kyoto University-Panjab University Joint Scientific Expedition to the Swāt Himalaya, S. MATSUSHITA conducted a geological reconnaissance in the Upper Swāt and Eastern Hindu Kush from middle July to late August. The course of journey on foot was: Kalām—Dadarili An—Ghizar—Gupis—Yasin—Nazbar An—Ano Gol—Zagar An—Mastuj.

Many specimens of the rocks and fossils collected by us in the field have been submitted for study to the following collaborators: igneous and metamorphic rocks to Professor G. KOJIMA, Hiroshima University; chemical properties of granitic rocks to Dr. Y. UKAI, age determination of rocks to Dr. I. HAYASE, Kyoto University; Cretaceous coral fossils to Professor M. EGUCH, Tohoku University; Cretaceous molluscan fossils to Professor K. ICHIKAWA and Mr. Y.MAEDA, Osaka City University. We are much grateful to these gentlemen for their kind collaboration. Among other collaborators, we are especially indebted to Dr.T.KASAMA, Osaka City University, who has kindly identified for us the volcanic rocks of the Green series.

We should like to express our heartiest gratitude to the Government of Pakistan for the permission of our Expeditions in 1955, 1956 and 1957. We are much grateful to Dr. Omar Hayat MALIK, Ambassador of Pakistan to Japan, for his good offices and endeavour to get permission of the expeditions, to Pakistan colleagues of the expeditions, particularly Professor Abdul Hamid BEG, Leader of the Joint Expeditions 1956 and 1957, Mr. R. A. TAHIRKHELI, Liaison Officer of the Joint Expedition 1957 and for Mr. Inam Ulah KHAN, geographer and member of the Expeditions 1955 and 1956 for their kind collaborations.

We are much indebted to the former Ambassadors of Japan to Pakistan Messrs. K. YAMAGATA and K. NARITA and other former officials of Japanese Embassy,

especially Messrs. T. FUKAI and Y. HACHIYA and the leaders of the Japanese residents in Karachi, particulary Messrs., M. ASANO and K. SUZUKI for their kind assistance in many ways.

We are much grateful to the Asahi Press and other sponsors.

We are thankful to the Leader of the Expedition 1955 Professor H. KIHARA, Leader of the Karakoram team Professor K. IMANISHI, Japanese colleagues and many collaborators of our expeditions for their warm and kind guidance and assistance.

Last but not least we are much indebted to Professor J. ASHIDA, President of the Fauna and Flora Research Society, for his assistance in many ways, especially in the publication of this volume.

In this volume is not included "Geological Research in the Western Karakoram (by S. MATSUSHITA and K. HUZITA)", which shall be involved in the Supplement of this series to be published in 1965

S. MATSUSHITA and K. HUZITA

2. Introduction

The Karakoram and Hindu Kush are two large mountain ranges belonging to the Alpine—Himalayan mountain system. The Karakoram is situated to the northwest of the Himalaya, parallel to the latter, extending from the northwest to the southeast for 500 km with a width of 100 km. Thus the Karakoram is far less than the Himalayas in length, but in height, the former with K2 (8611 m), the second highest peak in the world, and several other 8,000 m and many 7,000 m class peaks is next to the latter. There are many glaciers in the Karakoram with longer glaciers than those of the Himalayas.

On the other hand, the Hindu Kush, situated to the west of the Karakoram, and extending from ENE to WSW, makes a syntaxial junction with the latter in the Yasin-Ishkuman area about 100 km to the northwest to west-northwest of Gilgit.

The Western Karakoram and the easternmost part of the Hindu Kush are in Gilgit Agency, i. e. the northern part of Pakistan-occupied Kashmir. While the main part of Kashmir south of the Indus river has been surveyed geologically since the 1830's, the geological surveying was started behind in the north part of Kashmir north of the Indus, due to the fact that the land mentioned above is far from the civilized world and is extremely high and steep. Godwin AUSTIN (1864) was the first to report on the geology of the Karakoram. After that, however, the geological works seem not to have proceeded there. In the geological maps compiled in the 1880's, the geology of the Karakoram region is shown very rough.

The regular geological surveying in this region was for the first time carried out by G. Dainelli who participated in the F. De FILIPPI's Italian Expedition to the Himalaya, Karakoram and Chinese Turkestanin 1913 and 1914. DAINELLI's work was done for the most part in the Eastern Karakoram covering the Syok valley, Rimo glacier, Karakoram pass and the Depsang plateau. The remarkable results of his research* in the Karakoram were published in twelve volumes in the period from 1922 to 1934. DAINELLI himself studied stratigraphy, geological structure, geological history, glacier and natural geography of the Karakoram, while he submitted petrography to P. ALOISI and palaeontology to G. STEFAMINI, C. G. PARONA, E. F. MANCINI, M. GORTANI and G. MERLA.

Ph. C. VISSER of Netherland explored the Eastern Karakoram in 1922, the Western Karakoram in 1925 and again the Eastern Karakoram in 1929-1930. R. WYSS took part in the Expedition 1925 as a geologist.

G. O. DYRENFURTH of Switzerland conducted in 1934 an international expedition to the Baltoro glacier and made a geological research there.

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* Dainelli accompanied by A. Desio made a field work also in 1930 in the Eastern Karakoram.

A. DESIO of Italy, who participated in Prince SPOLETO's Italian Expedition to the Karakoram in 1929, made a research in the Baltoro district.

H. de TERRA, as a member of TRINKLER's German Expedition to Central Asia in 1927-1928, engaged in the research in the geology and geomorphology of the Western Kuenlun and the Eastern Karakoram. Participating in the Yale University Expedition in 1932, he studied on the geomorphology and Pleistocene deposits of Kashmir.

The other researches on the geology of the Karakoram region are few, among which C. A. McMAHON's one (1900) on the geology of the Gilgit district is worth mentioning.

From what stated above, it is apparent that, before the War II, the geology of the Western Karakoram was studied by only few workers.

After the War II, however, the situation has become quite different. Several systematic researches have been carried out. A. DESIO's expeditions since 1953 have been the most active. The leader of the Italian mountaineering expedition party, which succeeded in the first ascent of K2 (8611 m) on July 30 1954, led also the geological researches in the Baltoro glacier, Braldu valley and Istak valley in the same year.

H. J. SCHNEIDER of the German-Austrian Himalaya Expedition 1954 carried out the intensive studies of the Gilgit-Hunza district and made public in 1956, 1960 and 1962 the result of his studies.

T.E. GATTINGER who took part in the Austrian Himalaya-Karakoram Expedition 1956 carried out an intensive field work in the Baltoro basin and its south-western adjoining district as far as Skardu on the left bank of the Indus river. He published in 1961 the geological section between the Indus and the Shaksgam.

As stated in the Preface, as the members of the Kyoto University Scientific Expedition to the Karakoram and Hindu Kush 1955, S.MATSUSHITA and K.HUZITA engaged in the reconnaissance survey of the Western Karakoram.

Turning now to the Eastern Hindu Kush east of Mastuj there are rather few records of geological studies particularly before the War II. In 1914, then the Director of the Geological Survey of India H.H.HAYDEN made a reconnaissance survey in the Mastuj-Darkot-Yasin-Gupis-Gilgit-Hunza district on his way to Pamir. In this journey, he discovered Cretaceons marine animal fossils at Yasin.

After the War II, the Eastern Hindu Kush east of Mastuj has been often visited by geologists. In the number of the geologists who have studied, however, the region is inferior to the Western Karakoram.

Australian geologists J.F.IVANAC and others accompanied by the Pakistan geologists conducted a geological surveying in the northwest portion of the Gilgit Agency, i.e. the Mastuj-Yasin-Ishkuman-Gilgit-Hunza region in 1951. They published their results in 1956.

A. DESIO accompanied by his collaborators has often visited this region since 1955.

As stated in the Preface, K. Huzita carried out a field work in the Gilgit-Ishkuman-Yasin area in 1956.

Now let us turn to the Upper Swāt. We mean by the Upper Swāt the upper stream area of the Swāt river. The northern part of the Upper Swāt is called Swāt Kohistan and is situated to the south of the Eastern Hindu Kush. Swāt Kohistan had been a tribal territory untill about 1957 when the Second Kyoto University-Panjab University Expedition party of which S. MATSUSHITA was a member passed through the area. It is for the most part uninhabited and had never been surveyed geologically and had never been traversed by foreigners nor plainsmen till 1957. The environs of the Kalām village, the administrative centre of Swāt Kohistan, however, have been studied by geologists, though the result of the research has not yet been published.

3. Geological Research in Gilgit, Ishkuman and Yasin Areas

By Kazuo HUZITA

I. Outline of the surveyed areas of the First Kyoto University-Panjab University Joint Expedition.

The jointed party of Kyoto University and Panjab University led by Professor H.BEG and K.HUZITA left Gilgit on the 4th September, 1956, and returned to Gilgit on the 23rd November of the same year. The detail of the route of the expedition is shown in Fig. 3-1.

The chief object of this expedition was to expand the geological results obtained in the Western Karakoram including the area from the Baltro Glacier to the Hunza river by the Kyoto University Scientific Expedition in 1955 led by Dr. K.IMANISHI. The line shown by the Karambar river approximately coincides with the geographical boundary between the Batula Mountain Group which is regarded as the western end of the Karakoram range and the Hindu Kush or the Hindu Raj ranges which are comparatively lower than the former. It was one of our problemes what is the geological meaning of the division of these mountain ranges. Moreover, all formations constructing the Karakoram and the Himalayas swing their trends to the southwest in this area. This means that the area under consideration is on the northern extension of the axis of the syntaxial structure established by WAIDA in the Kagahn valley. It was also one of the problems of the expedition to research how to swing their strike from the structural point of view.

Two big tributaries, Gilgit and Hunza rivers, flow into the Indus near Gilgit, where the main river of Indus turns abruptly to the south crossing the western side of the massif of Nanga Parbat. Gilgit Agency is drained by three main branches of the Gilgit river; Karambar-Ishkuman, Yasin and Ghizar rivers. The morphology of the area is strongly controlled by the geological conditions. The arrangement of the mountain ranges is so parallel to the general trend of the structure that the Karambar, Ishkuman and Yasin rivers cutting these ranges almost perpendicularly offer good geological profiles of this area. Then, the routes over the Naltar Pass and the Ishkuman Pass and that of the Gilgit river allowed us to trace each geological division in the strike-direction. Through these sections the writer could recognize several rock zones composed of plutonic rock-masses and sedimentary or metamorphic groups.

H.J.SCHNEIDER (1957,1960) made intensive gelogical survey of Hunza area including the Batula Mountain Group in 1954 as a member of the German-Austrian

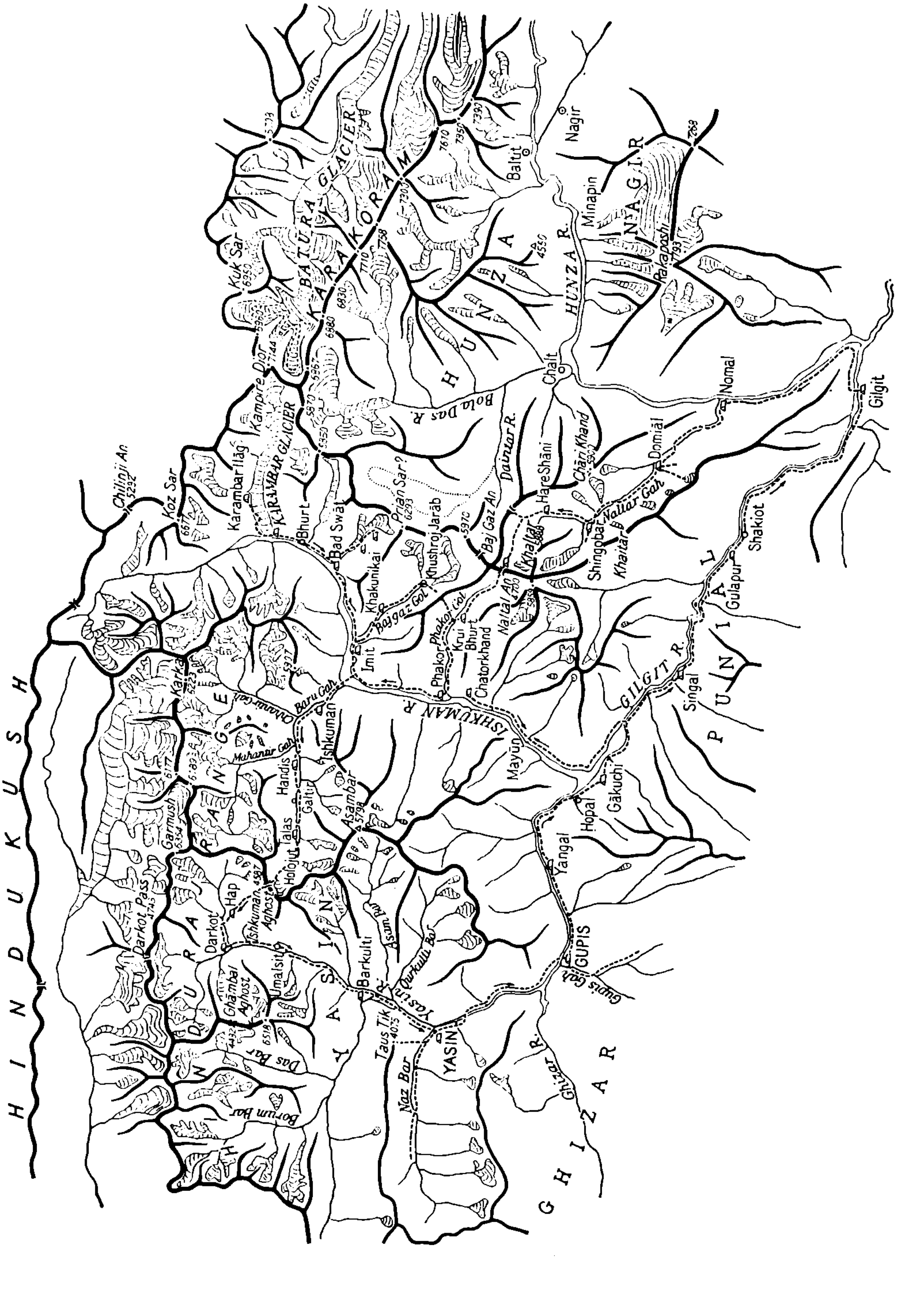


Fig. 3-1. Surveyed area of the First Kyoto University-Punjab University Joint Expeditoin in 1956. The route of the expedition is shown by dotted line. Approximate scale: 1/1000,000.

Himalaya-Karakoram Expedition, and he observed the sections along the Hunza river and its tributaries. He has devided the area into six rock zones, namely Zone V to Zone I and Zone H, from the north to the south.

J.F.IVANAC, D.M.TRAVES and D.KING (1956) surveyed the Gilgit Agency from Chitral to Gilgit including Yasin and Ishkuman areas in 1951 for the purposes of the general and economic geological researches.

These two researches are very important recent works referred in this chapter together with the H.H.HAYDEN's reconnaissance survey in 1914 which has established the foundation of the geological concept of these areas. The writer will describe the field observations along the routes trying to correlate the writer's division with those of them. They are tabulated as below, in which the approximate correspondence of each division is indicated by Roman numeral. The problems on the geological age of each division will be discussed later.

Table 3-1. Geological division of Gilgit-Ishkuman-Yasin areas.

Researcher	K. HUZITA	J. F. IVANAC	H. J. SCHNEIDER
Division	7) Quaternary deposits	7) Quaternary deposits	
	6) Granite of Ghizar valley	6) Ladakh Granodiorite	?) Zone H
	5) Gneiss of Gilgit	2) Karakoram Granodiorite	5) Zone I
		2) Darkot Pass Granodiorite	
	4) Yasin group	4) Yasin group	3) Zone II
	3) Green series	3) Green Complex	1?) Zone III
	2) Granite of Karambar		2) Zone IV
	1) Darkot group	1) Darkot group	1) Zone V

II. Section along the Yasin River

The profile along the Yasin river is considered to be most important, because the grade of regional metamorphism of rocks decrease here compared with that of the eastern areas such as Ishkuman or Hunza, and some fossiliferous limestones are exposed in this valley. It may offer a standard geological section of the Eastern Hidu Kush. This is the reason why the writer describes this section at first.

It is to be regreted that the writer had no time to re-examine the Paleozoic Darkot group of IVANAC in its type-locality which was selected in the north of Darkot village. H. H. HAYDEN (1914) firstly sketched the sequence of this group. He found the fossiliferous shally limestone containing a large number of Fusulinae and Bryozoa to run near Darband, and then reported that the fossiliferous series of Darband appeared to be underlain by a massive limestone and slates, often calcareous.

Owing to the severe march before daybreak in a snowstorm, HAYDEN could not see the hills on either side of the glacier of the Darkot Pass. He inferred, however, that they are composed of gneiss and granite. His inference has been later proofed by IVANAC. These granitic rocks was named "Darkot granodiorite" by him. IVANAC also said in his report that the Darkot group occupies over a distance of six miles between Darkot and the Darkot Pass and all beds dip northwards. He estimated the minimum thickness of the Darkot group about 5,000 m.

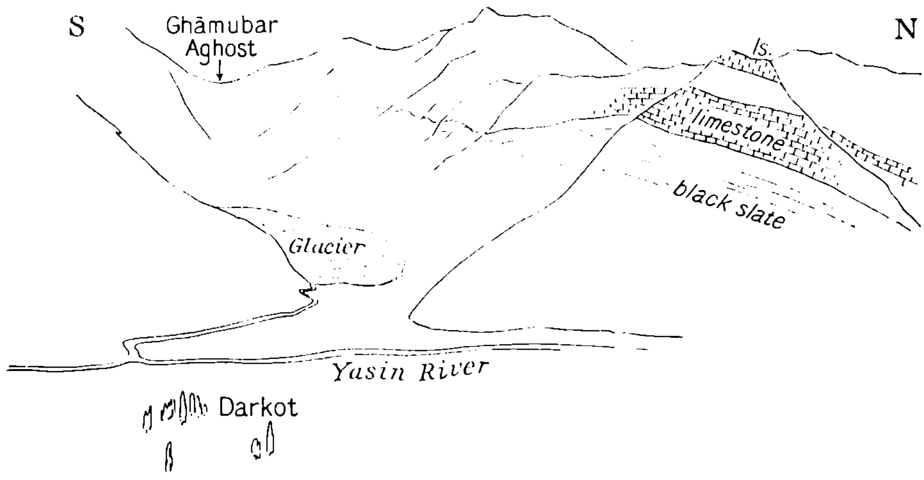


Fig. 3-2. A sketch of the Darkot group exposed along the western side of the Yasin river at Darkot.

The village of Darkot is situated on the lower terrace of the upper stream of the Yasin river. The snout of the East Ghamu Glacier closes to the village on the same level from the western side of the river. Although it had been covered by new snow, the writer could get a distant view showing that a thick white limestone bed inserted in the black slates runs westwards along the cliff of the northern side of the glacier to the Ghamubar Aghost (pass) dipping about 30° to the north. This limestone could be traced certainly up to Hap along the Neo Bar, a small tributary flowing into the Yasin river from the eastern side of Darkot.

To the south of Darkot, the valley becomes narrower bounded on either side by steep cliffs which are composed of muscovite-biotite-gneiss (Sample No. 252). Such gneissose rocks continue down to Umalsit. As already IVANAC pointed out, the Darkot group is inferred to have been intruded by these granitic rocks as well as the Darkot Pass granodiorite. The black slates exposed at the south of Umalsit are penetrated by numerous acid veins and partly change to hornfels, although a fault may run between them. This presumptive fault is regarded as the western extension of the Holojut fault which will be described in a later chapter.

This gneiss was called "Karakoram granodiorite" by IVANAC and he suggested that it belongs to the same batholith as the granodiorite distributed in the Batula Mustagh and the Karambar area, but such a interpretation is very duobtful. The relationship among them will be discussed according to the writer's observations

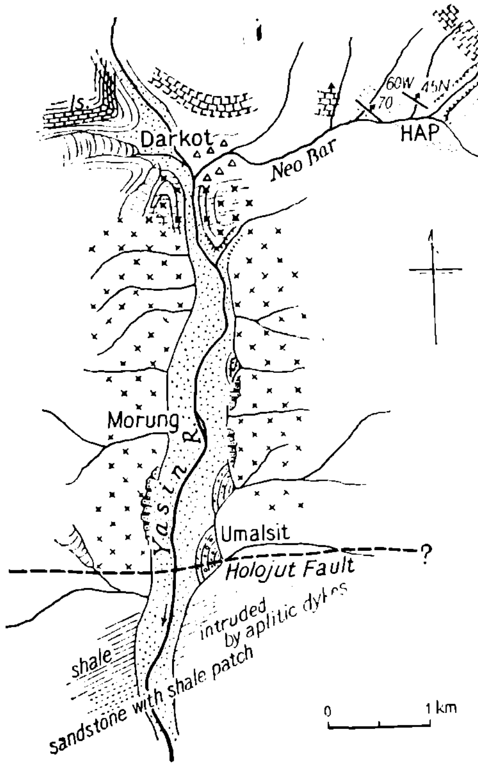


Fig. 3-3. Route map of the upper part of the Yasin river.

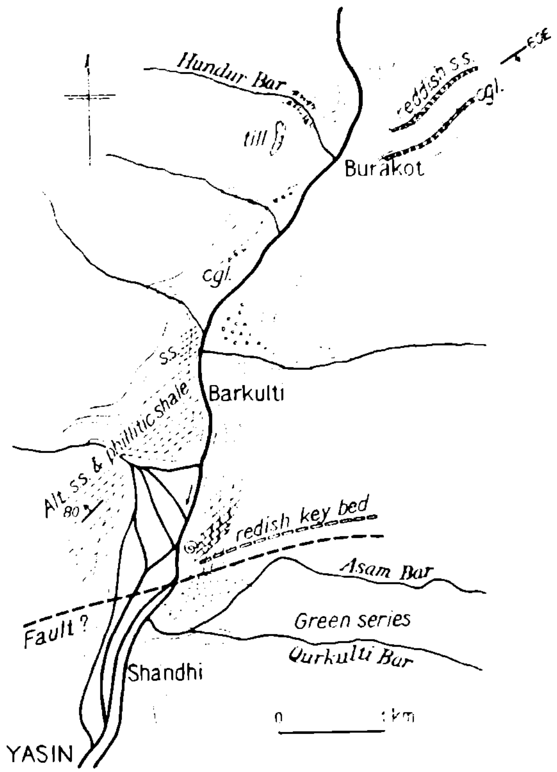


Fig. 3-4. Skatch map of the middle part of the Yasin river.

along the route crossing the Ishkuman Pass. At least, no gneissose rock could not be recognized around the Ishkuman Pass, while the gneiss zone apparently far extends westwards to construct the mountains more than 6,000 m high. When we got a splended panoramic view from the top of Taus Tik peak (4075 m), which is situated immediately north of Yasin village, the chain of snow-covered characteristic peaks of granite continuing westwards from Darkot area was strongly impressive (Peak of 6518 m in Photo. 3-12).

Most part of the section between Umalist and Yasin is occupied by the sedimentary rock sequences which have been metamorphosed comparatively stronger than those of the northern side of the granite zone. They consist of mica slates, quartzites and conglomerates. They are intercalated with two reddish sandstone beds which are partly conglomeratic and play a role of good key bed. They indicate that the strata of the middle part of the Yasin river run in the direction of NE-SW.

The dip of the strata ranges from 60° to 80°, partly vertical. The dip of the beds at river level, however, cannot be regarded as the general dip as shown in the panoramic sketch from the top of Taus Tik peak (Fig. 3-16). Generally speaking, the sequence developing between Umalsit and Yasin slightly dips southwards and has been overfolded near Yasin village (Photo. 3-1). It is probable that the sequence shows the stratigraphically contineous section without repeat. The upper horizon may appear from the south to the north.

On the eastern side of the valley, south of Barkulti, a thick massive limestone is exposed. IVANAC paied his attention to the slates and limestones which are interbedded with this limestone at the immediately south, and then he found that they have similar appearance and fossil assemblage to the slates and limestones in the Darkot group at Darband. He assigned these beds to the south wing of a large anticline of the Darkot group.

Green rocks appear from the northern cliff of the junction of the Asam Bar and the Qurkurti Bar to the south. They may be assigned to the Green series. At Yasin, HAYDEN, DESIO and IVANAC reported the fossiliferous limestone belonging to the Yasin group. The writer also could collect a number of fossil specimens from some boulders in the talus of the northern mountain slope near the mouth of Naz Bar, but many conditions did not allow us to make intensive survey of this part. The mother bed of these boulders and its stratigraphical position in the Yasin group was examined by S.MATSUSHITA, the leader of the expedition dispatched in the following year. He will describe the detailes of the geology of Yasin area in the next chapter.

Among the collection of the fossils obtained by the writer, K.ICHIKAWA and Y. MAEDA found the following species.

Plesioptyxis huzitai n. sp.
Adiozoptyxis cf. *A. conguandiana* d'ORBIGNY
Horiopleura haydeni DOUVILLÉ
Horiopleura haydeni var.

At the south of Yasin, thick basic lava flow is inserted in the Green series. According to T. Kasama, it falls under the category of spilite. The Yasin valley of this part becomes wider and forms a small basin, at the bottom of which granite is exposed intruding the Green series (Photo. 3-2). The Green series around Gupis are composed of greenish tuffs, agglomerates and limestones. From Gupis to the south along the Gupis Gah, biotite-granite is widely exposed. Many good outcrops showing the Green series intruded by granite which belongs to the Ghizar granite can be found along the Ghizar and Gilgit rivers (Photo. 3-10, 11).

III. Section along the Karambar and Ishkuman rivers

A big tributary flowing into the Karambar Glacier from the northern side of it is called Kichikurin Nara. The observations along this Nara (valley) show that the Koz Mountain Group, the highest peak of which is named Koz Sar (6677 m), is composed of black slates lintercalated with thick brown impure limestones. The boundary between this formation and the hornblende-biotite-granite constructing

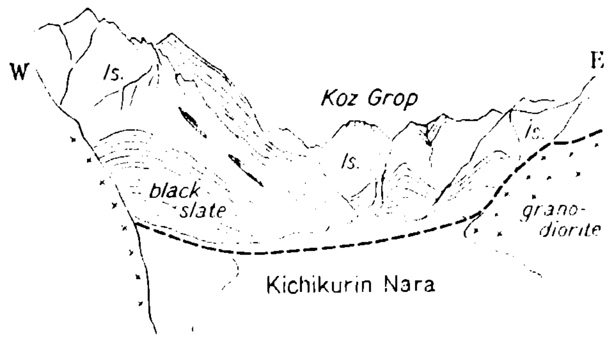


Fig. 3-5. Inner part of Kichikurin Nara seen from Karambar Ilaq to the north.

the Karambar Glacier area was very clear, although the writer could not approach to the very point. It is probable that a fault runs between them. IVANAC and others has found the westward extension of this fault at Pekhin, a small village situated at the north of the snout of the Karambar Glacier. Considering the zonal arrangement of the structure of this area, this sedimentary formation is undoubtedly belongs to the Palaeozoic Darkot group of IVANAC and certainly continues to the Zone V (Tethys-Karakoram) established by H.T. SCHNEIDER (1956), which was described as Younger Palaeozoic in age.

The Karambar granite is also no doubt the westward stretch of the granitic rocks occupying the central zone of the Great Karakoram range. The steep

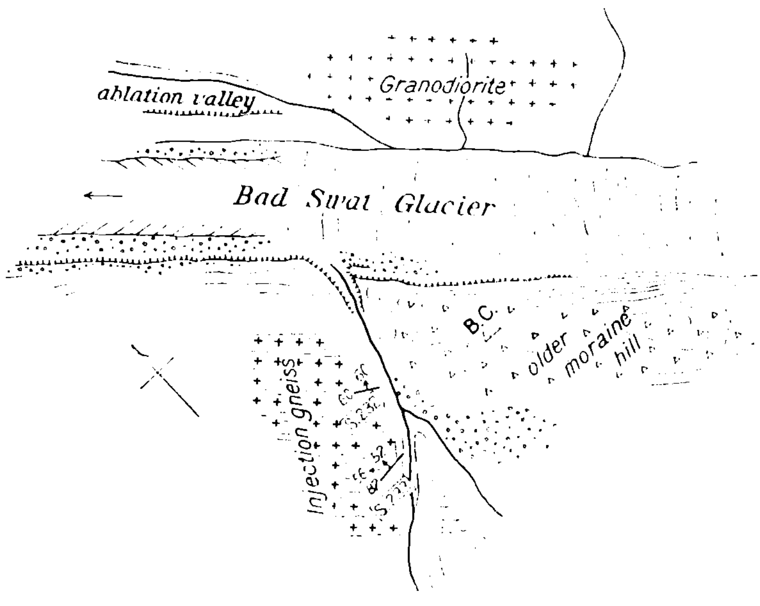


Fig. 3-6. Sketch map of the environs of the base camp settled at the left bank of the Bad Swat Glacier.

cliffs along the Karambar river from the snout of the Karambar Glacier to Bhurt show good profile of this granite zone.

The following outcrops to the south are composed of metamorphic rock series. They chiefly consist of muscovite-biotite-gneiss in which porphyroblastic parts are dominant. Biotite-schists are also intercalated.

The younger members of our party tried to attack Prian Sar peak (6293 m) hidden in the innermost part of the Bad Swat Glacier. The base camp was settled on the older moraine-hill at the southern bank of the middle part of the glacier. The sketch map of the neighbouring of the base camp is shown in Fig. 3-6.

The steep cliff of the northern side of a small tributary flowing into the Bad Swat Glacier at the northwest of the base camp offeres good exposure of the injection gneiss (Fig. 3-7). The petrographic details are given in the descriptions of sample No.232 and 233 of KOJIMA's report. The original rocks are inferred to be the alternations of sandstones and shales. A large block found on the river bed of this branch suggests the existence of the migmatite including the deformed elongate cobbles or pebbles, which indicates that conglomeratic beds had also been intercalated among the original alternations.

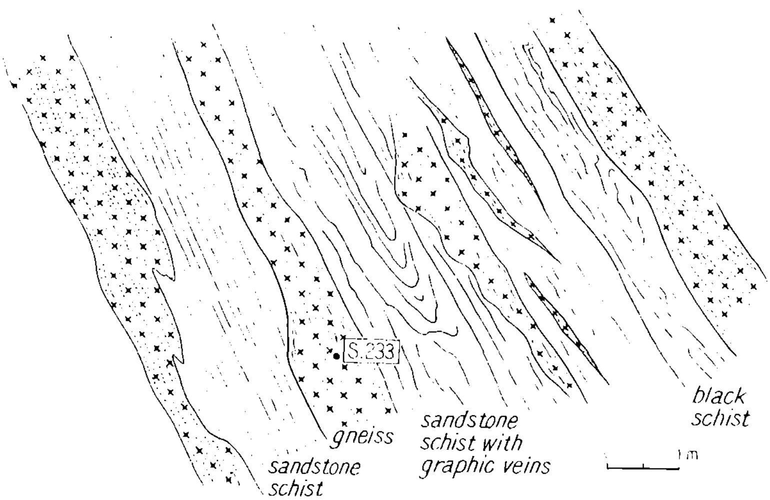


Fig. 3-7. Sketches of the gneiss at the southern bank of the Bad Swat Glacier.

A wall of well-stratified rock dipping about 50° to the northeast and running 60° northwestwards could be seen in the innermost part of the valley of the opposite side of the Bad Swat Glacier. These beds are inferred to belong to the Darkot group considering their facies and the general tendency of the structure of this region although we could only get a distant view of them. The grade of metamorphic effects of the Darkot group is considered to increase rapidly from this district to the east.

From Bad Swat to the downstream, sandstones, shales and quartzites belonging to the Darkot group run crossing the Karambar valley, and then a narrow zone of granite reappeares at the east of the junction of the Karambar river and the Bajigaz Gol.

The ascent of Prian Sar was unsuccessful and we returned to Imit. While staying there, the writer accompanied by K.Honda visited the Bajigaz Gol on 3rd October. Quite different from the Swat valley, this tributary is being deeply dissected by torrent. Only a small galcier is stagnant in the innermost part of the valley. It was noticeable, moreover, that the well-preserved higher terraces develop on both sides of the down half of the valley. They are more than 500 m higher than the river bed of the Karambar river. On the highest terrace we found a line of older moraine-hills with thin verved clay beds.

A long reddish brown limestone-wall continues in the same direction as that of the valley along the right bank. This limestone is supposed to be inserted in the black schists, which may be intruded by the granite before mentioned according to the observation of the northern cliff of Kukuni Kai village. On the river bed near the village, a large number of blocks of conglomerate were found.

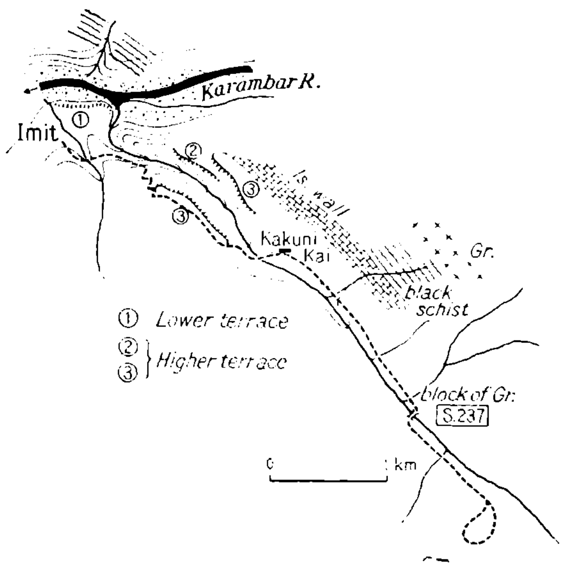


Fig. 3-8. Sketch map of the Bajigaz Gol.

From Imit to Phakor, we could see a thick formation mainly composed of black phyllite (Sample No. 226, 227), which was vertically intruded by a few wide dykes of diorite extending in the same direction as the strike of the phyllite. This zone has been so strongly weathered and eroded that the Ishkuman river has widened between Imit and Phakor.

At the western side of the junction of the Ishkuman river and the Baru Gah, a thick limestone is exposed dipping 60°-70°S striking NWW. This is undoubtedly identical with the limestone making a large wall along the Bajgaz Gol.

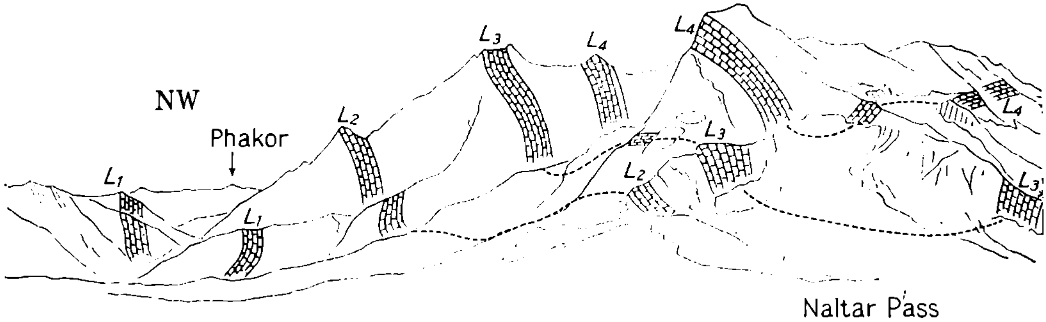


Fig. 3-9. Green series around the Naltar Pass.

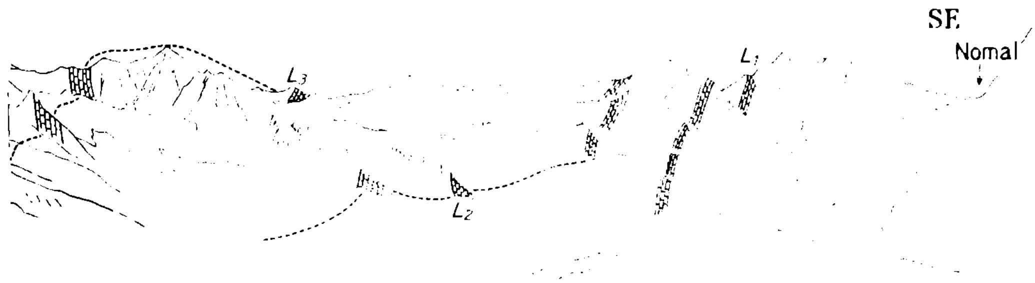
At the immediately north of Phakor, the colour of rocks changes from black to green. Alternations of green schists, black schists and limestones continue up to the north of Mayun. They certainly belong to the Green series. Almost vertical cliffs of the right bank of the Ishkuman river between Chatorkhand and Mayun clearly exhibit the details of the folding structure. Photo. 3-3 shows a typical closed syncline exposed at the south of Dain. The series is not really so thick as it appears to be.

A thick limestone bed crosses the river at the immediately south of Mayun, dipping about 80° to the north. A reddish bed could be recognized on the southern cliff of the Shahchoi Gah. It appeared to be very similar to the reddish sandstone belonging to the Yasin group although it was only a distant view. From Mayun to the mouth of the Ishkuman river, the Green series composed of alternations of green schists and thin crystalline limestones runs in WNW-ESE direction and is intruded by diorite or gabbroic rocks especially in the basin the of junction of the Gilgit and the Ishkuman rivers. IVANAC supposed that the Darkot group thrusts up against the Green series along the northern bank of the Gilgit river. So far as the writer observed, however, such a thrust fault could not be recognized. It is not inevitable to draw a probable thrust fault at the position suggested by him.

IV. Correlation between Ishkuman and Yasin sections

There are some similarities and differencies between the geological profiles of the Yasin and the Ishkuman rivers as described in the previous articles.

Generally speaking, all formations exposed in the Ishkuman section are considered to have been suffered from higher grade of metamorphism than those of the Yasin, so it is not easy to correlate them only by lithologic facies. The fossiliferous Yasin group does not yet find out not only in the Ishkuman section but in others of the more east. Moreover, two plutonic rock bodies are exposed in the northern part of the Yasin section separated by the thick Darkot group; the granite of the Darkot Pass and that of the south of Darkot village. Which corresponds to the



granite of the Karambar area in the Ishkuman section?

The observations along the route from Ishkuman to Darkot over the Ishkuman Aghost (Pass) will offer an answer for this problem. As already stated, the writer paid his attention to a thick crystalline limestone bed occupying the northern part of the zone of phyllite near Imit. This limestone bed was found out at first in the Bajigaz Gol making a large wall along the northern side of it. A limestone bed making the almost vertical cliff of the western side of the junction of the Karambar valley and the Baru Gah was undoubtedly regarded as the same as that of Bajigas.

We left Imit on 5th November and proceeded to the Ishkuman Pass. The village of Ishkuman is on the river terrace about 50 m higher than the river bed of Baru Gah. A large number of blocks of auto-brecciated limestones were found around the camp site, which might have been derived from the southern mountains of Ishkuman village. Outcrops of granite appeared at a little westwards from Ishkuman village. They show partly gneissose structure striking 70° northwest. This granite mass continued up to Handis, a small summer village situated at the junction of the Baru Gah and the Manthabtir Gah.

According to a distant view from Handis to the east, the peak of 5907 m high rising at the north of Imit was certainly considered to be composed of granitic rocks judging from the characteristic mountain shape controlled by joint system.

The boundary between the granite and the sedimentary group could be confirmed at a small outcrop of the southern bank of the Baru Gah. Although the boundary surface is well defined, it has not been faulted (Fig. 3-10). The black schists intruded by granite dip 80°-90° to the south and stretch northwestwards.

From Handis to the upper stream, the above mentioned sequence could be recognized as shown in the route map of Fig. 3-11. Among them, the limestone bed dipping steeply builts a great wall along the the northern side of the Baru Gah, and a large amount of blocks derived from the wall form taluses of big scale on the foot of the mountain slope (Photo.3-4). The wall extends almost westwards matching to the direction of the valley and can be certainly traced up to Holojut

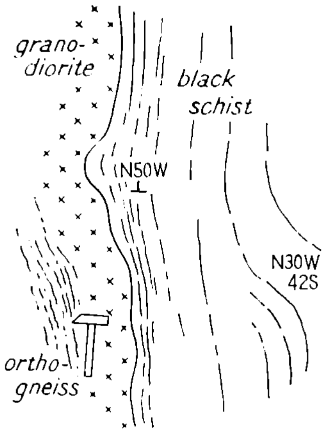


Fig. 3-10. An outcrop showing the boundary of the granite and the sedimentary group at Handis in Ishkuman area.

Black phyllite
White crystalline limestone
Black phyllite
Green schist
Black phyllite

basin, where may be the remnant of a glacial lake.

The panoramic view from Galtir to the west was sketched as shown in Fig. 3-12. The extension of the above stated limestone wall can be seen near the top of the mountain of the right corner. All strata dip to the north in this part, but those consisting the mountains on the right bank of the valley dip to the southwest. A large anticline can be recognized.

The crossing of the Ishkuman Pass was very hard disturbed by unexpected new snow-fall earlier than usual year. The area of the upper part of the valley than Holcjut had been covered by so heavy snow that the detailed observation was hardly possible. The uppermost part of the valley turns to the northwest at Holojut, and the limestone appeares at the top of the Pass striking also to the northwest. Although this limestone is separated from that of Holojut by a cirque-like snow-field, it is believed that the limestone bed gradually swings its strike to the northwest contrary to what we had expected. The change of the direction of the valley at this point seems to be controlled by such a geologic structure.

Moreover, at Hap, a small summer village at the northern foot of the pass, the writer found that the strata of this area have also the same trend as that at the top of the Ishkuman Pass. The limestone which seemed to be the extension of the above-cited one could be seen running at the immediately northeast of Hap.

It is noticeable that along the route of the Ishkuman Pass there is no evidence of the existence of the granite which is considered as the eastern stretch of the granite exposed at the south of Darkot.

In Fig. 3-12, we can recognize a fault along the southern wing of the sup-

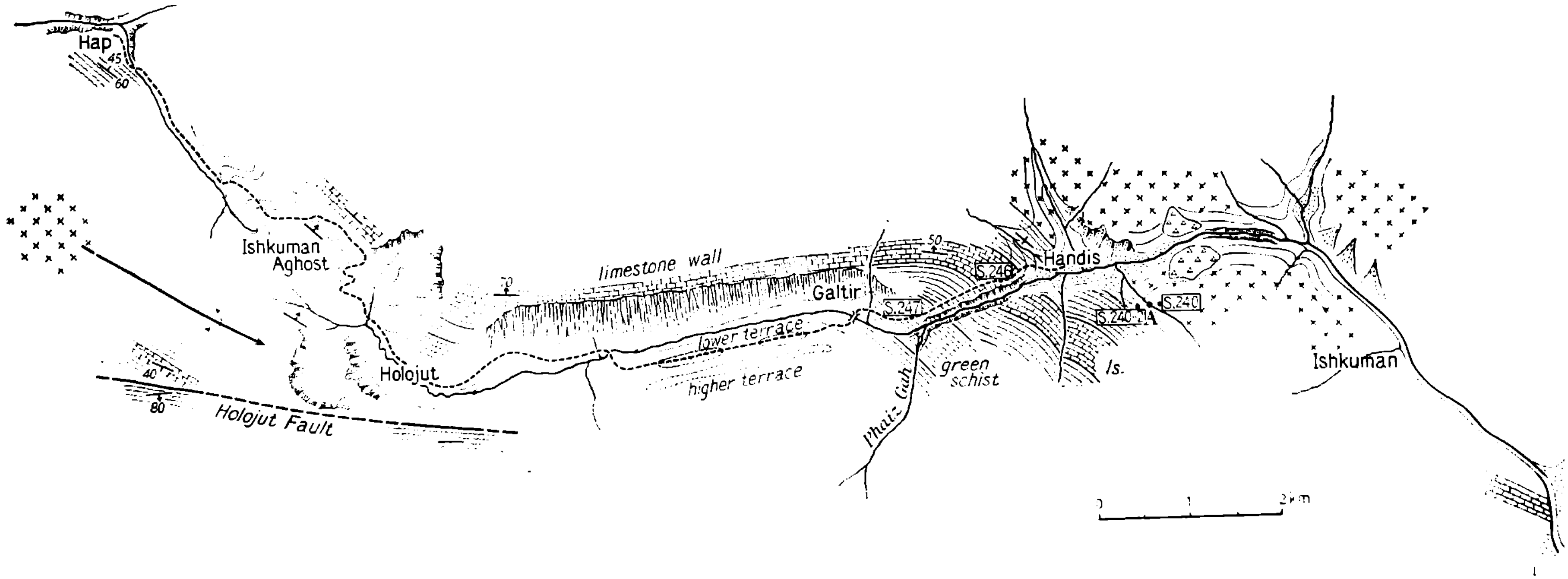


Fig. 3-11. Route map from Ishkuman to Hap. Point A is an outcrop shown in Fig. 3-10.

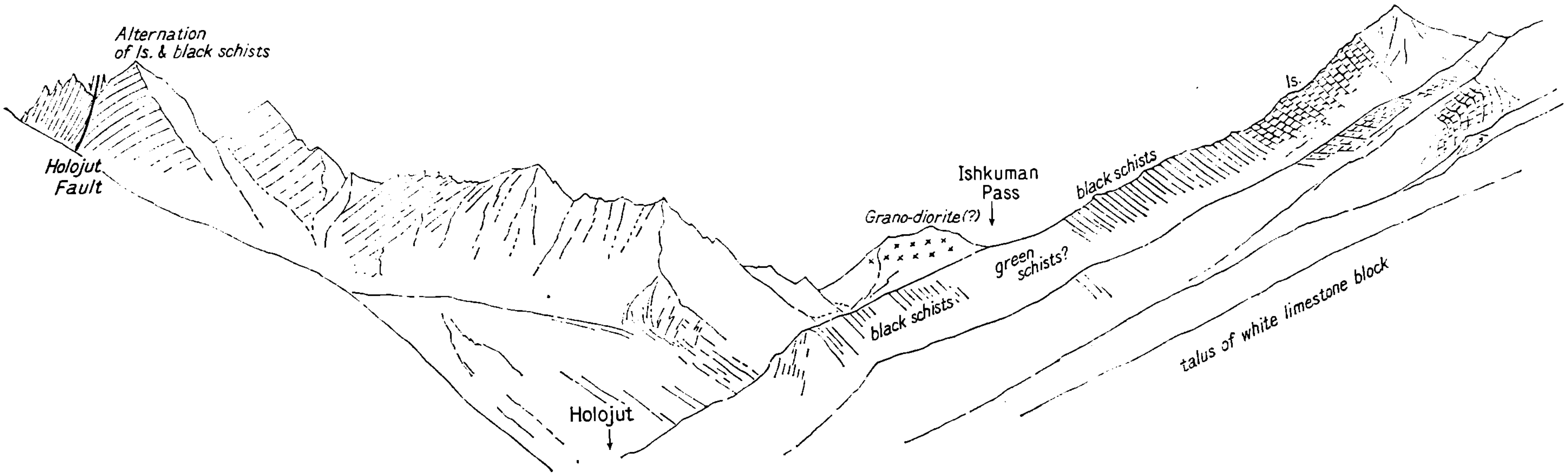


Fig. 3-12. The Ishkaman Pass as seen from the east. A large anticline can be recognized.

posed anticline. This Holojut fault may run from east to west, and is considered to cut the southern boundary of the granite mass in the section of the Yasin river.

Although IVANAC and others suggested in their geological map that the granite of Karambar area continues directly to that of the south of Darkot they did not confirm such a relation. Considering above stated observations, the writer interpretes the structure of this area as follow. The granite of the south of Darkot has intruded synkinematically along the axis of the large anticline of the Darkot group, and disappeares near the Ishkuman Pass as the anticline pitches to the east. This may be one of the reason why the Holojut fault becomes obscure to the east. The Karambar granodiorite probably extends to the "Darkot Pass granodiorite". From Handis to the north through Mahthartir Gah, we got a splendid distant view of snowy rugged peaks more than 6,000 m high belonging to the Hindu Raji range. They were infered to be composed of granitic rocks judging from their characteristic features. This batholith may extend to the Baltro Galcier area and then far to the Trans-himalaya range in Tibetan plateau as DAINELLI has suggested.

The panoramic view of the east from the top of Taus Tik peak has given us a concept of the general tendency of the geological structure of the Asambar mountain area occupying between the Ishkuman and the Yasin rivers. As shown in Fig. 3-16, the Holojut fault which was described in the previous chapter can be seen in the innermost part of a branch of the Garmast Bar. This fault may run between the granite and the Darkot group near Barkulti. To the south from the Holojut fault, the Darkot group generally dips to the south though almost vertical. The steep cliff of the more east, however, shows a good exposure of the Yasin group which is overturned near the top of the peak. The western slope of the Asambar mountain also exhibits very complicated folding. It is considered to be a local disturvance occurred by the gravitational gliding in the southern wing of the large anticline, along the axis of which the Darkot granite might have intruded.

As far as we could see, the reddish conglomeratic key beds inserted in the Darkot group runs northeastwards, but the reddish or purple coloured sandstone of the Green series running almost vertically in the middle part of the sketch extends along the northern side of the Asam Bar valley and gently turns to the east. The Asambar peak is considered to be just situated on the turning-point that the general strike of all formations of this area change from the Karakoram-direction to the Hindu Kush-direction.

Compared with the Yasin river section, metamorphic effects so increse in the Ishkuman river section that it is difficult to correlate both sections in details in such a extensive survey. The green rocks with many limestone beds exposed between Mayun and Gakuch, however, are certainly the same horizon as those distributed around Gupis, so far as we traced them along the Ghizar river.

A reddish bed seen near the mouth of Shachai Gah is noticeable. Although we could not confirm, this is a only horizon that the Yasin group can be expected to be found in the section of the Ishkuman river. From here to the north, green rocks repeat isoclinal folding as shown in Photo 3-3. The axis of this folding may coincide with that of the overfolding near Yasin considering the syntaxial bent in the Asambar area. Between Imit and Phakor thick phyllites are predominant. This part may be identical with the southern wing of the Darkot group in the Yasin section.

V. The relationship between the Darkot group and the Green series observed in the Phakor valley.

When we came down from the Naltar Pass and arrived at Krui Bhurt, we were surprized to see a quite different type of rocks cropping out along the northern ridge of the Phakor valley as shown in Photo. 3-8. The upper half of the watershed between the Phakor Gol and the Bajigaz Gol was occupied by black stratified rocks which look almost horizontal although the country rocks dip steeply. Such outcrops were considered to suggest us the existence of a low-anlge thrust or the unconformity at the bottom of these black rocks.

The writer and K.Honda climbed up the slope of the opposite side of Krui Bhurt and could confirm the following facts:

1) The black rocks are the soptted phyllites which are described as the sample No. 219 in J.KOJIMA's report.

2) Most dominant surfaces dip about 20° SE and strike N 80 E. Such planes are the schistosity planes. The original bedding planes are considered to be almost vertical because the fine alternations of comparatively coarse-graind part and muddy parts can be recognized as shown in Fig. 3-13.

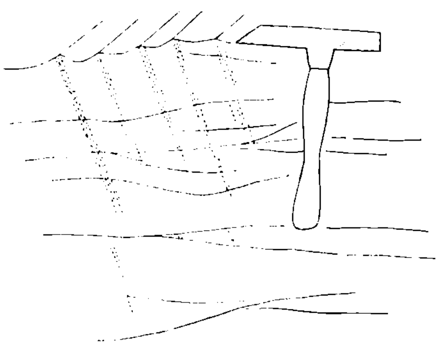


Fig. 3-13. A sketch of the black phyllite of the Phakor valley.

3) Even in the lower half of mountain slope, the rock wall is characterized by the intercalation of many lenticular black phyllites same as the upper half.

Such observations mean that the difference of the apparent structure is regarded as only a phenomeneon presented by the difference of the predominant schistocity planes which might bo due to the heterogenuity of rocks.

The formation including such black phyllites, however, is somewhat different from the green rocks with a few limestone beds occurred in the south of the valley. A fault may run between them almost coincided with the valley. From the structural point of view or considering the grade of metamorphism, the black formation certainly belongs to the Darkot group. Many large blocks of conglomerate have been washed out from the northern branch near Gujran Shar and the writer also could confirm a small outcrop of a conglomerate bed near Krui Bhurt. These conglomerates are very similar to those of Bajigaz Gol or Baru Gah. The green rocks of the southern side belong to the Green series undoubtedly.

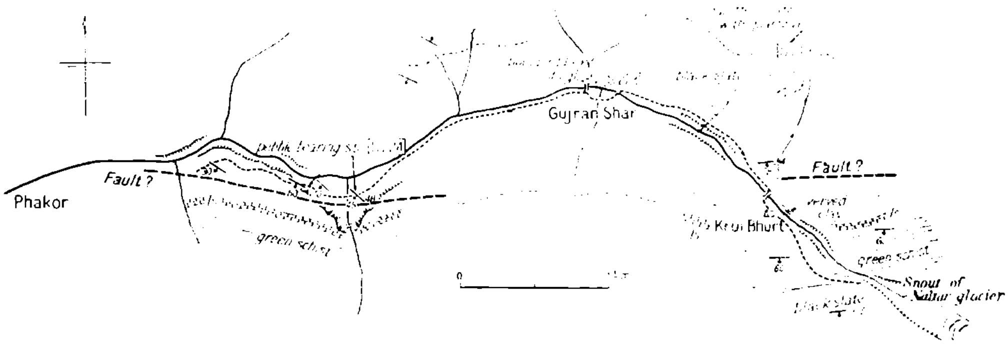


Fig. 3-14. Route map of the Phakor Gol.

VI. Observations along the Gilgit river and the Naltar Gah.

Along the Ghizar and the Gilgit rivers, we could examine many good exposures showing the relationship between the Green series and the granitic rocks. Generally speaking, these rivers almost coincide with the trend of the Green series, which has been disturved by intrusion or penetration of the granitic rocks everywhere all the way from Gilgit to Gupis. IVANAC has named these granitic rocks as the "Ladakh Granodiorite". According to the writer's observation, however, it may be reasonable to divide these granitic rocks into two divisions. The one is the granite widely exposed along the Ghizar river and another is the gneiss developing around Gilgit and in the Naltar Valley.

The Green series of this area is composed of green schists, which may have been originated in tuffs of basic volcanics, amphibolites and crystalline limestones. It is occasionally characterized by fine alternations of green schists and crystalline limestones, which are partly minor-folded especially near Hopar situated between Gakuch and Gupis. Around Hakis, about 5 km downwards from Gupis, we could see a large fresh cutting for the construction of the foundation of a hanging bridge. As shown in Photo, 3-9, limestone and green rock are intermingled in such a manner as to form a rock resembling a calcareous conglomerate, which is presumably autoclastic origin and may show the disturbance of the invasion of the granite batholith.

As far we went up the Baru Gah, a branch flowing into the Ghizar river from the south at Gupis, the Ghizar granite exposes up to the middle part of the valley at least. The mountain terrain between the Ghizar river and the main river of Indus is inferred to be chiefly composed of this granite. The Gizar valley is regared as the northern marginal zone of this granite batholith.

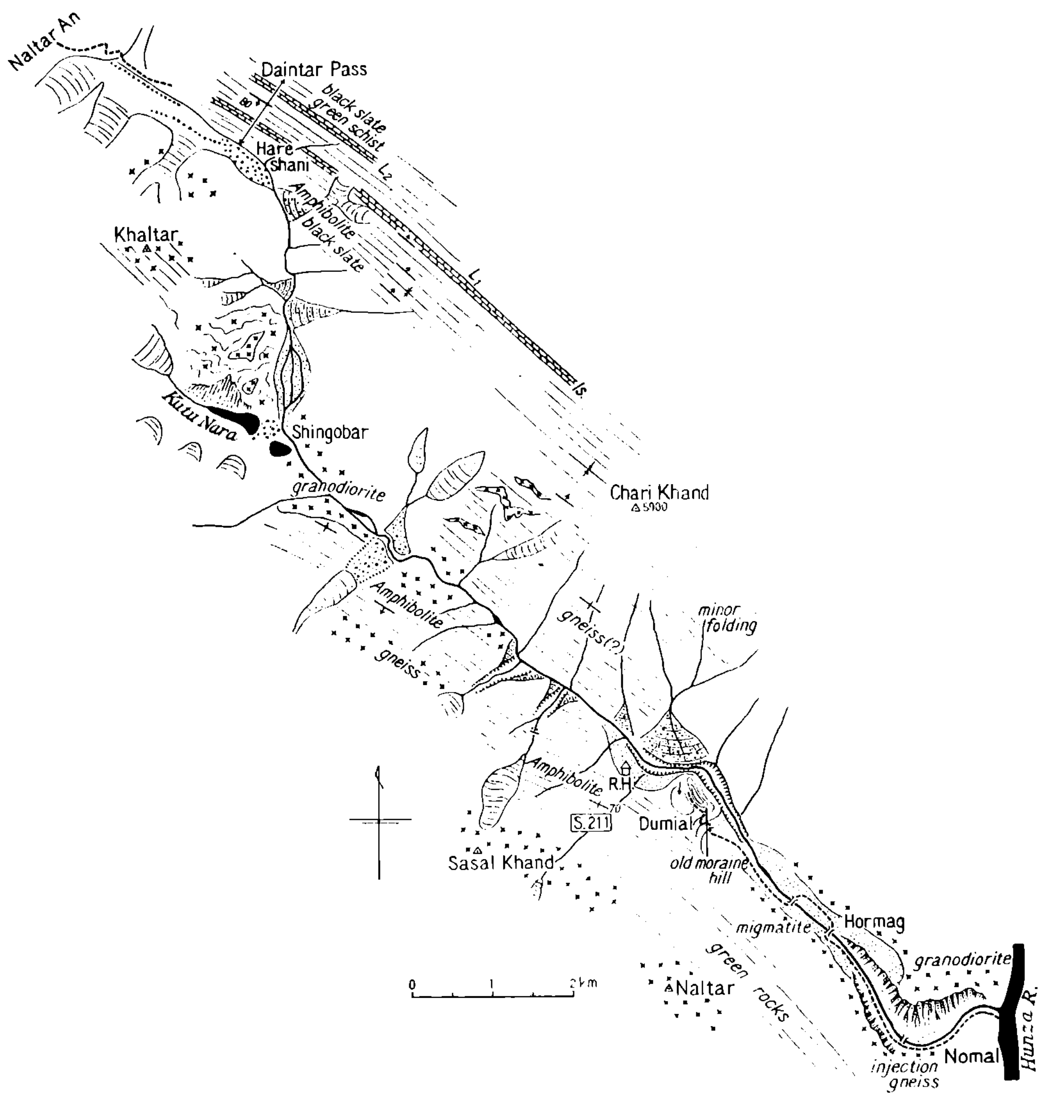


Fig. 3-15. Sketch map of the Naltar Valley.

The relationship between the Green series and th Ghizar granite can be examined all the way from Gupis to Gakuch. On the cliff of the immediately south of Gupis, a large laccolith of granite could be seen clearly (Photo. 3-10).

At many locations from Hakis to Hopar, the Green series has been intruded by the Ghizar granite. The contact effect of the granite to the country rocks is very poor. Near Hopar, the writer could see continuous section, in which angualr xenolithes of the country rock gradually increase as approach to the green rock wall and the front of the granite becomes dyke or vein shape (Photo.3-11). The sharply defined contact planes were also observed in many places.

As for the Ghizar granite, it is generally medium-grained, partly foliated but looks very young in age. From Hopar it changes gradually its facies, however, to dioritic and then to gabbroic. The plutonic rock exposed at the opposite bank of Gakuch can be defined as Gabbro (Sample No. 305).

The granite mass similar to that of Gupis reappears at the west of Gilgit. On the other hand, the environs of the Gilgit town are composed of gneiss penetrated by numerous pegmatite veins, which extends towards the western border of the dome of Nanga Parbat crossing the Indus valley. There are many opinions on the age of so-called "Gilgit gneiss" including such rocks as referred in KOJIMA's report.

What is the relation between the Gilgit gneiss and the Ghizar granite? The writer could find an outcrop near the Basinpar Bala village, west of Gilgit. It indicates that the Ghizar granite has injected to the Gilgit gneiss. Such a relation can also be inferred from the survey of the Naltar vally, which suggests that the gneiss or migmatite of this valley had originated in the Green series and then has been intruded by the granite resembling to the Ghizar granite. It is probable that some parts of the "Gilgit gneiss," at least, has been formed in post-Green-series and in pre-Ghizer-granite.

Photo. 3-1. A peak composed of the Yasin group seen from Taus Tik peak near Yasin.

Photo. 3-2. Yasin basin seen from the southern slope of Taus Tik peak.
(Photo. by K. HONDA)

Photo. 3-3. A syncline exposed at the immediately south of Phakor, Ishkuman river.

Photo. 3-4. The limestone-wall extending along the northern bank of the Baru Gah.

Photo 3-5. Granite mountains of the Hindu Raji range as seen from Handis.

Photo. 3-6. A telescopic photo of Mt. Asambar taken from the top of Taus Tik near Yasin.

Photo. 3-7. Black phyllite belonging to the Darkot group exposed at the south of Imit.

Photo. 3-8. The watershed between the Phakor valley and the Bajigaz Gol, viewed from Kurui Bhurt. (Photo. by K. YOSHIBA)

Photo. 3-9. A facies of limestone of the Green series observed near Hakis. White parts are calcareous.

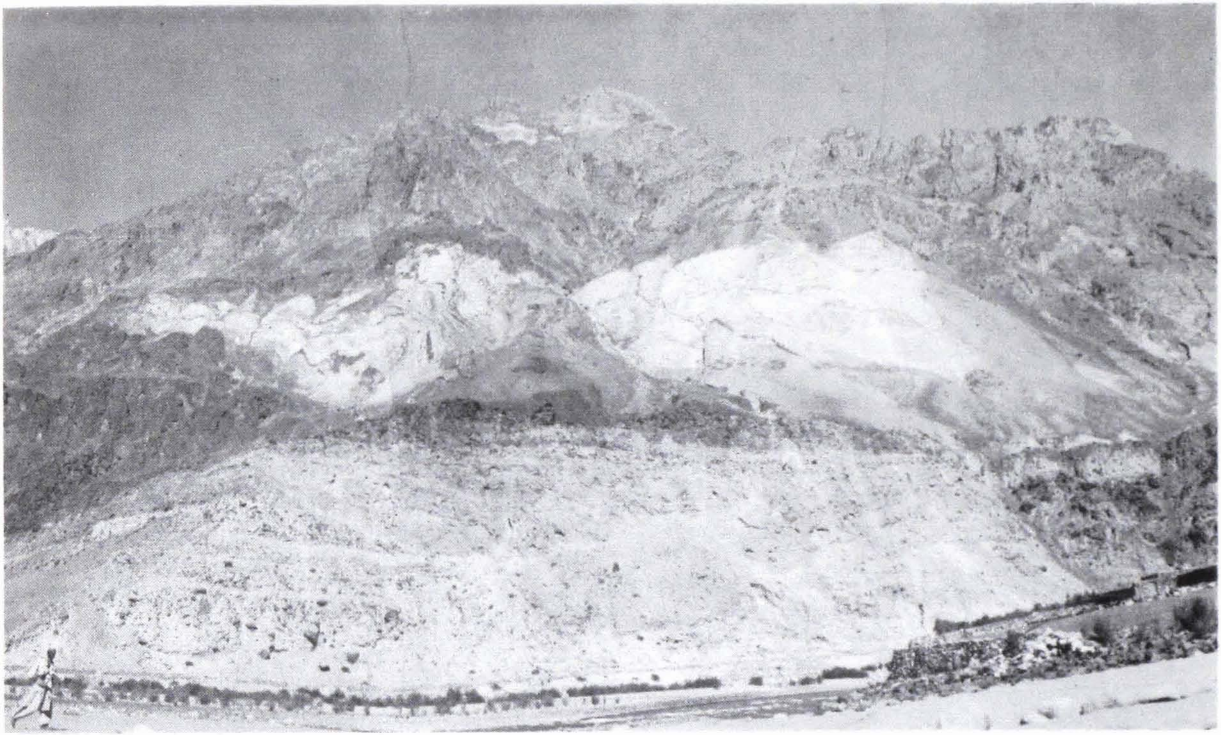


Photo. 3-10. A large laccolith exposed near Gupis.

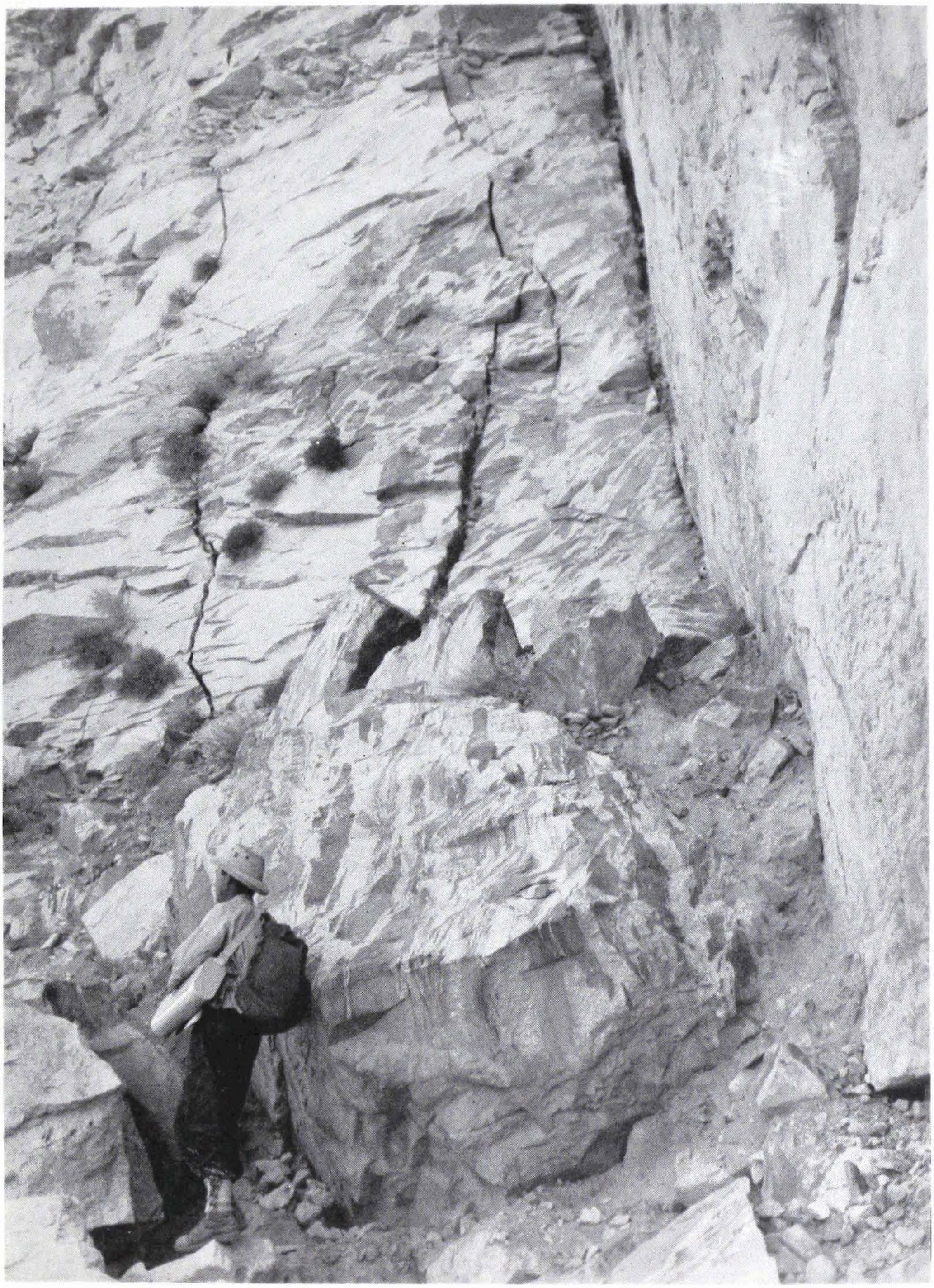
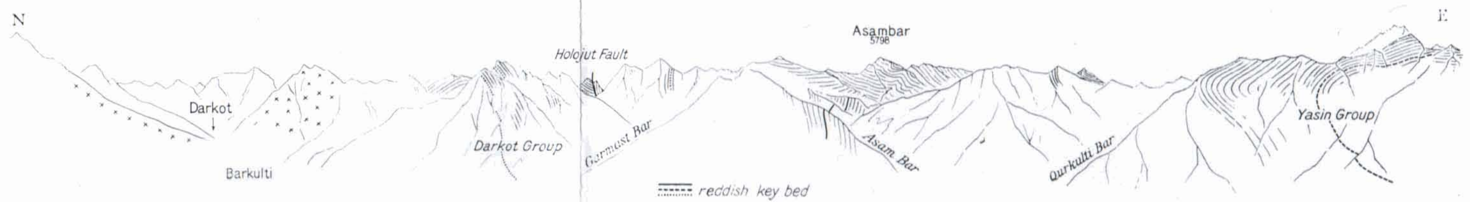


Photo. 3-11. An outcrop showing the intrusion of Ghizar granite to the Green series near Hopar.

Photo. 3-12. Panoramic view from the top of Taus Tik peak (4075 m), immediately north of Yasin.

Fig. 3-16.



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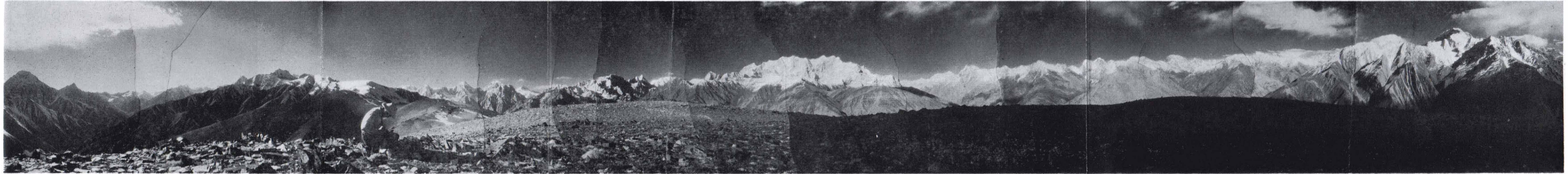

4. Geological Research in the Upper Swāt and the Eastern Hindu Kush

By Susumu MATSUSHITA

As mentioned in the Preface, in the Second Panjab-Kyoto University Joint Expedition 1957, the senior writer Susumu MATSUSHITA carried out a reconnaissance on foot along the following route, namely Kalām (2,100m high above sea level)-Dadarili pass (5, 060m)-Ghizar (2,900)-Gupis (2,020 m)-Yasin (2,400 m)-Naz Bar pass (4,977 m)-Zagar pass (5,009 m)-Mastuj (2,280 m).

The present Chapter is divided into the following two parts: In part 1 shall be described the writer's geological observation along the route of journey, while the writer's geological research shall be stated synthetically in Part 2.

Part 1. Geological Observation along the Route of Journey

In his field work, the writer prepared simple topographical and geological maps in a scale of about 1:35,000∼50,000 by compass and pace method.

The Swāt State, though belonging to Pakistan, is a semi-independent state ruled by the Wali of Swāt with an area and population of 10,000km and 570,000 respectively. The State is elongated in the north and south direction and is chiefly drained by River Swāt flowing southward. The Upper Swāt is a high mountainland with many snow-clad alpine peaks over 5,500 m above sea level. Swāt Kohistan, the northern part of the Upper Swāt with the administrative centre at Kalām is a higher mountainland with small glaciers and various relics of Pleistocene glaciation.

Before starting from Kalām for Ghizar, the writer made some geological excursions in the neighbourhood of Kalām and just near Bahrain, a village with another administrative centre about 45 km south of Kalām.

Kalām Basin. Kalām is situated on the bottom of an intermontane basin 10km long from the northeast to southwest and 2.5 km wide from the northwest to southeast. On either or one side of River Swāt and that of its tributaries there are developed several terraces, namely Terrace I 250-300m high above river bottom, II 80-100m, IV 20-25m, V 10m. All of them are gravel terraces compsoed of rounded boulders or cobbles of granite, quartz-diorite, sandstone etc. The terrace III on the right bank of River Swāt as well as of River Gabrāl with a width of 2km and a length of 4 km is the broadest. It is for the most part a flat or gentle-slope grass land except the portion near the westernm ountain foowheret the land is cultivated and small villages are scattered. On the east part of the terrace III under consideration stand the administrative office, old fortress, primary school, dispensary and resthouse, while old Kalām with a few houses lies on the left bank of River Gabral which joins River Ushū Gol at a place about 1000m downstream. The water of these rivers is very clear and ample. (See Fig. 4-1 and 4-2).

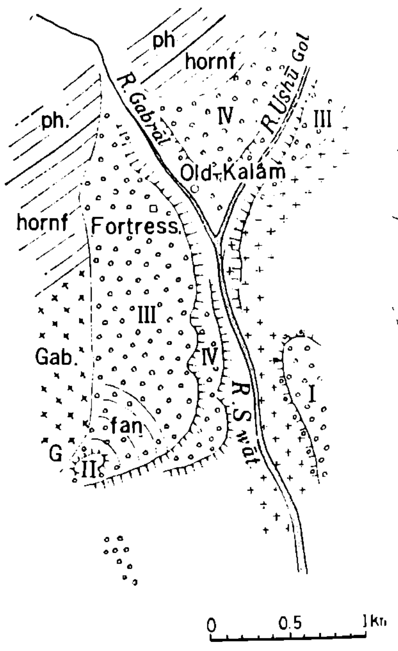

Fig. 4-1

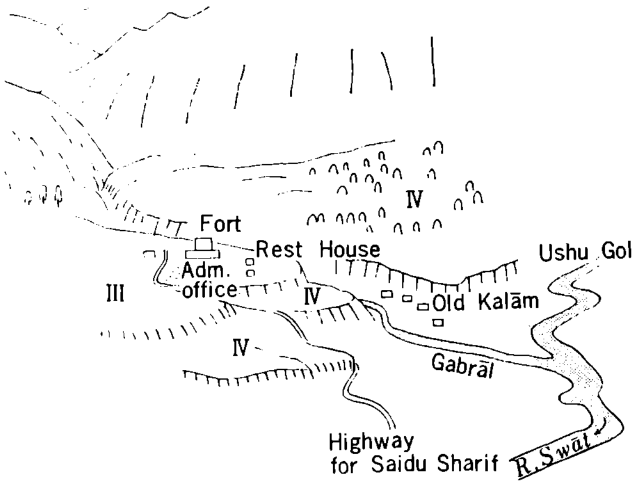

Fig. 4-2

Fig. 4-1. Idealized map of the Kalām Basin showing the distribution of terraces.
Fig. 4-2. Topography of Kalām and its vicinity as seen from the south.

The mountains surrounding the Kalām basin is composed of light greenish phyllite with a strike of NE-SE and a NW dip on the northwest side, underlying hornfels or quartzite on the west and north sides, intruding gabbφro on the southwest side and biotite-granite or biotite-hornblende-granite on the south, southeast and northeast sides. (See Fig. 4-1).

The mountains on both sides of River Swāt between Kalām and Bahrain seem to be composed of granite. The writer has confirmed the outorop of hornblende-granite-gneiss or gneissose hounblende-gneiss on the left bank of River Swāt at Bahrain.

From Kalām to Ghizar. (See skech maps). On July 18, the expedition party left Kalām for Ghizar and arrived at Paloga near the village of Ishgal. (see Fig. 4-3) The distance between Kalām and Paloga is 22 km, and the altitude of Paloga is 2,475 m. On both sides of River Ushū Gol near Kalām are developed fluvial terraces,

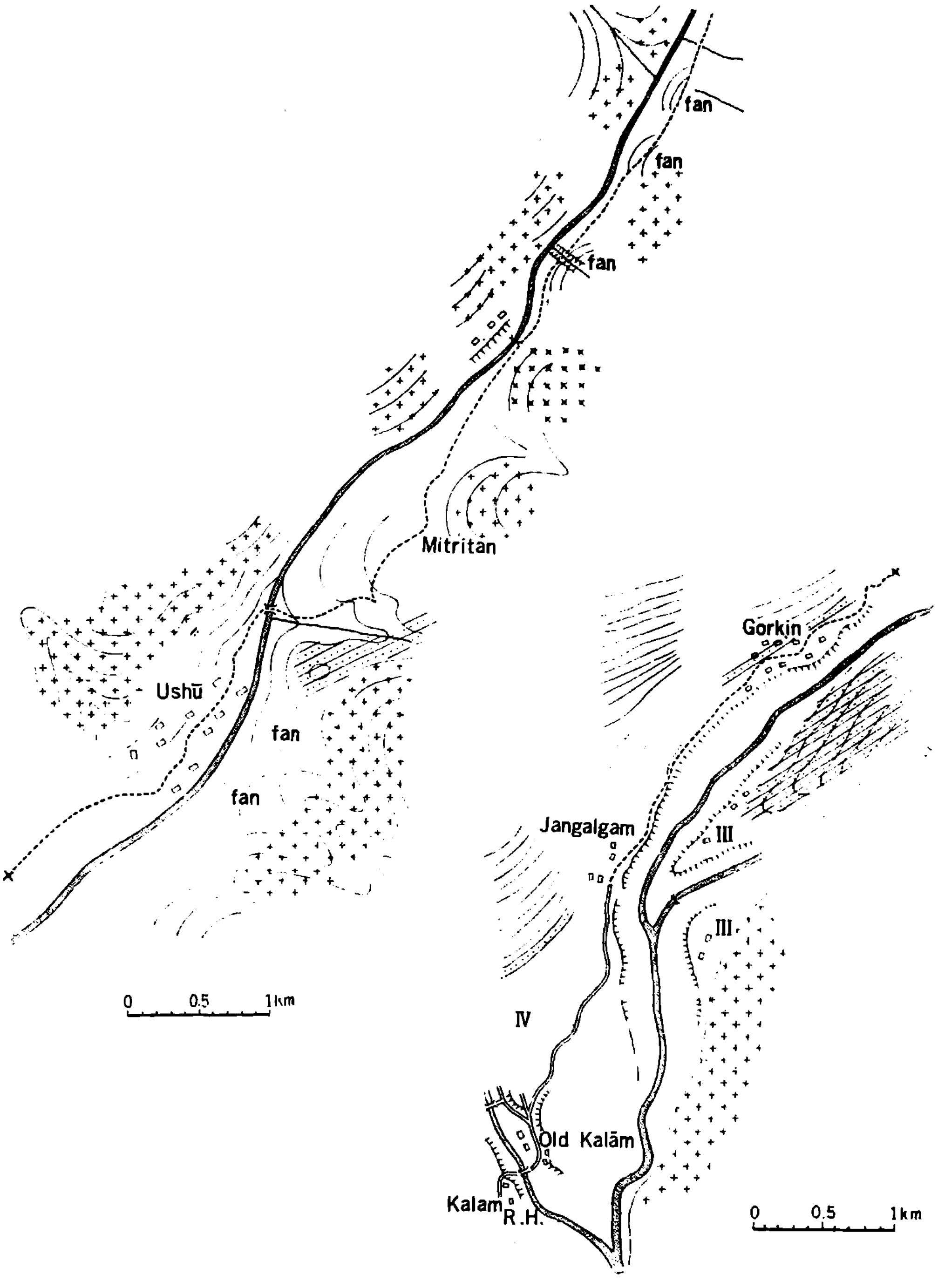

Fig. 4-3. Sketch map from Kalām to Paloga. July 18, 1957.

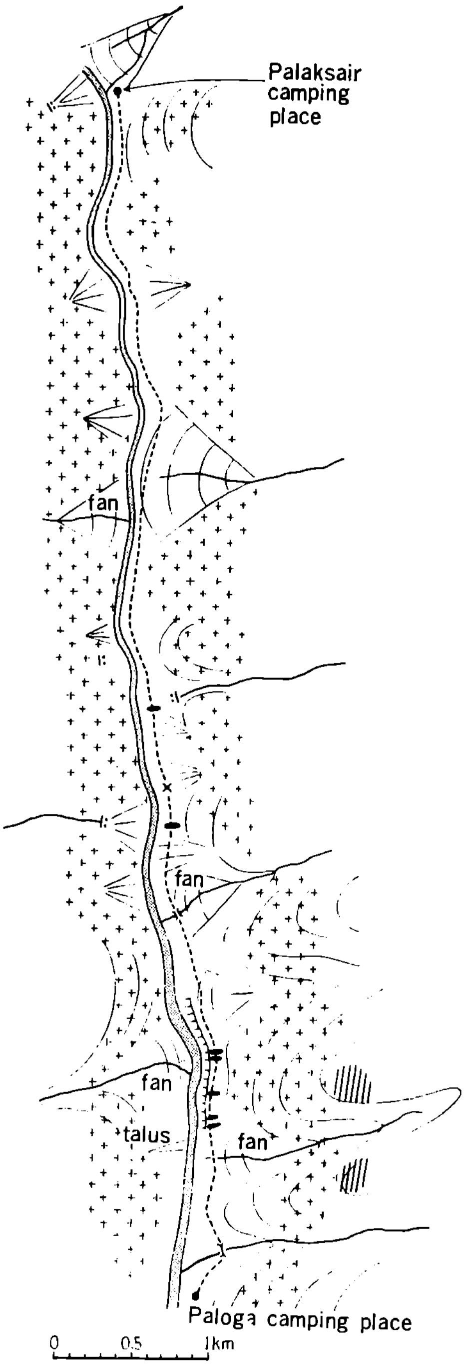

Fig. 4-4. Sketch map from Paloga camp to Palaksair camp. July 19, 1957.

That on the right bank of the river is a terrace IV, 20-30 m high above river bed and 50-500 m wide. It is forested in the immediate northeast of old Kalām and is cultivated and inhabited at the villages of Jangalgam and Gorkin. The mountain northwest of the terrace mentioned above seems to be composed of phyllite, the lowest part of the mountain consisting of hornfels bed cropping out at Gorkin with a strike of N70°W and dip of 70°SSW. That the hill on the left side of River Ushū Gol is also composed of hornfels bed dipping southwest is seen from Gorkin. Since the hornfels bed is overlain conformably by phyllite dipping northwest at 50° at the mountain foot west of Kalām, a fault is inferred from the facts mentioned above to exist from northeast to southwest at Gorkin, separating hornfels bed from phyllite bed.

Taking palce of phyllite, granite begins to compose the mountain on the right bank of Ushū Gol at Ushū. The mountains on the opposite side of Ushū Gol seem to consist of granite as well.

About 14 km upstream lies the big village of Mitritan on a terrace III on the left bank of Ushū Gol. The terrace, 450 m long and 300 m broad, is also a gravel terrace, consisting of angular or subangnalr boulder or cobble of hornfels and granite.

Up Mitritan there are few terraces and there are only a few small villages standing on a narrow terrace and small alluvial fans at the junction of the tributaries and the main stream.

From Mitritan as far as Paloga for about 8 km we proceeded on the left bank of Ushū Gol. Though there is a narrow terrace on the opposite side, there is no terrace on this side. We crossed several alluvial fans. The writer has learned by the outcrop and the rock fragments from a fan or talus that the higher part of the mountain on the left bank is composed of hornfels or phyllite, while its lower part is of largely granite and partly quartz-diorite.

On July 19, we proceeded from Paloga to Palaksair. (See Fig. 4-4). The The distance between the two places is 8.5km and the altitude of Palaksair is 2,675m. There is no terrace. Most tributaries join the main stream, forming hanging valleys and water falls 80m high above the bottom of the main valley. Below every water fall is forming a talus. This valley must have been glaciated in the Pleistocene time.

The mountains on both sides of Ushū Gol is largely composed of granite, but

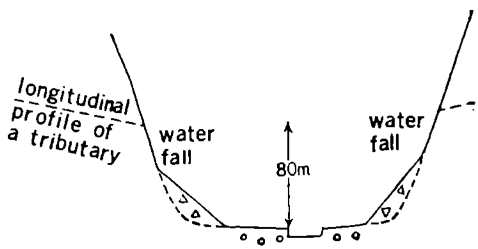

Fig. 4-5. Idealized section of the Ushū Gol Valley.

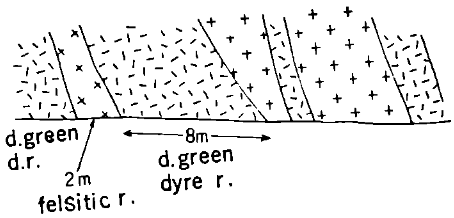

Fig. 4-6. Outcrop of granite with dykes. Besides some talcs-chist, sericite-quartz-schist and chlorite-schist crop out half way up the mountain near the village of Ishgal.

the writer has observed many outcrops of dark green compact dyke rocks cutting granite. The dykes have a width of 1.6-20m. The granite is cut by aplite or pegmatite as well.

On July 21, we proceeded from Palaksair to Deshai. (See Fig. 4-7). The distance 8.5 km, altitude of Deshai 3,020m. The glacial topography such as U-shaped valley and hanging valley with water fall becomes more marked. A higher water fall, 200m high, has been observed on the right side of Ushū Gol. The river bed of Ushū Gol shows change in its gradient at four places between Palaksair and Deshai. (See Fig. 4-7). Where the gradient is reverse or horizontal, the water is dammed up or has been dammed up before and afterwards has drained. A small lake called Mahodand with a length of 1 km and a maximum width of 300m is the largest water. Of the four cases of the gradient change under consideration, only one case is due to an end moraine of a glacier, the other cases being the result of excessive development of alluvial fans or taluses. The uppermost step is of the former case and lies 500m downstream the Deshai camping place.

The geology of the mountains on both sides of Ushū Gol is hornblende-granite and gneissose granite and is associated with dark green intrusive rock. According to my student Mr. F. OKITSU who made an observation at an otucrop 1.5 km north-west of Palaksair camp and 120m above the bed of Ushū Gol on the left bank, the sequence of the formation of rocks is as follows, i. e. 1) gneiss, 2) dark greenish grey fine-grained dyke rock and 3) hornblende-granite.

On the other hand, according to the writer's observation from this side of a large exposure of gneissic rock on the opposite side and 600m below Lake Mahodand, the attitude of foliation plane of gneiss is N 40 E and 65°NW.

There is no permanent village above Palaksair in the valley of Ushū Gol, though we saw here and there summer huts for pasturing tribesmen.

On July 22, we walked from Deshai to Diwangar. (See Fig. 4-9). The distance between the two camping places is 6.5 km, the altitude of the Diwangar camping place being 3,350 m. The topography observed on this day is almost the same as

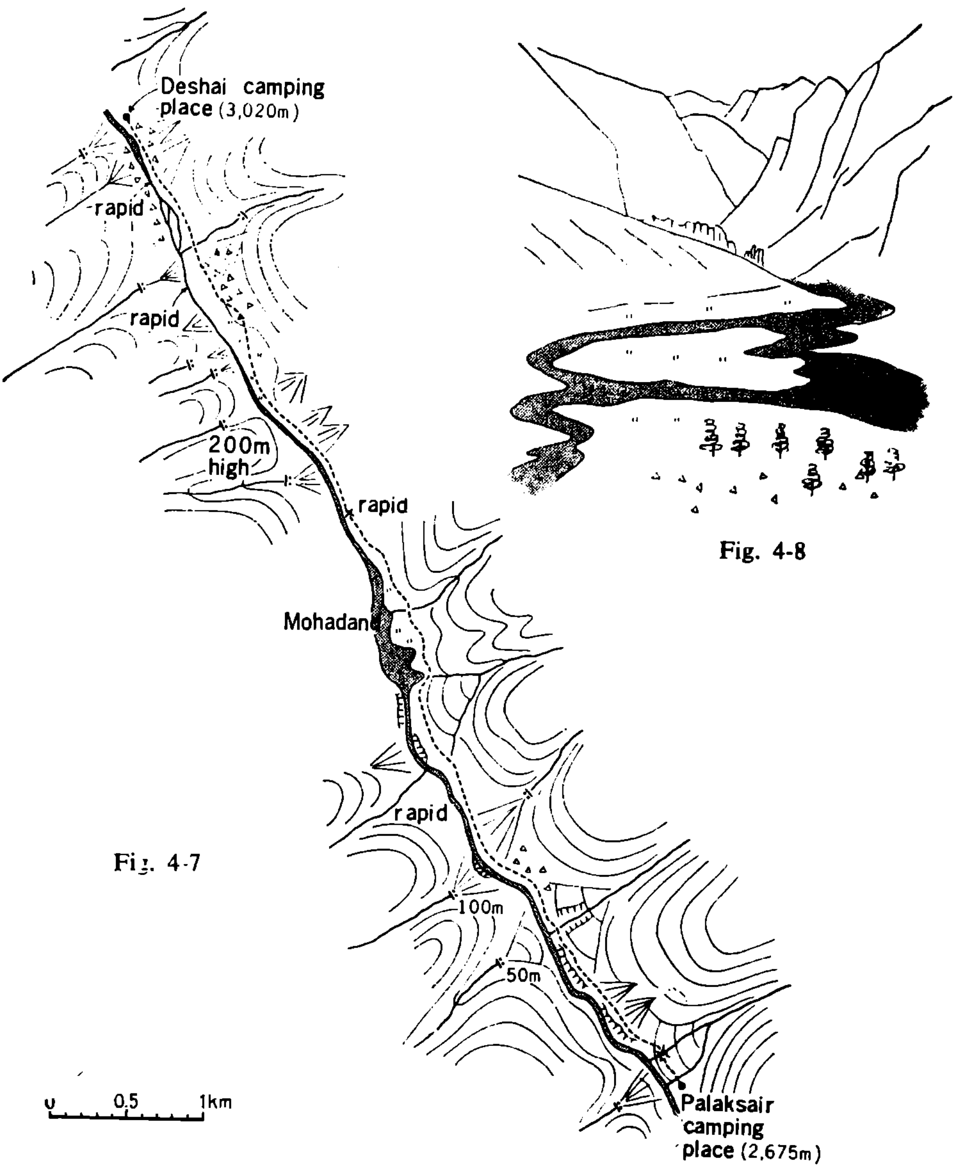

Fig. 4-7

Fig. 4-8

Fig. 4-7. Sketch map between Palaksair and Deshai. July 21, 1957.
Fig. 4-8. The upper valley of Ushu Gol as seen from a point 800 m SSE of the Deshai camping place toward downstream. July 21, 1957.

that on the preceding day, though between Deshai and Diwanger there is only one gradient change of the river bed that was caused by the excessive development of a talus. The river course of Ushū Gol changes its direction from the east-southeast to south at Diwangar, where a large tributary from the east joins the main stream, forming a large alluvial fan, 800 m long, 500 m wide and 150 m high, and branched rapids.

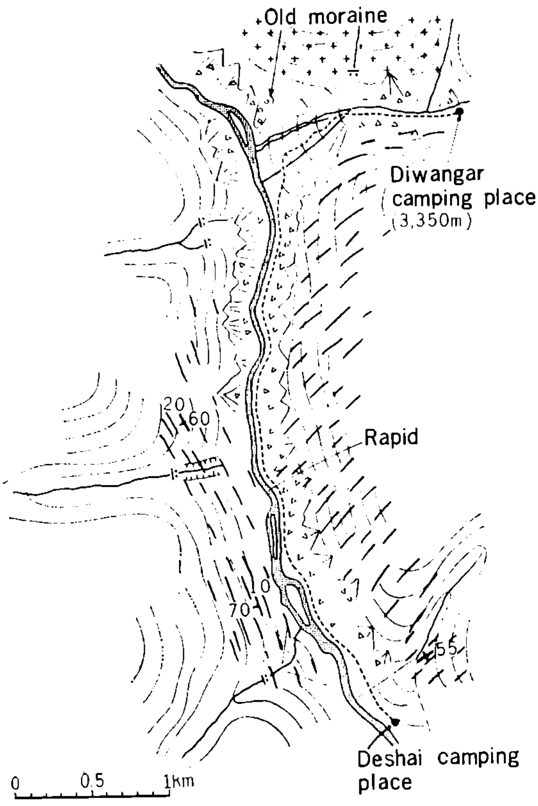

Fig. 4-9. Sketch map from Deshai to Diwangar.
July 22, 1957.

Our Diwangar camping place was set about 1.3 km above the confluence in the large Diwangar valley with a 250 m wide bottom into which a large talus, 250 m wide, 300 m long and 100 m high invades from the north. The writer could observe far from the Diwangar camping place a 250 m high terrace on the right bank of Ushū Gol and a few snow-covered cirques (relics of glaciers of horse-shoe type). The marked U-shaped valley of Ushū Gol above the Diwangar conflucence can be viewed from the Diwangar alluvial fan, though the form of the steep valley walls are modified at their foot to some extent by the talus deposits. (See Fig. 1 of the photograph pages.)

The mountains on both sides of Ushū Gol between the Deshai camp and the Diwangar confluence are composed of biotite-gneiss. At an outcrop of gneiss 500m northeast of the Deshai camp, the attitude of the foliation plane was measured at N 55° E and 90°, while on the right side of Ushū Gol were measured the foliation plane of gneiss at two large exposures at N 10° W, 70° WSW and N 20°W, 60°WSW respectively. At the former outcrop mentioned above, the gneiss is cut by a dyke, 35 cm wide and N 52°W and 22°SW, of fine-grained basic rock. The white precipitous mountain to the north of the Diwangar fan is surrounded by very steep rock cliff with no tree nor grass and shows many joints of various attitudes. This mountain consists of gneissose granite with abundant porphyroblasts of felspar. Thewriter observed on this day a fragment of ball granite on the way from Deshai camp to the Diwangar confluence.

On July 23 we ascended the Diwangar valley as far as 4,150 m high point on a moraine wall where we pitched tent. (See Fig. 4-10). The distance between the Diwangar camp and this fifth camp is 11 km.

There are three gradient changes of the river bed in this part of the Diwangar river. These have been caused mostly by the excessive development of talus. In the lowest case, a small shallow lake, 500 m long and 200 m wide in maximum, is preserved. A swamp as large as the small lake just mentioned is left behind it. Many moraine walls were observed on this day chiefly on the southern wall of the Diwangar valley and in the valley bottom. They may be classified as follows:

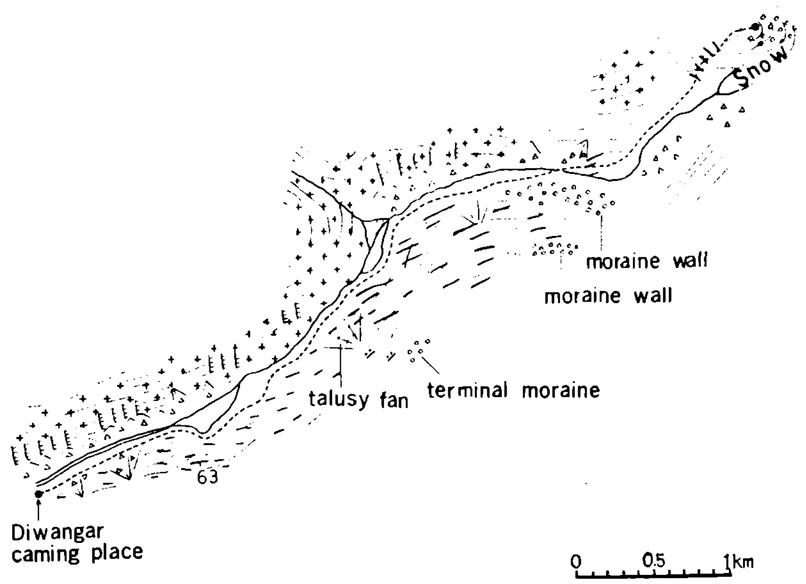

Fig. 4-10. Sketch map from Diwangar to 4,200 m high point. July 23, 1957.

1) terminal moraine belonging to an extinct glacier of horse-shoe type, on the south wall of the valley,
2) lateral moraine along the Diwangar valley on its south bank,
3) old terminal moraine in the Diwangar valley.

It is a charactersitic feature of the topography in this part of the Diwangar valley that the north wall is steeper than the south wall, forming precipitous cliffs in many places. The difference between both walls in the steepness is due to the difference in geology. The northern wall is mostly made up of whitish gneissose granite with numerous large porphyroblasts of felspar, while the south wall is composed of biotite-hornblende-gneiss with the foliation plane with an attitude of N 70°-90°E and 63°-70° S. There are many outcrops showing that the latter is cut by the former. The latter is also cut by irregularly shaped pegmatite.

On July 24, starting from the fifth camping place (4,150 m) early in the morning, we ascended the snowy valley northward, and crossing the Dadarili Pass (5,061 m), a pass in the east and west mountain range separating the arid Hindu Kush from the humid Upper Swāt, descended the northward valley as far as a point about 7 km south-southwest of Ambezh* where we set the sixth camp. (Figs. 4-12 and 4-13). The distance between the fifth and sixth camping places is 14 km, while the altitude of the latter is 3,510 m.

The fifth camping place is situated near the junction of the Diwangar river from the east with its large tributary from the the north. This snowy tributary that we ascended on the day in question and its vicinity are full of glacial topography, old and

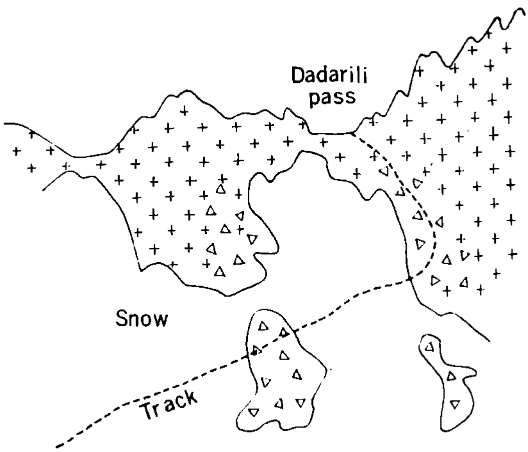

Fig. 4-11. Dadarili pass as seen from the south snowy valley. July 24, 1957.

young moraines and even living small glaciers. The snowy valley in question is the relic of an extinct glacier in which, though partly covered with snow on that day, three terminal moraines, two lateral moraines, one glacial lake and two hollows may de discriminated.

We could enjoy from the top of the Dadarili pass the magnifcient view of the many small living or extinct glaciers of horse-shoe type lying in a row near the top of the mountains on the east side of the snowny valley mentioned above as well as the west side of the northern valley. (See Fig. 2 of the photographic pages).

The 1 km long snowy valley starting from the pass northward is probably an extinct glacier covered with snow. At its former snout is formed 10 m high moraine

* A Kohistani word meaning the confluence. This place is not inhabited.

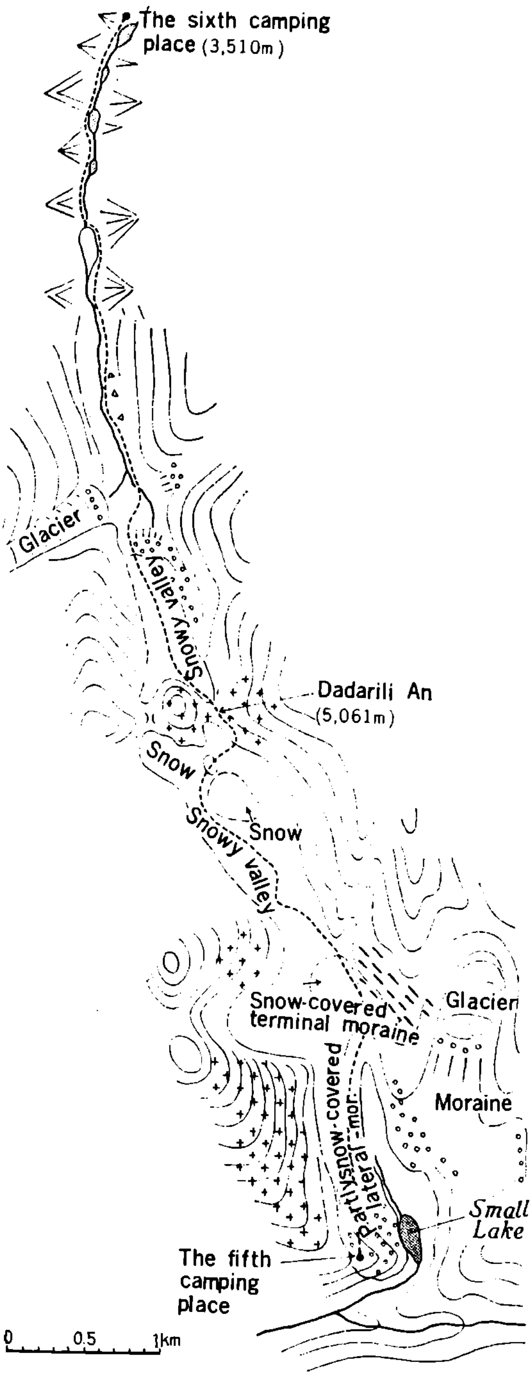

Fig. 4-12. Sketch map betwen the fifth and sixth camping places. July 24, 1957.

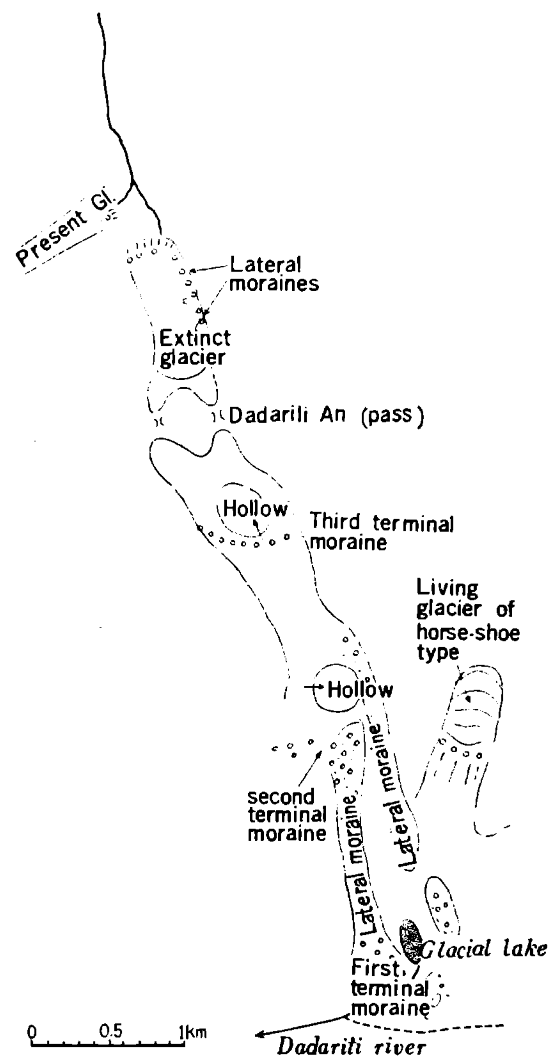

Fig. 4-13. Schetch map of the vicinity of the Dadirili pass. July 24, 1957.

wall. On the right side of the snowy valley, there are two rows of lateral moraine. Below the snout of the extinct glacier above mentioned two tributaries join the main stream from the east as well as the west. The west tributary comes from the moraine-covered snout of a living small glacier, while the east tributary originates from a moraine wall without living glacier.

Below this confluence there are several small* lakes in the northward valley. (See Fig.4-12.) It is apparent that they have been formed by the excessive development of taluses from one side or both sides of the valley.

The geology of the area is as follows. The mountains to the east of the north and south valleys from the Dadarili Pass seem to be mostly made up of banded gneiss, the attitude of foliation of which is N 45°W, 90° on the south of the Dadarili Pass and N 65°W, 80° SSW on the north. On the other hand the mountains to the west of valleys mentioned above including the top of the Dadarili Pass seem to be composed of gniessose granite with numerous large porphyroblasts of felspar.

On July 25 we continued to descend the northward valley as far as the seventh camp. (See Fig. 4-14). The distance between the sixth and the seventh camping places is 13 km, while the altitude of the latter place is 3,225 m. The river along which we proceeded below Ambezh is called Shunji Gol.

Though there is no glacier in this part of the valley, there are many glacial feautures such as U-shaped valley, hanging valley with water fall, moraine wall below melted glacier, relic of old moraine wall and "roches moutonnées", remnants of Pleistocene glaciation. Among them, a hanging valley with water fall (W_1 shown in the map) on the left wall of the valley is 150 m high, while another one (W_2) 120 m high is seen on the right side of the valley. A moraine wall (M_1) stands 300 m above the valley bottom on the left bank and about 300m southwest of W_1. It has been formed by a melted small valley glacier and is accompanied by a high talus below it. M_1 shown in the map is probably the relic of an old terminal moraine of a large valley glacier at a later stage of the Pleistocene epoch. Below Ambezh we can observe two groups of "roches moutonnées" along the path. One of them situated 1.5 km north of Ambezh is composed of a few rounded minute** rock hills of gabbro or diorite oriented northeast and southwest. The writer observed horizontal striae preserved on a surface of a hill dipping northwest at 35°. The other group 1 km south of the former is of the similar character. The "roches moutonnées" just mentioned must have been formed by the Pleistocene glaciation in which a very long valley glacier leading from the Dadarili Pass to Ghizar is inferred to have existed.

Apart from the glacial topography, there are several fans. The fan indicated

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* Largest one is 300 m long and 100 m wide.

** 10-13 m long, 3-4 m wide and 2-3 m high.

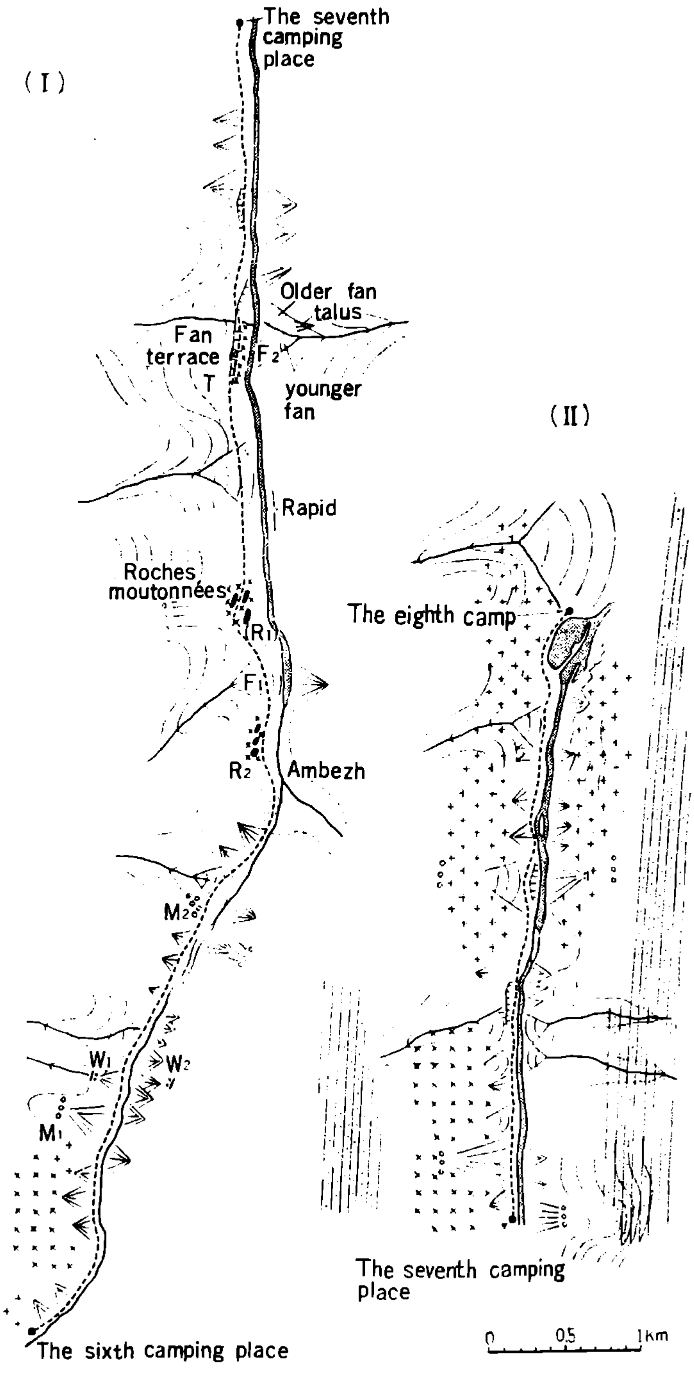


Fig. 4-14. Sketch map between the sixth and eighth camping places. July 25 and 26, 1957.

as F_1 in the map below Ambezh on the left side of Shunji Gol is partly being eroded. Another fan on the right side of the river and 2 km south of the seventh camping place is made up of the older and parlty eroded fan and the younger one partly covering the former. Just opposite this fan, a fan terrace (T in the map), 1 km long, 0.5 km wide and 60 m high above river bed measured at the edge of the terrace, is on the left bank.

The exposure of rocks is not good along the path, for unless the valley is very broad, the valley bottom as well as the foot of the mountains on both sides of the valley are concealed by a large amount of rock debris forming the taluses and fans. The mountains to the west of the valley between the sixth camp and Ambezh are inferred from the rock fragments forming the taluses or fans to be composed of blackish porphyrite at the upper half of the mountains and of gabbroic rock and gneissose granite with large porphyroblasts of felspar at the lower half.

The bottom of the Shunji Gol valley between Ambezh and the south end of the fan terrace T is broad, and therefore the "roches moutonnées" composed of basic intrusive rocks mentioned above are exposed. The similar rocks crop out at the cliff of the terrace T which is considered to have been caused by the upheaval of the part of the valley.

On July 26, accompanied by a few members, the writer proceeded to the eighth camp set on the north shore of a lake. (See Fig. 4-14). The distance from the seventh camp to the eighth one is only 5 km, the altitude of the latter being 3,190 m. Compared with those on the preceding day, the glacial features observed on this day are not many. According to the writer's observation, there are four moraine walls each of which is situated high above the valley bottom and has been formed below a small tributary valley glacier and is accompanied by a high talus below. One of of them standing 500m northwest of the seventh camp is 3500 m high. Another one

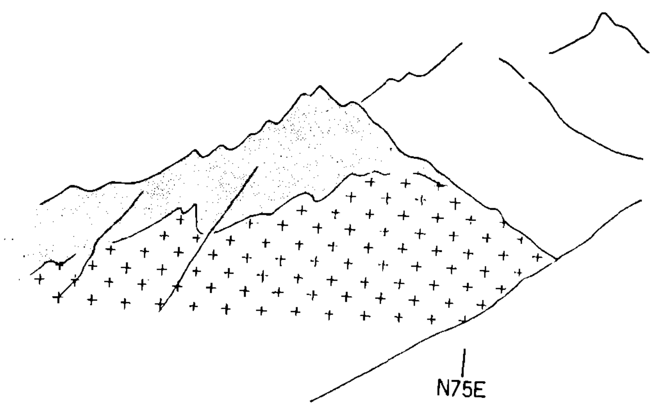


Fig. 4-15. The mountains on the right side of Shunji Gol as seen from the top of the fan A,

lying on the right side of the valley midway between the seventh and eighth camps is accompanied below by a water fall 120 m high above the valley bottom. There are no "roches moutommées" in this part of the valley. The larger tributaries join the main stream, forming fans. One of them situated just north of the eight camp is a large fan, 170 m high, 650 m long and 1 km wide. The lake on the north of which we set the eighth camp is 500 m long from the north to the south and 400 m wide from the east to the west. Ones and spit and one sand bar project from the south as shown in the map.

This lake must have been formed by the excessive development of the fan immediately north of the lake.

The geology of the northern half of this part of the Shunji Gol valley is different from that of its southern half. The northern half is composed of biotite-hornblende-granite, while the southern half consists of gabbroic rocks. The boundary between the two rock bodies mentioned above seems to pass from northwest to southeast. The upper part of the mountains on both sides of the valley, however, is composed of blackish or dark greenigh volcanic rocks. Since the biotite-hornblende-granite mentioned above includes in some cases the xenolith of grey porphyrite, and an intrusive contact between the volcanic rocks above and the granite below is seen from a distance (See Fig. 4-15.), the granite is inferred to be younger than the volcanic rocks just mentioned. With regards to the relation between the volcanic rocks and gabboro, the writer has observed a rock fragment in which the latter is is injected by the former. The sequence of the formation of the rocks, therefore, is as follows. The gabboric rock is the first, the volcanic rocks the next and the granite is the last.

Next day, on July 27, leaving the eighth camp in the morning, we arrived at the Ghizar camp in the afternoon. (See Fig.4-16). The distance between the two camps mentioned above is 12 km, the altitude of the Ghizar camp being 2,910 m. A small cultivated field begins to appear just northeast of the eighth camp, and between the eighth camp and near the Ghizar camp there are two lonely hamlets of Shudastri and Heridan each consisting of only one house.

There are two moraine walls (M_1 and M_2 in the map) high above the valley floor. The moraine wall M_2 forms two steps, the upper one 300 m high above the floor of the Shunji Gol valley being accompanied by a small glacial lake above. The transverse profile of the Shunji Gol valley is, as a whole, U-shaped as shown in Fig.4-19.

There are many taluses and fans on either side of the valley.

The mountains on both sides of this part of the valley are made up mostly of hornblende-granite or biotite-hornblende-granite, except for that the upper part of the mountains is composed of volcanic rcks. As stated above, the volcanic rocks composing the mountain that is illustrated above (Fig. 4-15) are older than the

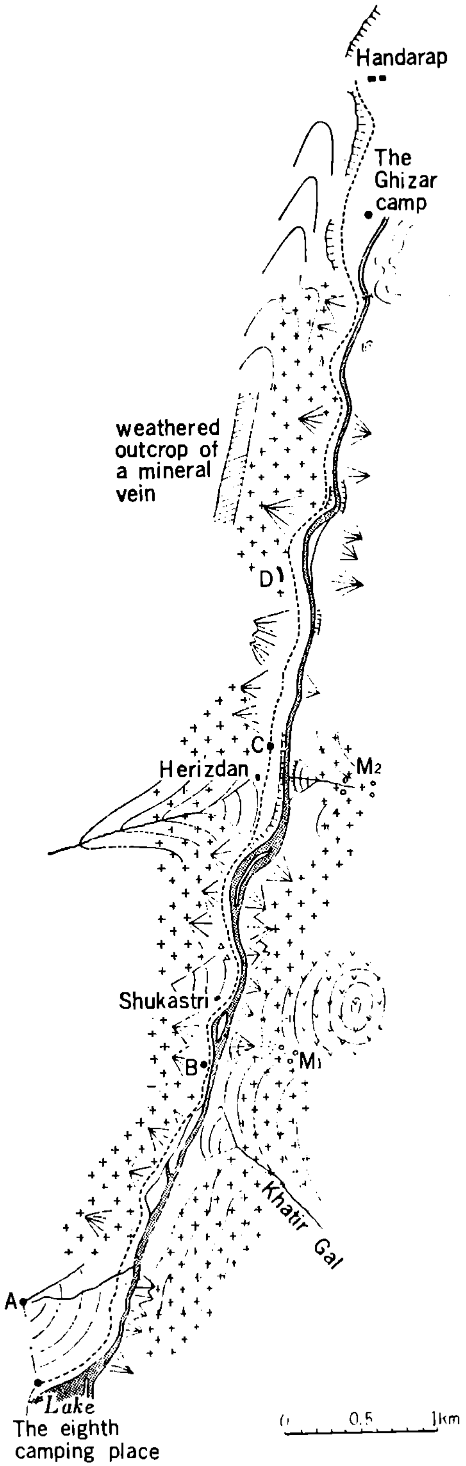


Fig. 4-16. Sketch map between the eighth camp and the Ghizar camp. July 27, 1957.

granite. But the case of another mountain about 1.2 km north of the former is different. In this case, the base of the volcanic rocks is flat and they are connected with a dyke cutting the underlying granite (See Fig. 4-17), and an outcrop (point D in the map)shows that the granite is cut by the dykes of blackish very fine-grained rock or porphyritic rock. (See Fig. 4-18). Therefore the volcanic rocks illustrated are inferred to be younger than the granite. Accordingly there must be two kinds of volcanic rocks, namely one is older and the other younger than the granite.

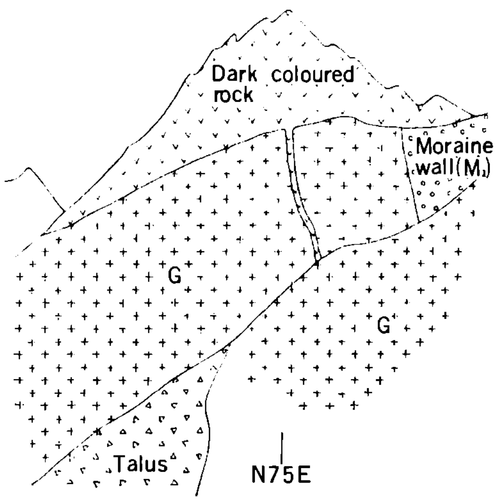


Fig. 4-17. A mountain and a moraine wall (M_1) on the right side of the Shunji Gol valley as seen from Point B. July 26, 1957.

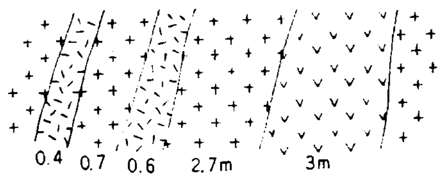


Fig. 4-18. The outcrop D.

A marked yellowish brown weathered mineral vein lying 1.5 km south-southwest of the Ghizar camp and half-way up the mountain west of Shunji Gol is visible from the path leading to Ghizar. This mineral vein extends from north to south, dipping west at 70°, and has a width of 50 m. The fragments of this vein among the talus deposits below it show quartz with a silvery sulphide mineral. The existence of such weathered mineral veins in the upper part of the mountains on both sides of the valley and further on the mountain north of Ghizar is apparent from their distant view.

On the following day (July 28), we stayed at the Ghizar camp and the writer made a short excursion nearby.

The Ghizar camp, as called by us, was set near the south end of an alluvial plain extending from the north to the south for 1.5 km with a width of about 700 m, formed near the confluence of River Shunji Gol with its main stream the Ghizar River. Exactly speaking, the camping place does not ile at Ghizar, but at the village of Handarap. True Ghizar stands on the 80 m high river terrace on the left bank of the Ghizar River just north of the above-mentioned plain which may be called the Ghizar plain tentatively.

On both sides of the southern part of the Ghizar plain just named, there are rock terraces. The one on the left side is 40-50m high, while the ones on the right one on the left side is 40-50 m high, while the ones on the right side are 10-30 m and about 70 m high respectively. The lower terrace on the right side composed of granodiorite is a well-established glacial pavement, of which surface is polished, rounded and striated, the direction of the striae being N 10°E. (See Figs. 4-3 and 4-4 of the photograph. pages; Fig. 4-4. taken at point A). A striated rock surface has been observed also at point A' of the rock terrace on the left side of the plain in

Fig 4-19. Northward view from point C. July 27, 1957.

question. The rock surface mentioned above has an attitude of N58°W and 50° NE, the stria dipping toward one's left at 20° on the suface. Whether this stria is due to glaciation or not is not known.

There are four terraces on the west of the Ghizar plain. They are terrace I (160-170 m above the Ghizar plain), II (120-130 m), III (90-110 m) and IV (80-100 m). (See Fig. 4-22). They are mostly composed of silt and gravel and partly of rocks. The lowest terrace, namely terrace IV is the same in height as the 80 m high terrace on which stands the village of Ghizar, as mentioned above. The latter is also mostly made up of silt and gravel and partly of rocks as shown in Fig. 4-20.

It may be inferred from the facts mentioned and illustrated above that the

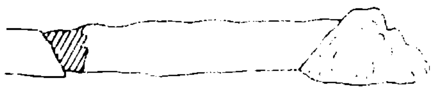


Fig. 4-20. A sketch of the Ghizar terrace, showing a rock outcrop at the right and the cutting by the Ghizar River at the left, as seen from point C. July 29, 1957.

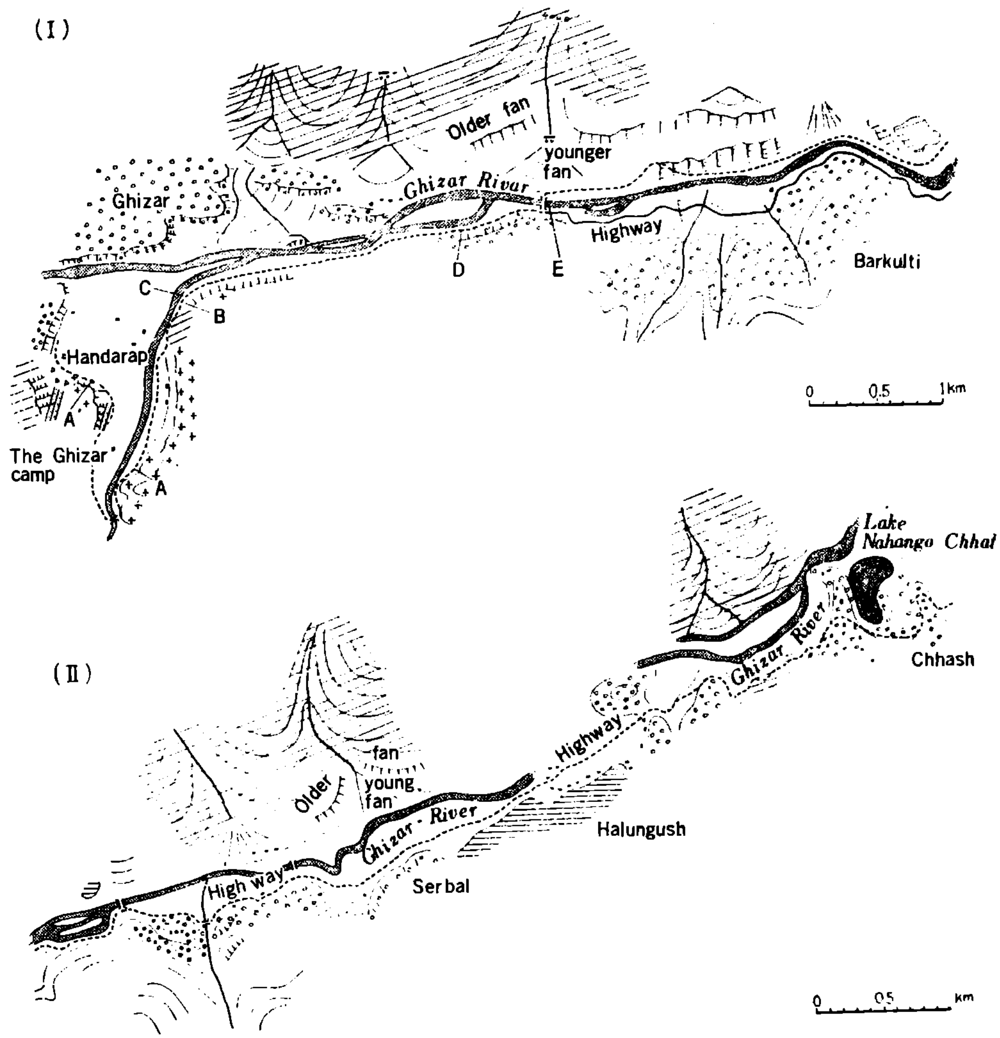


Fig. 4-21. Sketch map from the Ghizar camping place to the Shamran. July 29, 1957 (I).

surface of the terrace IV west of the Ghizar plain had been continuous to that on the left bank of the Ghizar river before they were separated from each other by the fluviatile erosion of the Ghizar river, and that the Shunji Gol valley glacier

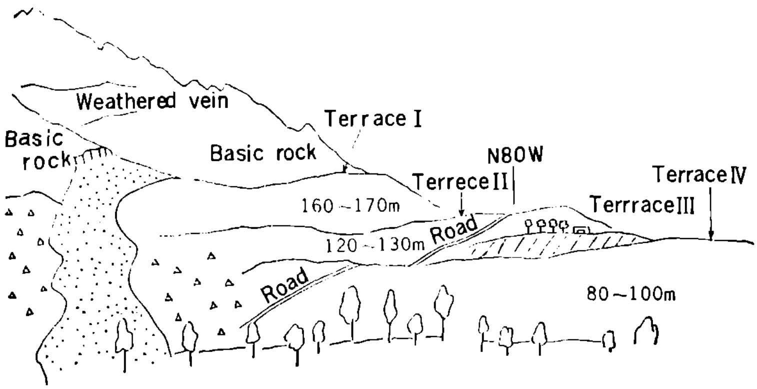


Fig. 4-22. The terraces to the west of the Handarap plain, Ghizar, as seen from point B. July 29, 1957.

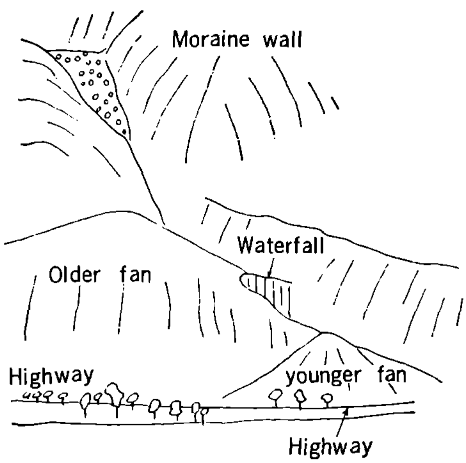


Fig. 4-23. Topography on the north side of the Ghizar river as seen from southwest (point D). July 29, 1957.

in the Pleistocene period which rounded and polished the rock surface and marked the striae on it near the Ghizar camp was in existence before the formation of the terraces I and II west of the Ghizar plain.

The geology of the vicinity of the Ghizar camp is shown in the sketch map. The rock terraces east and west of the Ghizar camp are mostly composed of granodiorite associated with dark green basic intursive rock and quartzose rock, the latter of which seems to have some relation with the sulphide ore minerals. The higher hills behind the terraces west of the plain consist of green basic porphyritic, probably pre-Tertiary volcanic rocks with brown weathered mineral veins.

From Ghizar to Yasin. On July 29, we left the Ghizar camp eastward for Gupis 70 km downstream the Ghizar river. (See Fig. 4-21). We proceeded along the Ghizar river on its right bank as far as Shamran on this day. The distance from the Ghizar camp to the Shamran camp is 23 km, the altitude of the latter being 2,560 m.

At a point 6 km, along the path we took, from the Ghizar camp, crossing the main stream of the Ghizar river, there is a bridge which passes the Gilgit-Shandur pass highway, a trunk line of communication in the Gilgit Agency. From here we took this highway on the right bank of the Ghizar river. On both sides of the Ghizar are well developed river terraces or alluvial fans. On the right side there are two gravel terraces with rock outcrops in the lower part in some cases. On the other hand, however, the development of alluvial fans on the left bank is marked. According to the writer's observation, there are on the left side at least two sets of alluvial fan, each of which consists of an older fan and a younger one. After the older fan was partly eroded, a younger one has been or is still being formed in the eroded part of the older one. One of the sets stands just north of the bridge passing the Gilgit-Shandur Pass highway mentioned above. (See Fig. 4-23). In this set a water-fall, 200 m above the plain, is above the top of the younger fan. Far up the tributary there is a moraine wall, 500 m above the plain. (See Fig. 4-28). This moraine wall is accompanied by a cirque above. About 250 m below this moraine wall has been the eroded top of the older fan.

3,000 meters above the bottom of the Ghizar valley stand on both sides of the valley over 5,000 m high and steep mountains covered with snow in the upper part but with no tree nor grass even in the lower part. Though the Hindu Kushinclud-ing this district is arid, the Ghizar river and its tributaries flow with ample water, for these streams are fed by snow and glaciers. Being irrigated by the from water snow and glaciers, some of the terraces and younger fans are cultivated and inhab-ited, forming oases in the mountain desert.

This side the Chhase village near this day's destination Shamran there is a small lake called Nahango Chhat with a length of 450 m and a maximu width of 300 m. This lake is in a small valley in a dissected gravel terrace and seems to have some relations with the Ghizar river.

The mountains on the north side of the Ghizar seem to be composed of greenish volcanic series, though the writer could not observe in situ. But he could infer so from his observation at the outcrops on the south side. In some cases there are outcrops below or between the alluvial fans. A 1.2 km long rock cliff on the north bank of the Ghizar to the north of Barkulti seemed to consist of the rock similar to that exposed at the highway on the south bank near Barkulti. The latter rock is a grey fine-grained rock and has been determined as an altered tuff by Prof. G. Kojima. At the outcrops along the highway about 1-2 km east are exposed dark green volcanic breccia or porphyrite or diabase. The diabase is exposed also in the lower part of a terrace of Halungush.

The river terraces developed on the south side of the Ghizar river are mostly composed of gravel, but the terraces between Halungush and Lake Nahango Chhat are comsiderably dissected and composed of grey white silt or silt and sand associated with gravel, probably lacustrine deposit which dip in one case northeast at 50°.

On July 30 proceeded we along the highway from the Shamran camp to the Pingal camp (resthouse). (Fig. 4-27). The distance between the two camps is 14 km, the altitude of the latter being 2,500 m. The Shamran camp was set at an oasis on the southern river-beach of the Chhashi Gol river, a tributary of the Ghizar river. The former river joins the latter about 800 m below the Shamran camp. These two are joined by another tributary Bahushtaro Gol from the northwest at the same point as that between the former two. These three rivers make a concordant junction.

A striated pavement is found on a green schist on the 30 m high terrace opposite the camp. The pavement dips toward west-southwest at 20°. The direction of the stria is N 60° E. There are two river terraces in the area between Shamran and Khashan, 6 km below Shamran. The higher one is 60-70 m, while the lower is 30 m both above the river bed. They are gravel terraces with rock outcrops in some cases. (Fig. 4-26). Here and there alluvial fans are formed mostly on the lower terrace. Below Khashan for about 2 km there are no terraces on both banks of the Ghizar. Then the two terraces reappear. The granite mountains on the north bank are steep, forming high taluses in some cases. Eapecially the one between Shamran and Khashan is 450 m high and 3.5 km long.

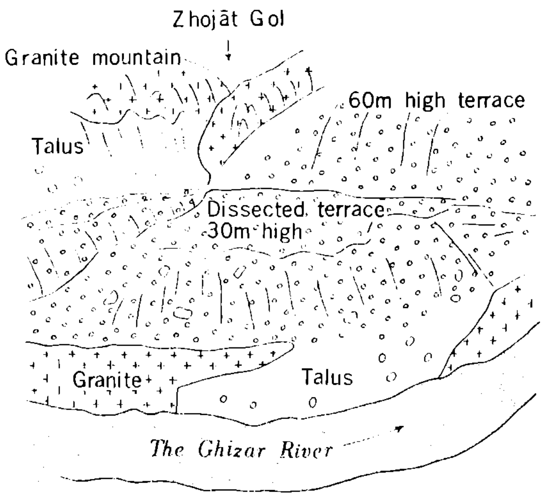


Fig. 4-24. 30 m high terrace dissected by the Zhojāt Gol river, a left bank tributary of the Ghizar as seen from point A' on the highway. July 30, 1957.

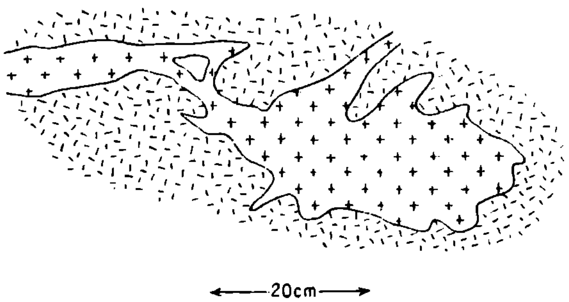


Fig. 4-25. A part of a boulder of a fan from the south showing the greenish fine-grained igneous rock injected by granitic rock collected from Point B. July 30, 1957.

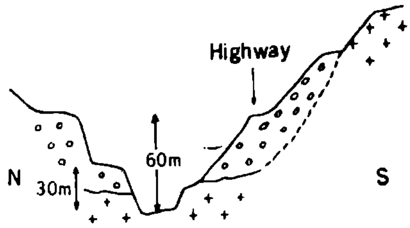


Fig. 4-26. A Schematic geologic section of the Ghizar valley at point C. July 30, 1957.

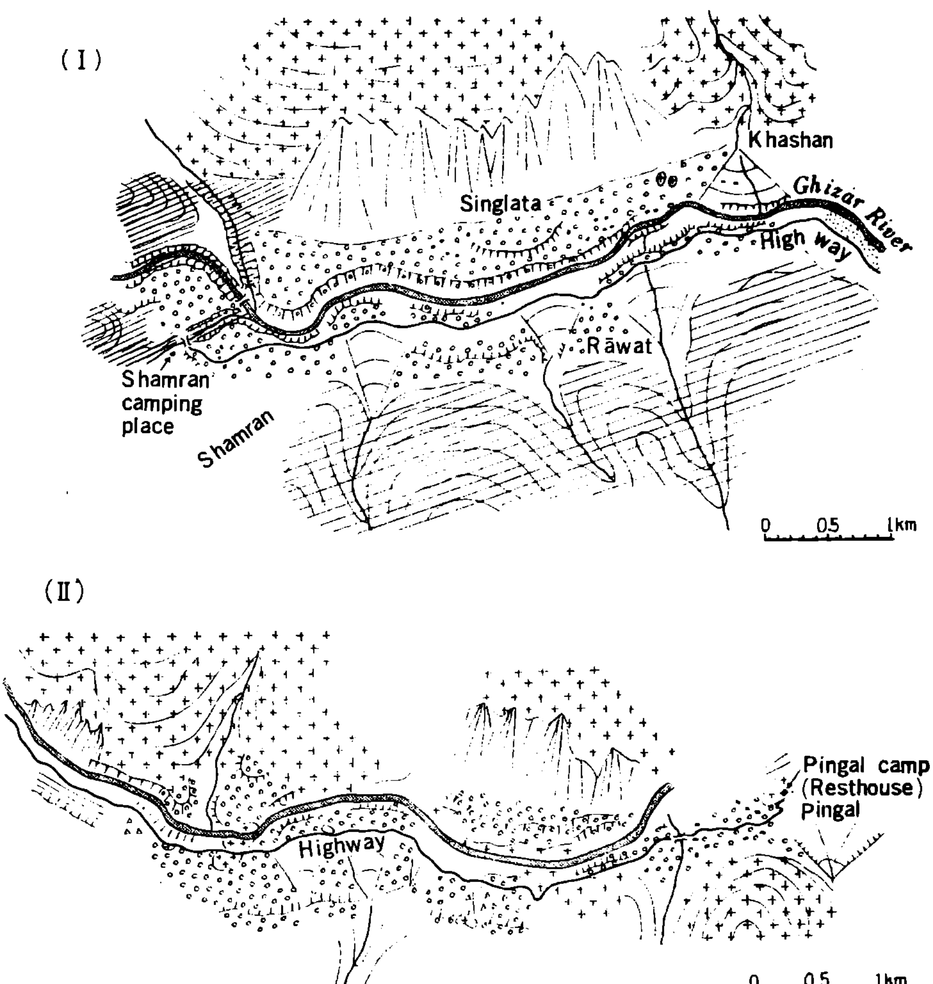


Fig. 4-27. Sketch map between Shamran camp and Pingal camp. July 30, 1957.

As mentioned above, the mountains on the north side are composed of granite. On the south side, however, the mountains behind the terraces between Shamran and the place opposite Kashan are inferred from the fact that the pebbles to boulders found in the alluvial fans are solely of red tuff, tuff-sandstone, shale, green rock and conglomerate with limestone pebbles to consist of the Green series. Actually green rocks crop out along the highway in the gorge part of the Ghizar river mentioned above (marked A in the map). Below this gorge appears biotite-granite along some parts of the highway and even on the south of the highway as shown in the map. A schematical geological profile may show the geological relations. But abundant pebbles and cobbles of conglomerate as well as dark green rocks without those of granites suggest that most parts of the southern mountains except the lowest part are composed of the Green series. A piece of cobble of dark green rock shows the injection of granite into the former. (Fig. 4-25). We obtained a pebble of limestone with coral fossil which was determined afterwards as *Thamnasteria matsushitai* indicating the Lower Cretaceous age by Prof. M. Eguchi. (See Chapter 8 of this volume.)

On July 31, we walked from Pingal to the Jaljulit camp for 21.5 km, the latter's altitude being 2,370 m above sea level. (See Fig. 4-28). The glacial topography is not marked in this part of the Ghizar valley. There are two river terraces, the higher and the lower. The higher terrace is in most cases 50 m and in some cases 70-80 m high. It is composed of rock only or rock and gravel. The 50 m terrace on the right bank of the Balti Gol river is largely composed of gravel. On the other hand,

The Ghizar valley between Pingal and Jaljulit and its neighbourhood is largely made up of the Green series and granite. The western half of the area is occupied by granite, while the eastern half by the Green series, the boundary between the two being well observed from the highway at Tangai. That the contact is intrusive is apparent. The granite is a fine- or medium-grained biotite-granite. The Green series in this area is largely composed of "green rock" by a field name, which includes basic volcanic rock and tuff. The rock specimens from the point about 250 m apart from the contact are, according to Prof. G. KOJIMA's determination, thermally metamorphosed basic tuff and basalt. The Green series is represented by green schists with a schistosity of N 60 W to the west of the Balti Gol valley for a distance of about 2.5 km measured in straight line from NE to SW. According to Prof. KOJIMA's determination, the green schist is epidote-actinolite-schist and the associated sandstone-like rock is a hornblende-biotite-granodiorite.

The gravel bed forming partly or wholly the several tens of meter high terraces is an Upper Pleistocene fluviatile deposit. the lower terrace is a 20-30 m high gravel one. The Balti Gol river, a large tributary of the Ghizar with water one third in quantity of the main stream and another tributary the Sosat Gol river, though

(To be inserted between the 23rd and 24th lines on page 60.)

the lower terrace is a 20 to 30 m high gravel one. The Balti Gol river, a large tributary of the Ghizar with water one third in quantily of the main stream and another tributary the Sosat Gol river, though not so large as the former, form no alluvial fan in the confluence with the main stream. On the contrary the smaller tributaries form alluvial fans and make discordant junction. The village of Pingal stands on the younger fan formed in the eroded part of the older fan. The granite foundation on which the Payokush fan has been formed is exposed on the left bank of the Ghizar. (See Fig. 4-28.)

Fig. 4-28. Sketch map between the Pingal and Jaljulit camps. July 31, 1957.

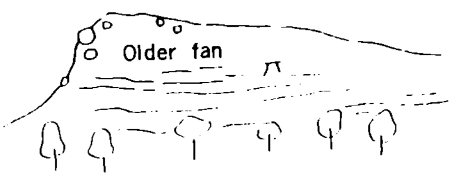


Fig. 4-29. A dissected older fan as seen from Point D on the highway. July 31, 1957.

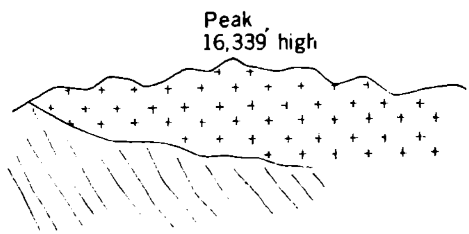


Fig. 4-30. Granite mountain with the 16,339' high peak beyond a mountain of Green series. July 31, 1957.

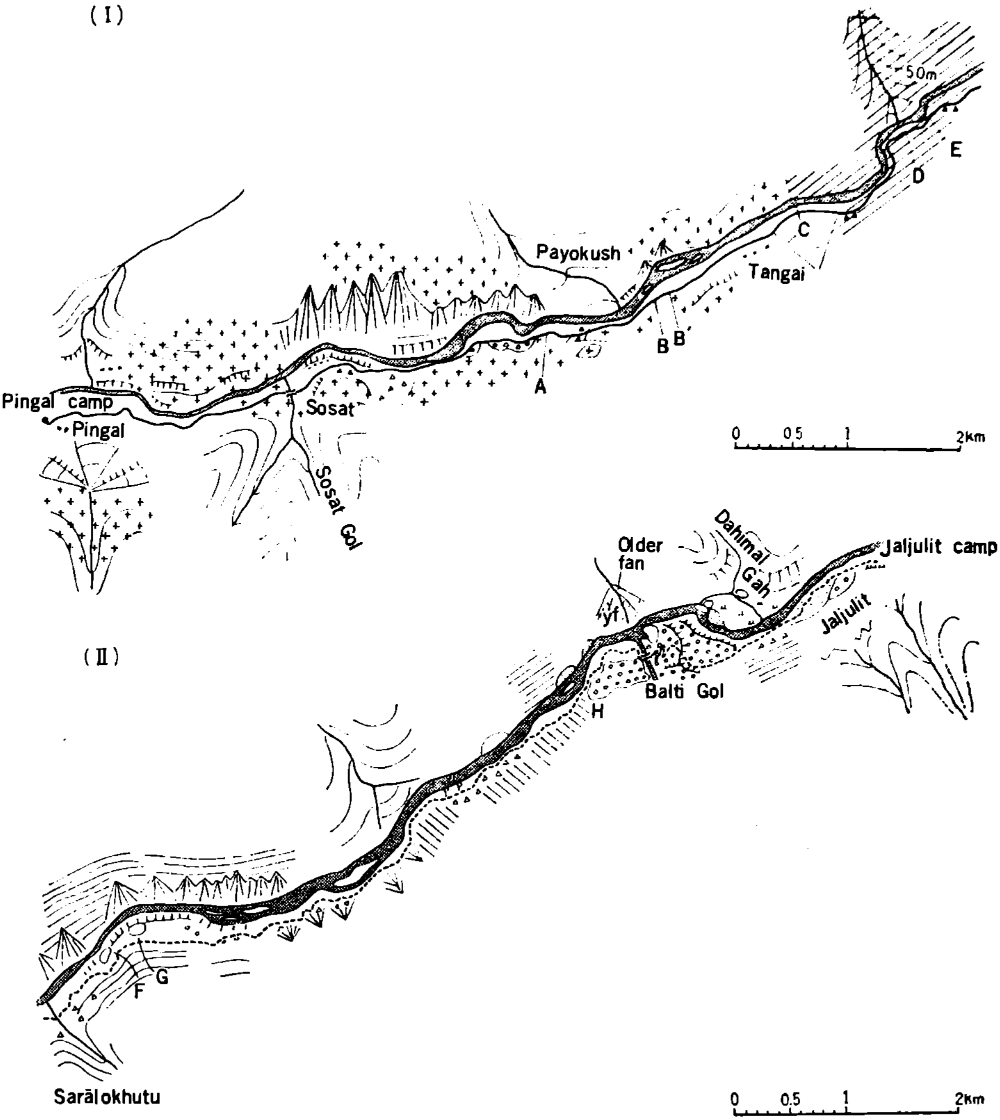


Fig. 4-28. Sketch map between the Pingal and Jaljulit camps. July 31, 1957.

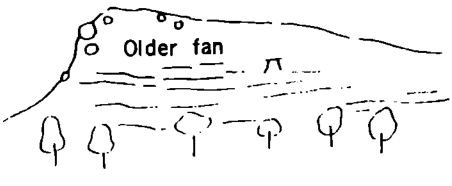


Fig. 4-29. A dissected older fan as seen from Point D on the highway. July 31, 1957.

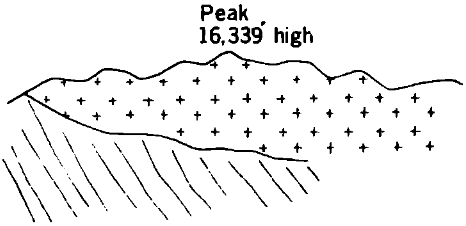


Fig. 4-30. Granite mountain with the 16,339' high peak beyond a mountain of Green series. July 31, 1957.

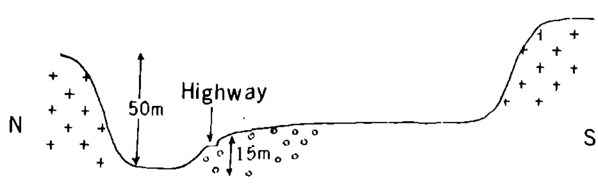


Fig. 4-31. Schematic profile of the Ghizar valley showing the terraces west of Tangai. July 31, 1957.

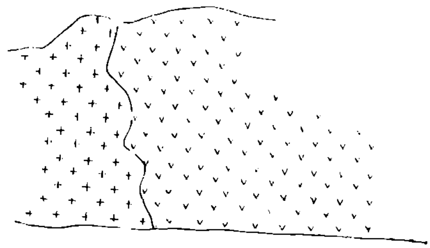


Fig. 4-32. Outcrop of the boundary between the granite and green rock as seen from Point C on the highway. July 31, 1957.

not so large as the former, form no alluvial fan in the confluence with the main stream. On the contrary, the smaller tributaries form alluvial fans and make discordant junction. The village of Pingal stands on the younger fan formed in the eroded part of the older fan. The granite foundation on which the Payokush fan has been formed is exposed on the left bank of the Ghizar. (See Fig. 4-33.)

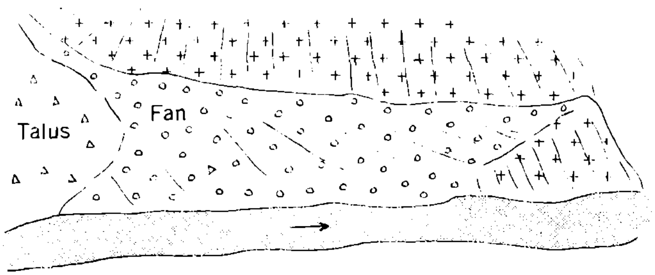


Fig. 4-33. The Payokush fan as seen from Point A on the highway. July 31, 1957.

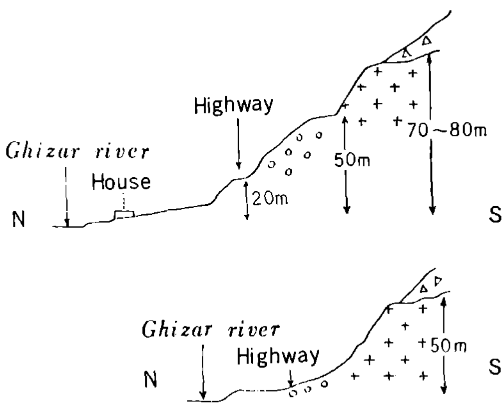


Fig. 4-34. Schematic profiles at B and B′ opposite to Payokush. July 31, 1957.

As mentioned above, there is a peculiar deposit, perhaps boulder-clay, lying above the 300 m high cliff of green rock on the left bank of the Ghizar, opposite Sarālokhutu. This white-coloured deposit is about 50 m thick and seems to be composed of whitish clay and boulder, forming earth pillars as a result of erosion. This peculiar deposit may be a glacial one. (See Fig. 4-37).

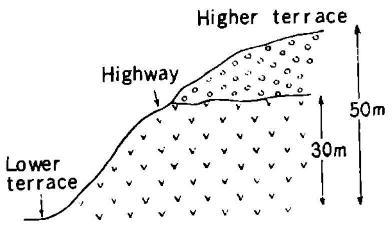


Fig. 4-35

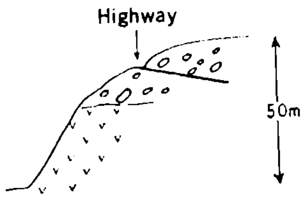


Fig. 4-36

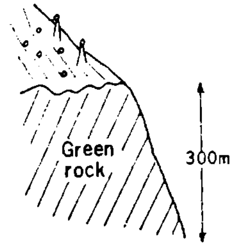


Fig. 4-37

Fig. 4-35. Profile of the higher terrace as seen from Point F. July 31, 1957.
Fig. 4-36. Profile of the higher terrace as seen from Point H. July 31, 1957.
Fig. 4-37. Schematic profile of the 300 m high cliff of green rock covered with boulder clay opposit to Point G. July 31, 1957.

On August 1 proceeded we from the Jaljulit camp to the Gupis camp (resthouse). The distance between the two camps is 23 km, while the altitude of the latter is 2, 020m. (See Fig. 4-38).

The Jaljulit camp was set at the foot of a 50 m high terrace which is composed of 15 m thick gravel bed above and the green rocks below (Fig. 4-39). About 400m down the river, the terrace becomes wholly gravel one in which the gravel bed is covered by scree deposit. (See Fig. 4-40.) Further 400 m down the river, we entered a gorge with steep valley-wall showing continuous outcrop of rocks and without any terraces. This gorge extends for about 8 km as far as the village of Khalti which stands on a cultivated fan formed by a stream from the north. Down the river from Khalti, wide terraces develop on the south side, while the mountain becomes lower on the north side. The terrace on which the villages of Aliabad and Jundrot stand is 80-120 m high and is composed of gravel and probably everywhere bed rocks as well. (Fig. 4-41).

The geology of this area may be briefly summarized as follows: the Green series composed of amphibolite and green schist is intruded by granite and gneiss, all these being cut by a fault with lateral displacement along the Ghizar river and covered by a Pleistocene terrace deposit. The Green series is broken into three parts by the intrusion of granite and gneiss, as shown by Fig. 4-38. The attitude of the schistosity of the green schist, a component of the Green series is N 80°W and 85° S. The amphibolite, another component of the Green series is a blackish

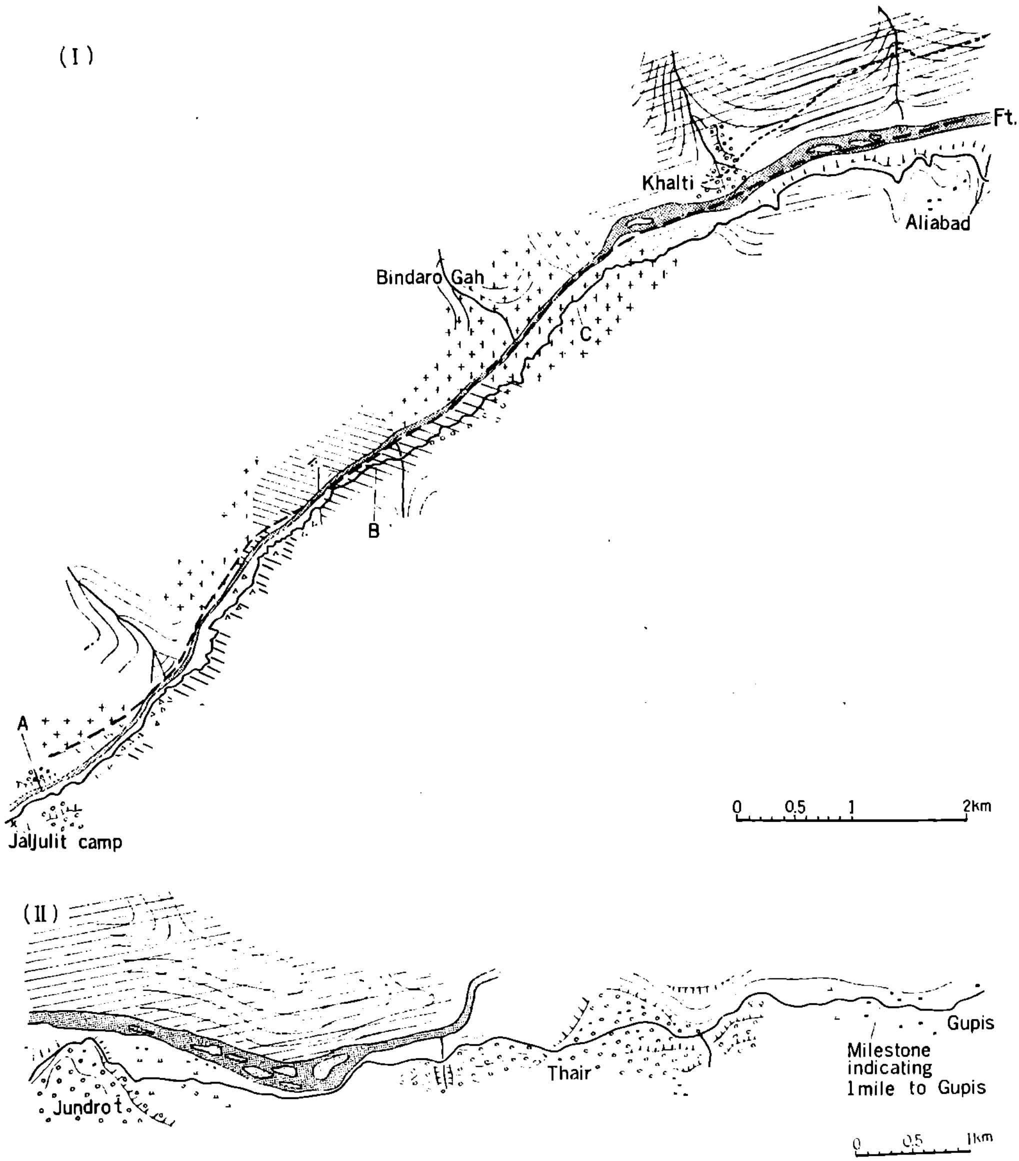


Fig. 4-38. Sketch map between Jaljulit and Gupis. August 1, 1957.

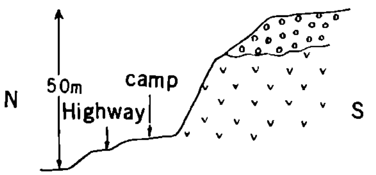


Fig. 4-39. Schematic profile of the Jaljulit camping place and its vicinity. Aug. 1, 1957.

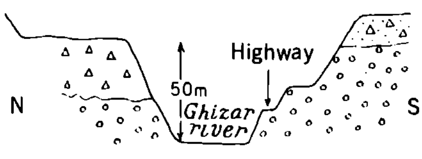


Fig. 4-40. Schematic profile of the Ghizar valley at Point A. Aug. 1, 1957.

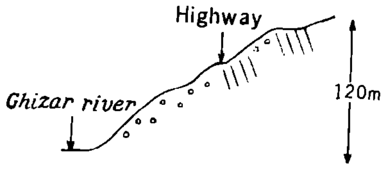


Fig. 4-41. Schematic profile of the south bank of the Ghizar river on the west of Aliabad. Aug. 1, 1957.

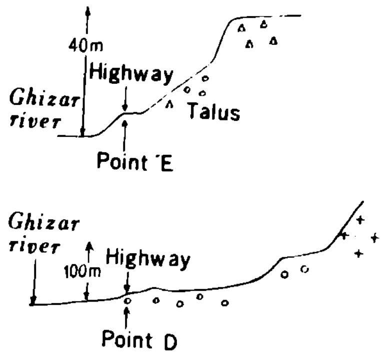


Fig. 4-42. Profiles at Points D and E to the east of Jundrot. Aug. 1, 1957.

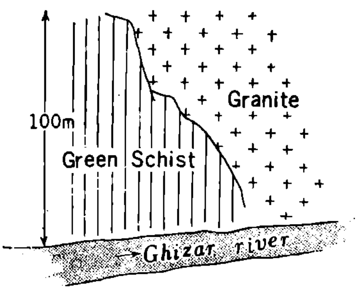


Fig. 4-43. Boundary between the green schist and the granite, as seen from Point B on the highway. Aug. 1, 1957.

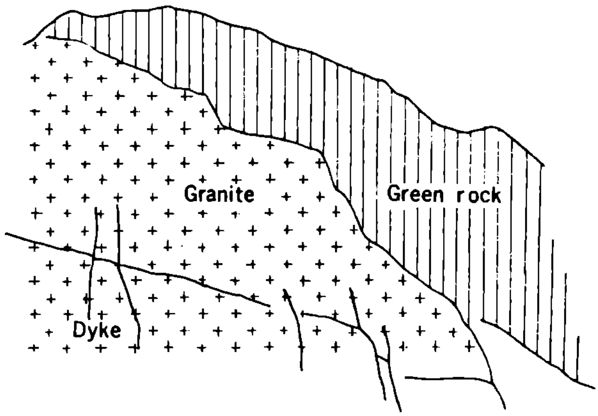


Fig. 4-44. The boundary betweeen the green rock and the granite, as seen from Point C 1.5 km southwest of Khalti. Aug. 1, 1957.

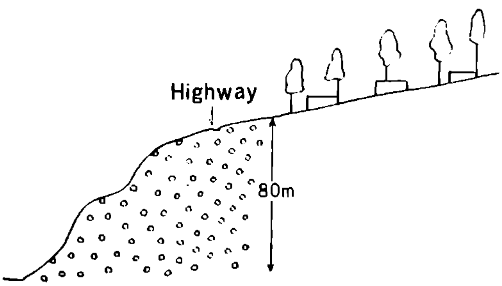


Fig. 4-45. Profile of the Aliabad terrace, as seen from the west. Aug. 1, 1957.

rock looking like a hornfels. The gneiss or gneissic granite intruded into the Green series is, according to Prof. G. Kojima, a hornblende-biotite-granodiorite-blastomylonite. Its schistosity has an attitude similar to that of green schist. The boundary between the green rock and granite on the opposite side of the Ghizar river is well observed from the highway (Fig. 4-43). That the green schist is cut by veins of aplite (hornblende-aplite-blastomylonite, according to Prof. G. KOJIMA) and the amphibolite is cut by small dykes of granite (biotite-hornblende-quartz-diorite, contaminated, according to Prof. Kojima) is also well observed on the highway. Amphibolite occurs in granite as well. It may safely be inferred from the observed facts mentioned above that the Green series has been intruded by granitic rocks and then these rocks concerned have partially been subjected to cataclastic metamorphism. The green schist intercalated with white limestone of the Green series is in some cases overturned.

It may be inferred from the discordance in the rock distribution between both banks of the Ghizar river as shown in the sketch map that a left-lateral fault with a lateral displacenent of 0.7-1.0 km passes through the Ghizar. (See Fig. 4-38).

With regards to the Pleistocene deposits, the terrace deposit is mostly fluviatile, but it is in some cases covered by scree deposit as shown by Fig. 4-40.

Although the glacial deposit is few in this area surveyed by the writer on this day, up the steram forming the Khalti fan there is a moraine wall. Accordingly it is apparent that the Pleistocene glaciation took place in this area as well.

During our stay at Gupis, the writer together with his assistant Mr. F. OKITSU tried some geological excursions in the vicinity of Gupis. The village of Gupis stands on the large fan formed by the Gupis Gah river, a tributary from the south of the Ghizar river. Between this Gupis fan and the Jundrot terrace mentioned above there are terraces on the south side of the highway. A part of these terraces has been surveyed by the writer. They are two, the upper and the lower: the upper terrace is 50 m high, while the lower one is 20 m high. The former is composed of

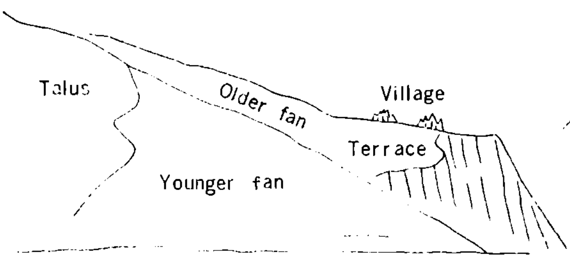


Fig. 4-46. A steep, small alluvial fan as seen from Point B on the opposite side of the Ghizar river. Aug. 7, 1957.

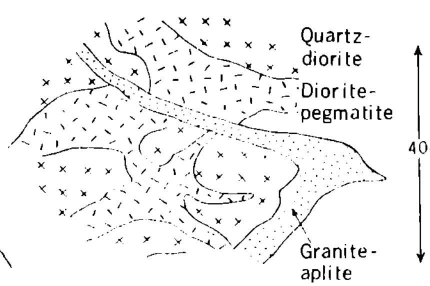


Fig. 4-47. An outcrop showing the succession of three different intrusive rocks at Point A on the highway leading to Yasin. Aug. 7, 1957.

gravel intercalated with thin layers of fine sand, whereas the latter consits of gravel with occasional association of fine sand layers.

On August 7, we proceeded on foot northward from Gupis to Yasin for 24 km.

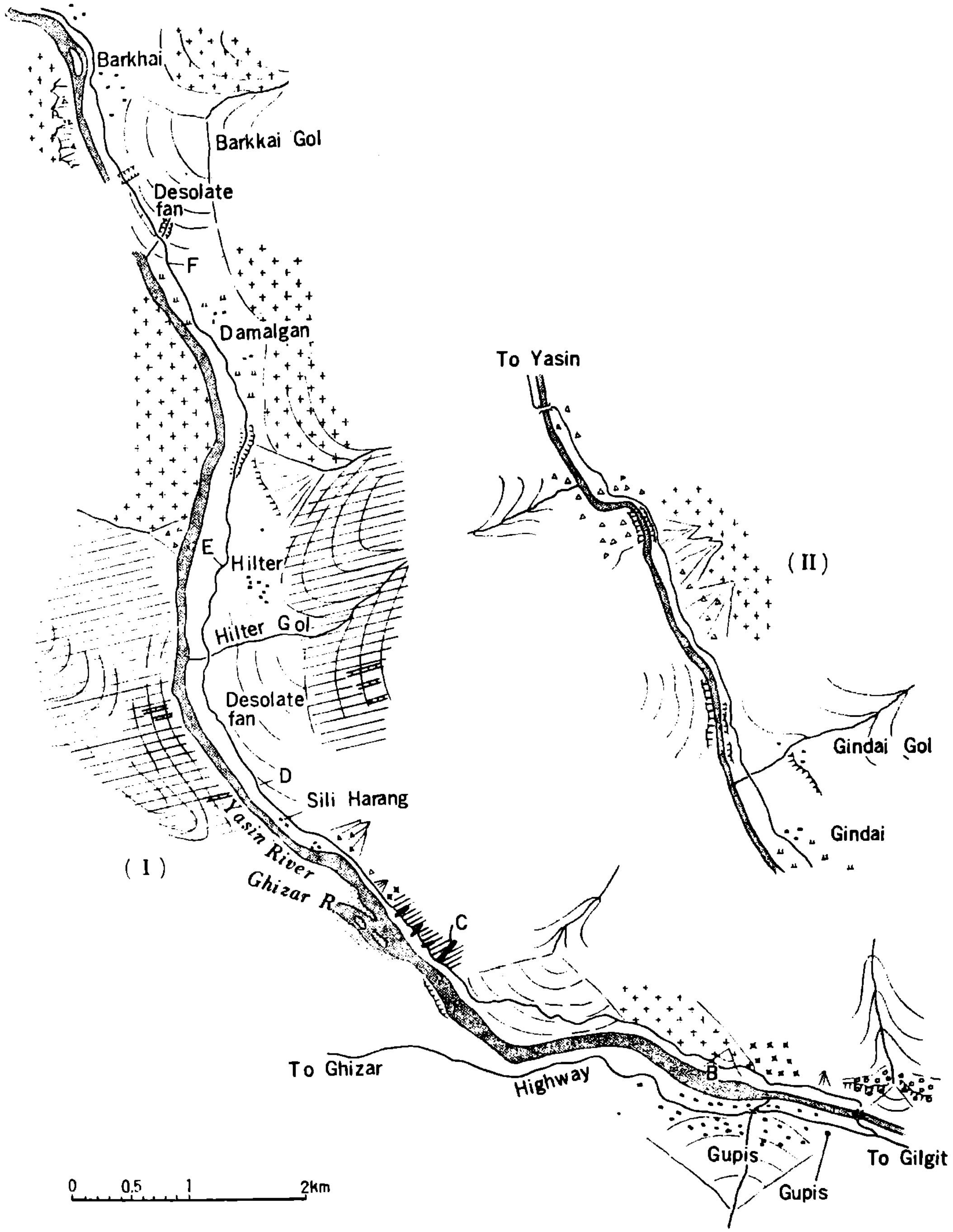


Fig. 4-48. Sketch map between Gupis and Yasin. August 7, 1957.

The altitude of the Yasin camp (resthouse) is 2,400 m. (See Fig. 4-48). A jeepable highway from Gupis leads to Yasin mostly on the left bank of the Ghizar river and the Yasin river, a large tributary of the former, except near Yasin which stands on the right bank of the river with the same name.

The Yasin river in this part of its course flows mostly near the west margin of the alluvium with a width of several hundred meters. Each tributary on both sides of the Yasin form near its confluence with the main stream an alluvial fan, in rare cases talusy. The water of the Yasin river is turbid, while that of the Ghizar is relatively clear. It is interesting to observe that the water of these two rivers does not mix with each other at their junction immediately and that the boundary between these two water bodies persists for about 1 km from the junction point. It is most probable that in this high mountain district, the turbid river water with burden of glacial mud may form the lower layer, while the light clear water the upper one, making difficult to mix with each other. It may safely be concluded that there are a considerable number of glaciers in the drainage area of the Yasin river, while there are very few of them in the drainage of the upper Ghizar.

A few small alluvial fans are formed particularly on the left side of the Yasin ~~Yasin~~ river. Some of them are desolate, not cultivated.

Geology of the area between Gupis and Yasin is summarized as follows. The Green series composed of green schist intercalated with crystalline limestone and associated with amphibolite has been intruded by a small quantity of diorite, and then a large amount of granite.

There is a small stream from the north that forms a small alluvial fan just east ofthe bridge crossing the Ghizar river near Gupis. On both sides of the stream just mentioned crpos out a diorite. Angular cobbles are mostly of crystalline limestone some of which contains garnet and diopside. There is a gravelly terrace above the small fan just mentioned. The terrace is composed of yellow ochre loess-like earth in the uppermost part. That the Green series is composed of green schist intercalated with limestone is well observable, particularly from Point D (Fig. 4-49). The green schist is injected by a grantie along schistose plane (Fig. 4-50). At Point C there is an outcrop of rocks showing that amphibolite is intruded by a diorite and then by a granite (Fig. 4-51). At Point A there is a good outcrop showing that a quartz-diorite is injected by a diorite-pegmatite and then by a granite-aplite (Fig. 4-47). Fig. 4-52 may suggest the intrusive contact of granite with the Green series, though the figure does not show the actual boundary between the Green series and granite. The granite in the area covered by us on this day is, according to Prof. KOJIMA, a hornblende-bitite-orthogranite.

The existence of a left-lateral fault passing through Damalgan and Hilter from NNW to SSE is inferred from the discordant location of the Green series-granite boundary on both sides of the Yasin river.

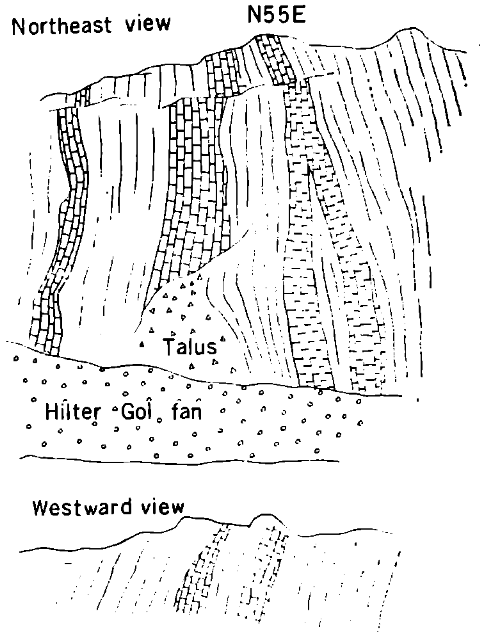


Fig. 4-49. Green schist intercalated with limestone. as seen from Point D at the southern margin of the Hilter Gol fan. Aug. 7, 1957.

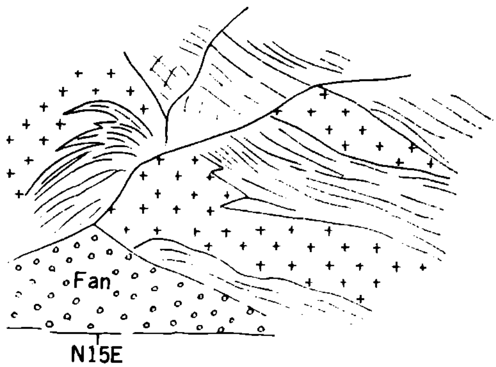


Fig. 4-50. Large exposure of green schist injected by a granite to the east of Barkhai, as seen from Point F.

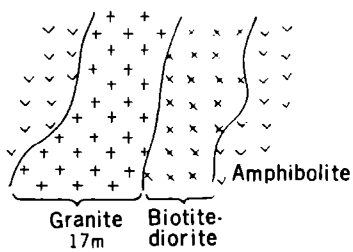


Fig. 4-51. An outcrop of granite intruded into the amphibolite at Point C. Aug. 7, 1957.

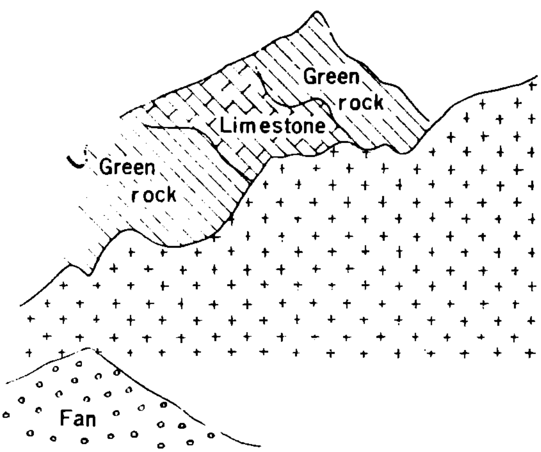


Fig. 4-52. Northward view from Point E. Aug. 7, 1957.

On the next day i.e. August 8, in the afternoon the writer together with the four accompanying students tried to search and collect the fossils of the Yasin group. (See Fig. 4-55).

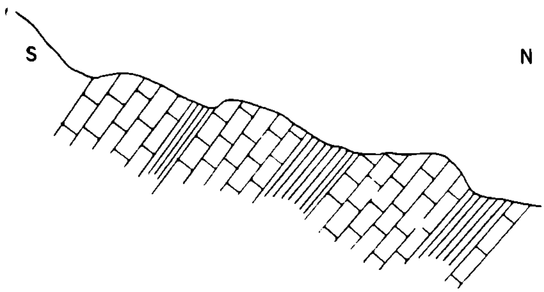


Fig. 4-53. Profile of a part of the Yasin group of the hill south of A. Aug. 8, 1964.

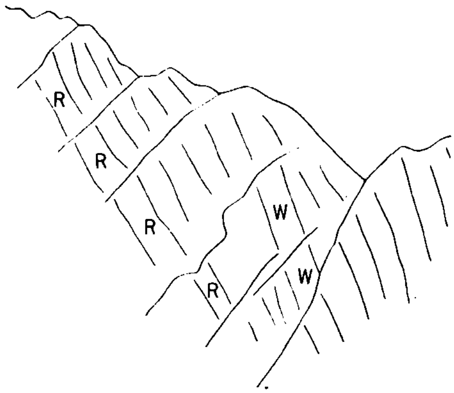


Fig. 4-54. Good exposure of the Yasin group 400 m to the west of the Yasin resthouse, as seen from the resthouse. Aug. 9, 1957. R: Red purple slate. W: Whitish limestone.

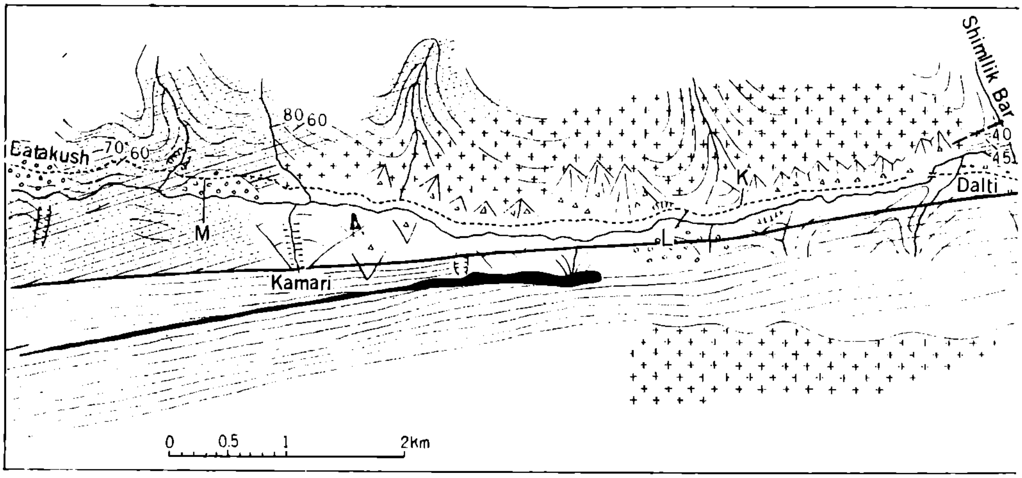


Fig. 4-55. Sketch map between Yasin

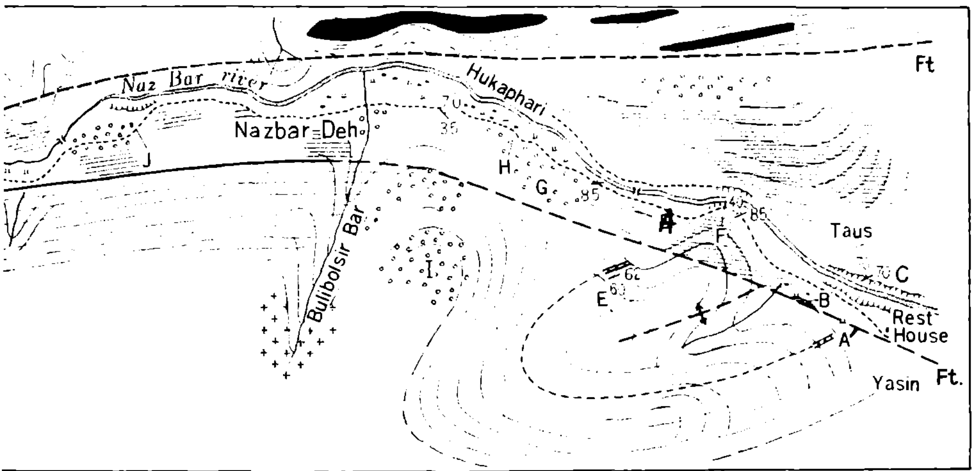
The Cretaceous molluscan and coral fossils were first discovered by HAYDEN in 1914 at Yasin, on his way to his Pamir expedition. The fossils collected by him therefrom were afterwards studied and described by H. DOUVILLÉ in 1926. After the War II the beds were again surveyed and the fossils therein were collected in 1951 by IVANAC, TRAVES and KING who gave the name of the Yasin group to the lower Cretaceous formation, the fossils collected by them being identified by Brunschweiler. A. Desio also visited Yaisn in 1954 and 1955 to make clear the stratigraphic sequence of the Cretaceous and to collect fossils therefrom.

When K. HUZITA visited Yasin in 1956 in the First Panjab-Kyoto University

Joint Expedition, he collected a few Cretaceous fossils, though he had no preliminary knowledge that the fossil had been found therefrom before.

As HUZITA got the fossils mentioned above from limestone fragments at Point A, on the road on the right bank of the Naz Bar river, the writer surveyed the geology of the hill to the south of A and together with the students tried to collect fossils. The alternation of the 60 m thick light grey compact limestone and the 20-40 m thick red purple slate dipping southeast at 60° composes the hill. (Fig. 4-53). The gastropod, pelecypod and coral fossils are contained in the light grey compact limestone. Though we saw numerous fragments of fossiliferous calcaceous sandstone, we failed to find an outcrop of this sandstone. It is probable that this sandstone lies at a higher horizon.

Yasin is a large village standing on a broad fluviatile terrace, 1 km wide and 5 km long. The Yasin resthouse lies near the north end of the village. From the resthouse westward is observed a good and large display of strata just like that on the hill to the west, forming a high cliff at the west margin (marked A′ in the



and Latin Kush. August 9, 1957.

sketch map) of the Yasin terrace about 500 m west of the resthouse (Fig.4-54). Here the strata dip north-northwest at 60°. Though we had no time to visit this outcrop, these strata must belong to the Yasin group and the geologists who have visited Yasin before have probably collected the Cretaceous fossils here.*

While the Yasin group dips north-northwest at high angle here, it dips southeast

* HAYDEN mentioned in his report: "---------- in the cliffs immediately behind the Rest House on the right bank of the river -----." (Records of the Geol. Surv. India. Vol. XLV, pt, 4, 1916, p. 295.)

at high angle as well on the hill (E) to the west of this cliff as mentioned above. Therefore it may be inferred that the Yasin group forms a syncline between A and and E.

From Yasin to Mastuj. On August 9, we left Yasin for Mastuj and entering the Naz Bar valley we set camp at Latin Kush, a summer hamlet about 20.5 km west of Yasin. Latin Kush is 3,250 m above sea level. (Fig. 4-55).

Terrace topography is fairly developed in the valley of Naz Bar. The river runs eastward through a point 250 m north of the resthouse, forming 20 m high cliff which is composed of gravel from Point C eastward and rock from there westward. Notwithstanding the difference of the terrace material, the surface of the terrace is uniformly flat.

Between Taus and Hukaphari, there is a gravel terrace, 20 or 30 m high, on either side of the Naz Bar. It is composed of gravel and rock opposite Point F, while it consits wholly of gravel at the village of Hukaphari (Fig. 4-56). Behind this gravel

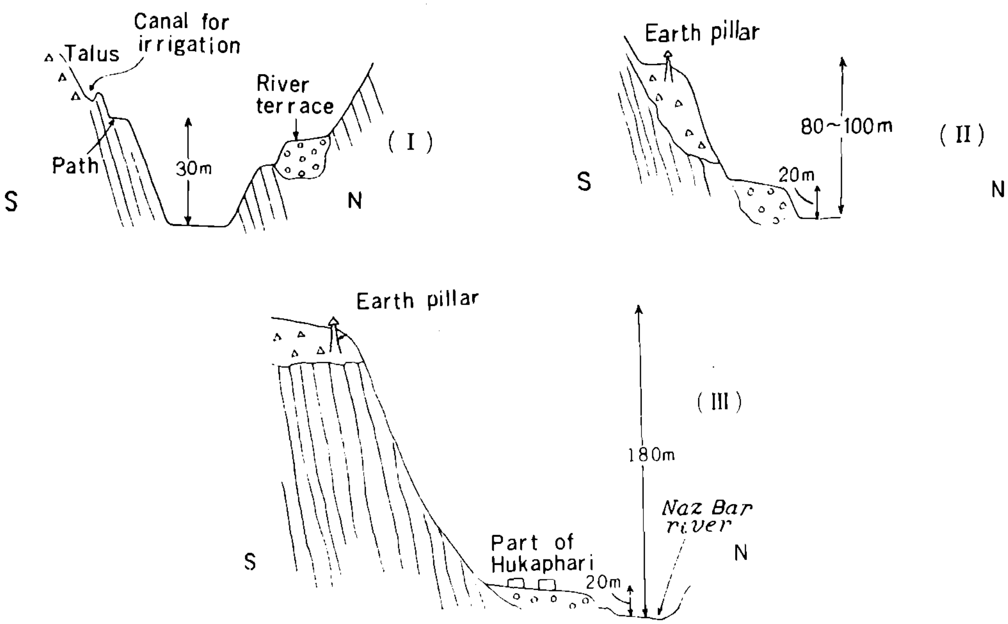


Fig. 4-56. Transverse sections of the Naz Bar valley. Aug. 9, 1957. (I), (II) and (III) pass through Points F, G and H respectively.

terrace of Hukaphari, there are two higher terraces, 80-100 m and 180 m high which are almost wholly or only in the uppermost part composed of angnlar boulder and clay forming earth pillars (Fig. 4-56, (II) and (III)). A further terrace, 300 m high, formed of Pleistocene deposits is observed from below (Point I).

From Naz Bar Deh upstream there are developed a gravel terrace, 50-70 m high

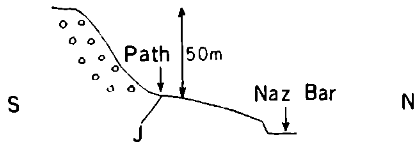


Fig. 4-57. Profile of the south bank of the Naz Bar valley at Point J. Aug. 10, 1957.

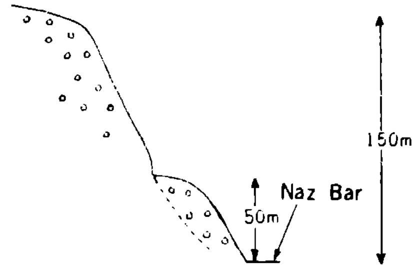


Fig. 4-58. Profile of the south bank of the Naz Bar Valley after the observation at Point L on the north bank. Aug. 10, 1957.

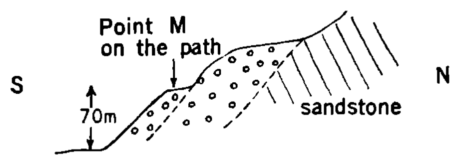


Fig. 4-59. Profile of the north bank of the Naz Bar through Point M. Aug. 10, 1957.

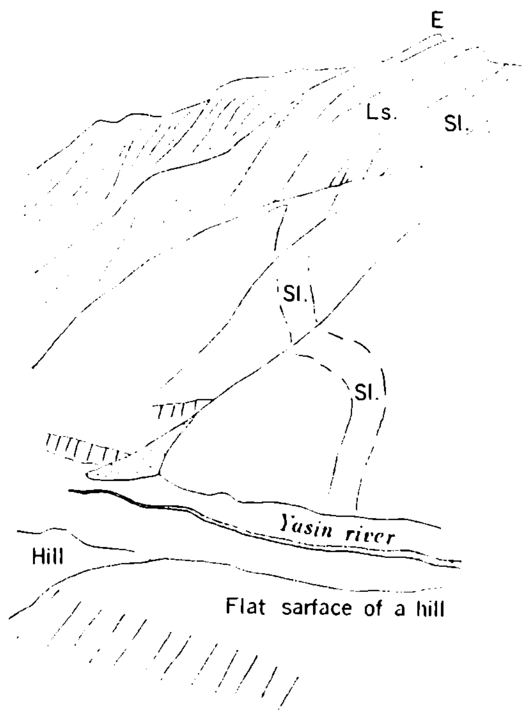


Fig. 4-60. A good exposure of the Yasin group on the left side of the Yasin river as seen from Point C (2,560 m above sea level). Aug. 8, 1957. Ls: limestone, Sl: red purple slate.

and a 150 m high boulder clay terrace with earth pillars (Fig. 4-58).

The geology of the lower course of the Naz Bar valley covered by us on this day is tabulated in descending order as follows.

Terrace deposit } ----Pleistocene
Glacial deposit }
Granite------------------Tertiary
Yasin group-----------Lower Cretaceous
Darkot group----------Permo-Carboniferous

The Green series which is considered to be overlain by the Yasin group does not occur in this area.

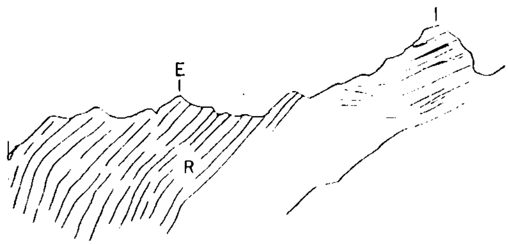


Fig. 4-61. Long distance view of the mountains on the east side of the Yasin river from Point K. Aug. 10, 1957. E: east, R: purple slate, l: limestone.

Accordine to IVANAC and others, though the expression is different, except the Quaternary, all the sediments, partly metamorphosed, in Naz Bar and the district north of the river are included in their Darkot group. Some necessary parts of their descriptions about the group are cited below. "The Darkot Group is the sediments and metamorphics, of the Upper Palaeozoic age, which outcrop between Darkot village and Darkot Pass----." "On the west side of the (Yasin) valley, south of Barkulti, slates. dipping 60°-70° north-west, are the main rock type---. On the north and south side of Thui Gol, massive quartzites are exposed; farther south, massive limestone, slates and quartzites, outcrop to Naz Bar, where they overlie the Cretaceous Yasin Group."

The grey phyllite (calcareous semi-schist, after Prof. Kojima), hard sandstone and sandstone-hornfels that the writer observed in Naz Bar are considered to belong to the Darkot group. A phyllitic slate, which is also a member of the Darkot, crops out at Point B immediately northwest of Point A where the Yasin group is well exposed. The boundary between the two groups is not expossed, but it may safely be inferred from the facts mentioned above, the distribution of rocks and the folding of the Yasin group that the the two groups make a fault-contact with each other, the fault passing in a WNW-ESE direction. Though there is no outcrop of the Yasin group by the road, the red purple slate and light grey limestone of the Yasin group are exposed in the cliff about 500 m south of the road and just east of Kamari. The Yasin group on the left side of the Yasin river is well observable from the Naz Bar valley as well as the hill west of Yasin, owing to its cospicuous colour (Fig. 4-63). The group seems to exist also in the hill on the north bank of the Naz Bar river.

The Yasin group in this area seems to be distributed and to form the structures as shown in the sketch map. (See Figs. 4-55 and 4-64).

The granite occurs on both sides of the Naz Bar, i.e. on the north side between Shimllik Bar and Kamari, whereas on the south side soutn of the east-west line about 1-2 km south of the Naz Bar, west of Balibalsir Bar, one of its large tributary. The granite seems to be distributed in accordance with the geological structure, for example it extends nearly parallel to the strike of strata. According to Prof. Kojima, some of the so-called granite in this district is biotite-granodiorite. The sandstone of the Darkot group is indurated near the contact with the granite.

The Pelistocene deposits in Naz Bar are all terrace deposits and have been mentioned above in connection with the topography. They are classified into (1) fluviatile deposits and (2) probable glacial deposits. While the former are gravel deposits composed of rounded cobble and boulder and sandy matrix, the latter are made up of angular or subangular boulder and clay matrix with vertical joints. The probable bounder-clay deposits are, when subjected to erosion, are liable to form earth pillars.

On August 10, we proceeded from Latin Kush to our camp at the northeast foot of Naz Bar An. The distance between the two places is 14 km and the altitude above sea level of the latter is 3,950 m. (See Fig. 14-64).

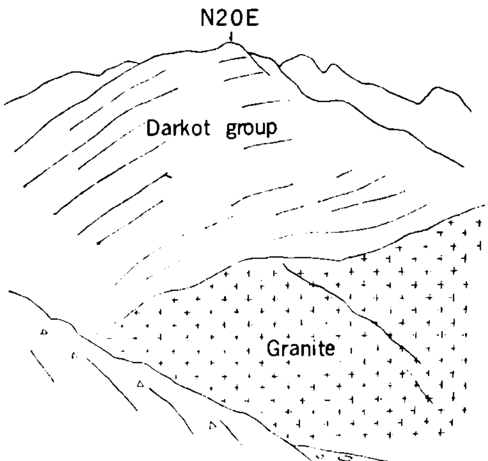


Fig. 4-62. A mountain composed of the Darkot group and granite, as seem from Point A. August 10, 1957.

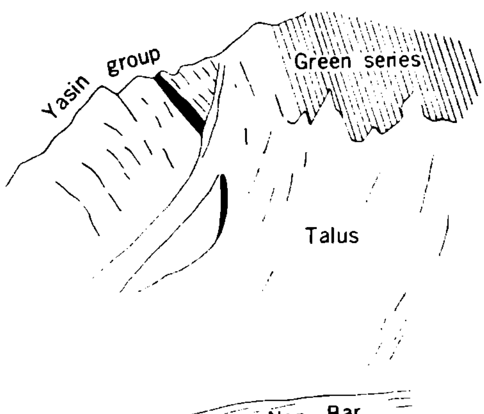


Fig. 4-63. A part of the right side of Naz Bar as seem from Point B. August 10, 1957.

The Latin Kush camp was set on the bed of Naz Bar and below a river terrace, 300 m wide, 20 m high and 1 km long. A similar terrace with a height of 15-20 m again continues from the Multan river, a tributary of Naz Bar westward for 2.5-3.0 km on both banks of Naz Bar.

From this part of Naz Bar upward, glacial features are conspicuous. There are not only moraine walls with cirques on the south side of Naz Bar, 60-120 m above the river bed, but also an old moraine wall, 12-15 m high on the present river bed of Naz Bar. Further an actual small (60 m ? long) glacier is observable on the south side of Naz Bar, about 100 m above its bed. Beolw the snout of this glacier and above a moraine wall on the south side of Naz Bar, there is a clay deposit with angular boulders.

The geology in this part of the Naz Bar valley is stated below. The lower half of this area, particularly on the north side of Nar Bar, is composed of the metamorphosed hard Darkot sandstone dipping north-northwest at 60°, whereas the upper half of this area, especially on the northern side of the Naz Bar valley, is largely occupied by the granite which is intrusive into the Darkot group and has metamorphosed the Darkot rocks. The granite body crops out extending in a ENW-WSW direction with a width of 2 km (Fig. 4-64). On the south side of

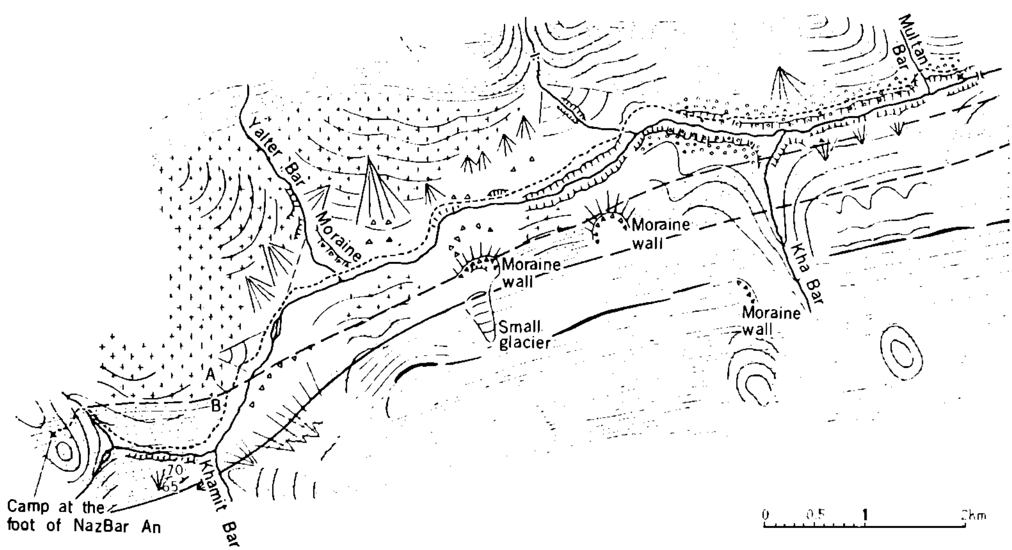


Fig. 4-64. Sketch map between Latin Kush and the eastern foot of Naz Bar An. August 10, 1957.

the granite, the Darkot sandstone seems to lie in accordance with the general trend of the granite. Further on the south side of the Darkot group just mentioned is the Yasin group with its conspicuous red purple slate, the two groups making a fault-contact. The dark green amphibolite of the Green series composing the higher part of the mountains on the south side of Naz Bar extends from ENE to WSW on the south side of the Yasin group. Lying between the Darkot group on the north and the Green series on the south, the Yasin group on the right bank of Naz Bar becomes narrower from Khar Bar west-southwestward. When the fault separating the Yasin from the Darkot crosses the Khamit Bar river, the Yasin at last disappears and from there westward the Darkot contacts with the Green series directly.

On August 11, leaving the camp at the northeast foot of Naz Bar An and crossing the pass, we descended as far as Ano Gol, where we set camp. The distance between the two camps is 16 km and the altitude above sea level of the Ano Gol camp is 3,725 m. (Fig. 4-65).

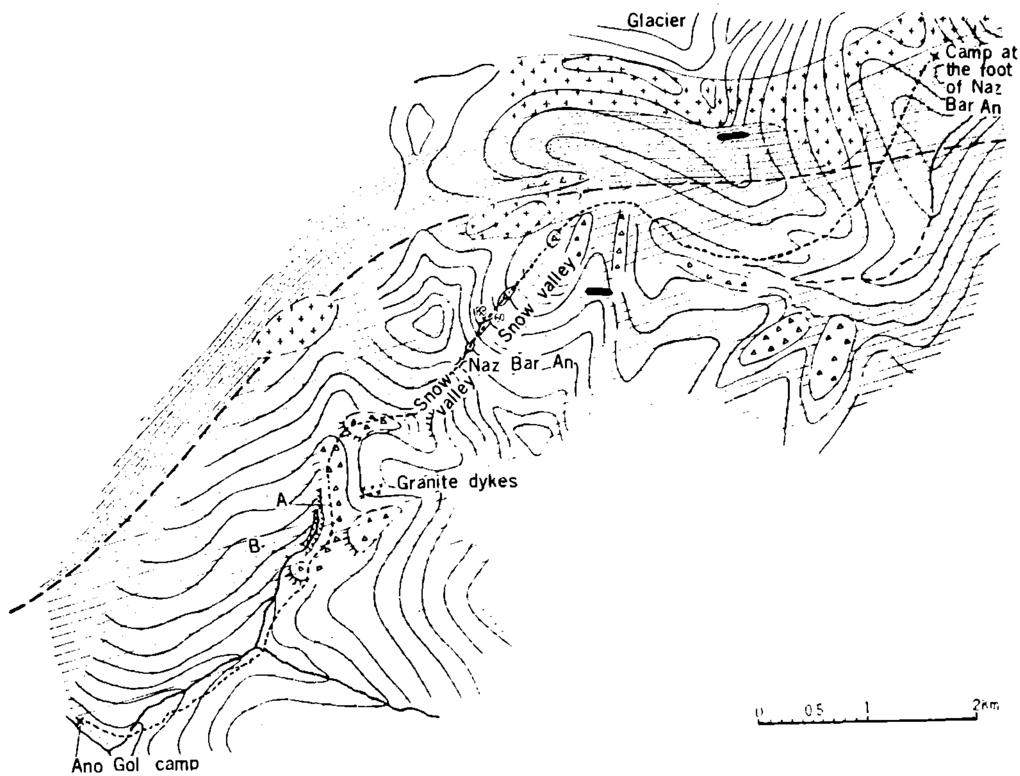


Fig. 4-65. Sketch map between the camp at the eastern foot of Naz Bar An and the Ano Gol camp. August 11, 1957.

Though the valley is not deep in this upper course of Naz Bar and no actual glacier is visible from our route, there are abundant relics of former moraines, ground and lateral on the river beds higher than 4,200 m. Midway between Naz Bar An and the Ano Gol camp, there is a ground moraine, 1 km long, 100-150 m wide and 10-16 m high, filling the bed of the valley leading from Naz Bar An to Ano Gol. The upper surface of this moraine fill is somewhat uneven. The moraine fill has been cut by the present river as deep as 5-15 m along the right margin of the valley.

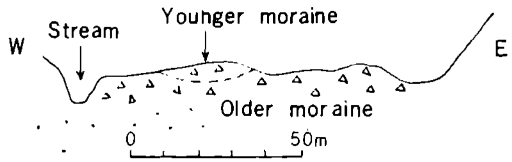


Fig. 4-66. Section of a moraine filling the valley from Naz Bar An to Ano Gol at point A. August 11, 1957.

As shown in Fig. 4-66, the ground moraine consists of the older one coated brown black; the older is covered by the younger. While the older moraines are of greenish black rocks belonging to the Green series, the younger ones are of fresh granite. This moraine terminates at the height of 4,250 m.

The geology of the Naz Bar An district is the west-southwest extension of that of the district covered by us on the preceding day. The longitudinal fault on the right bank of the Naz Bar valley separating the Yasin group on the south side from the Darkot group on the north side seems to extend west-southwestward, crossing Ano Gol, as far as Mastuj. The fault in question changes its direction from WSW to SW and passes through a point about 1.5 km to the north of Naz Bar An. The Green series on the south side of the fault is composed largely of green black amphibolite or green phyllite (chlorite-calcite-muscovite slate and calcareous green semischist after Kojima). The red slate seems in some cases to be included in the Green series. In the Green series, there are many small parts stained yellow brown due to the oxidation of sulphide ore minerals.

The Darkot group in this district also seems to include red slate. The granite which has been intruded into the Green seies as well as the Darkot group crops out imtermittently as shown in the sketch map, the general trend of its outcrops being in accordance with that of the fault. As in the outcrop to the immediate east of the route from Naz Bar An to Ano Gol, there are granite dykes extending in a nearly

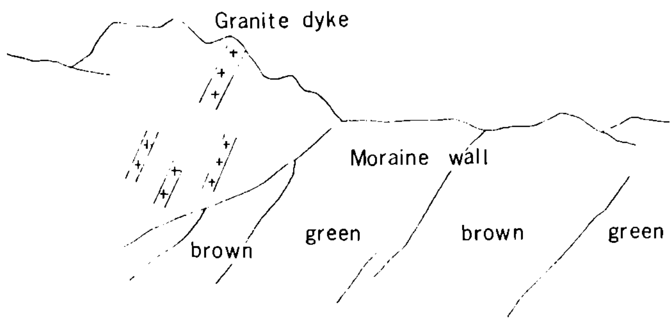


Fig. 4-67. Granite dykes in the Green series and a moraine wall with different colour bands as seen from point B. Aug. 11, 1957.

E-W direction in the Green series (Fig. 4-67).

On August 14 we walked from the Ano Gol camp to the Rashkot camp o nthe right bank of the Bahushtaro Gol river for 8.3 km, the altitude above sea level of the latter place being 3,410 m. On the next day, Aug. 15, we proceeded down the Bahushtaro Gol river as far as the entrance to the Zagar An pass, where we set the Bahushtaro camp (Fig. 4-69). The horizontal distance between the Rashkot and the Bahushtaro camps is only 5.5 km, the altitude above sea level of the latter being 3,153 m.

The Ano Gol camp was set on a wide dry river-bed of Ano Gol running straight nothwestward. To the immediate south-southwest of the camp, there is well visible an actual, though small, glacier on the left bank of Ano Gol. The glacier is more than 600 m long; the horizontal distance from the camp to the snout of the glacier in question is 500 m (Fig. 4-68).

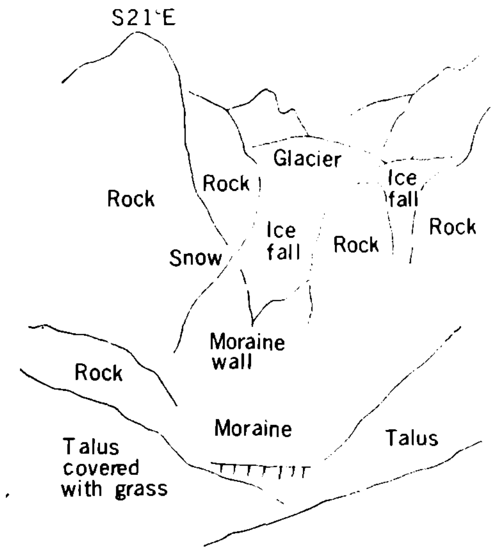


Fig. 4-68. Small glacier in a left bank tributary valley of Ano Gol as seen from Ano Gol camp. Aug. 12, 1957.

On the right bank of Ano Gol as well, there is a moraine wall in a tributary valley at point A, 1 km from the Ano Gol river, but no actual glacier has been visible above the moraine wall.

There is also a moraine (west of Rashkot camp) above the flat alluvial fan of the Ju Bar river, a right bank tributary of Bahushtaro Gol near the summer hamlet of Haringal Shāl. An actual glacier at the source of Ju Bar is visible far from the above mentioned fan. (Fig. 4-69).

There are water falls with three or four steps in a left bank tributary valley

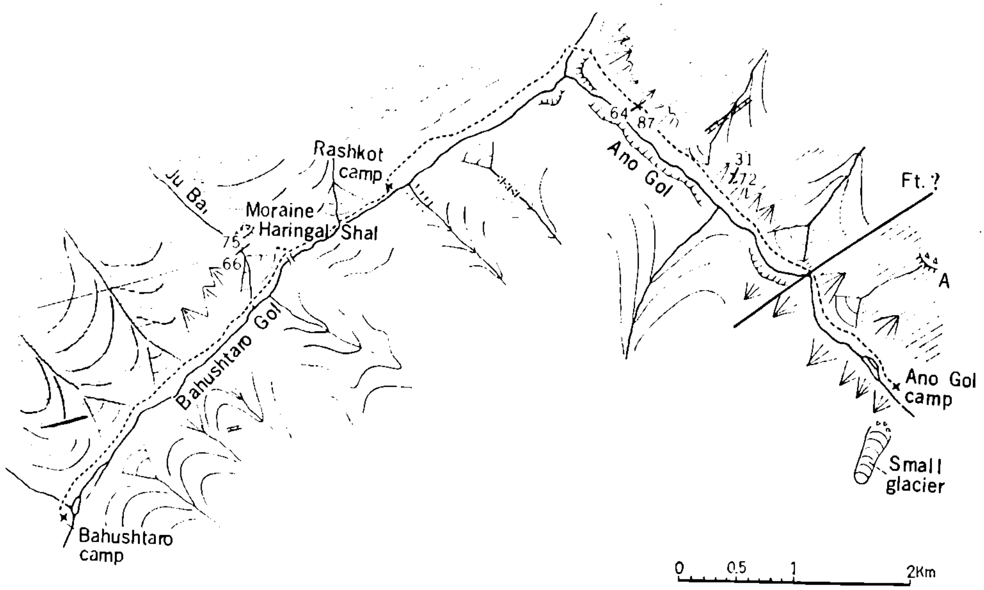


Fig. 4-69. Sketch map along the route between the Ano Gol camp and Bahushtaro camp. August 14 and 15, 1957.

of the Bahushtaro valley to the east of the Rashkot camp.

The geology of the district covered by us in these two days is the Darkot group and the Green series. The boundary between these two formations is the west-southwest extension of the Naz Bar fault and seems to cross the valley of Ano Gol at a point 1.2 km northwest of the Ano Gol camp. The general trend of strata and also of the Naz Bar fault is NE-SW. The Green series is composed of dark green rocks, probably amphibolite, while the Darkot group consists of black phyllite, sandstone, whitish quartzite with a small amount of mica-schist and red slate and the intercalation of limestone.

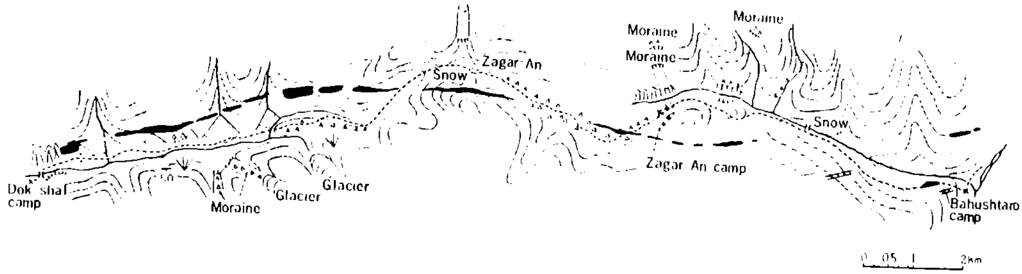


Fig. 4-70. Sketch map along the route between the Bahushtaro and Dok Shāl camps. Aug. 16 and 17, 1957.

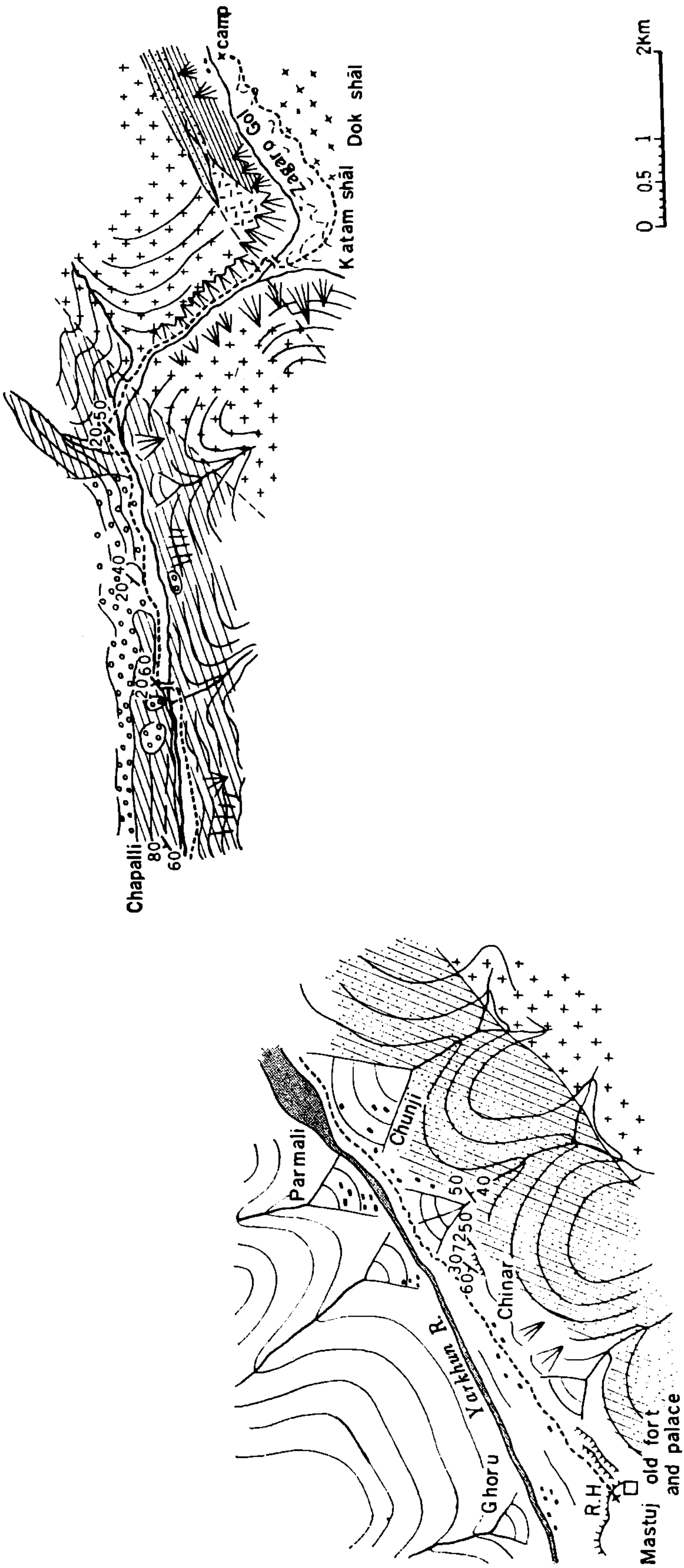


Fig. 4-71. Sketch map along the route between Dok Shāl and Mastuj. August 18 and 21, 1957.

On Aug. 16, leaving the Bahushtaro camp, we went up a valley westward as far as the east end of the ground moraine of the extinct glacier which occupied the above-mentioned valley and set the Zagar An camp there (Fig. 4-70). The distance between the two camps is 8 km and the height above sea level of the latter is 4,100 m. On the next day, August 17, crossing Zagar An (5,009 m), we proceeded to the small village of Dok Shāl where we set the Dok Shāl camp. The distance between two camps is 14.3 km, the height above sea level of the latter being 3,660m (Fig. 4-70).

There are many glacial features along the route between the Bahushtaro and the Dok Shāl camps. On both sides of Zagar An, there are more than 4 km long ground moraines in the main valleys. As mentioned above, we set the Zagar An camp on the ground moraine, on both sides of which there are lateral moraines. The present stream flows on the north side of the northern lateral moraine. In the

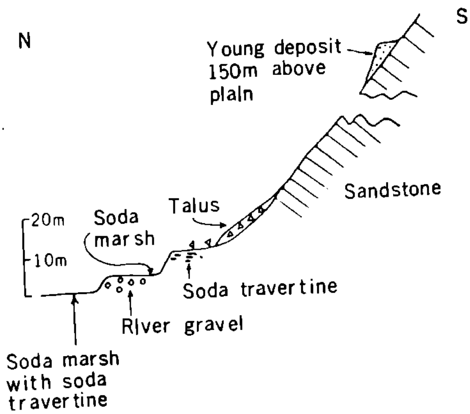


Fig. 4-72. Transverse profile of the south half of the Yarkhun valley to the immediate east of the Mastuj R.H. Aug. 21, 1957.

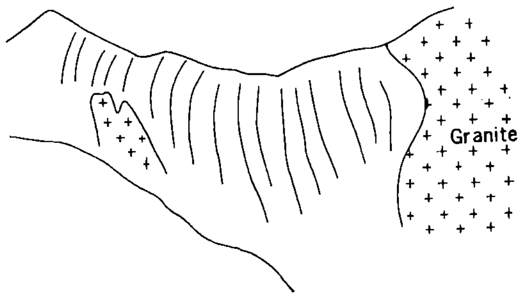


Fig. 4-73. Eastward view from Point August 18, 1957.

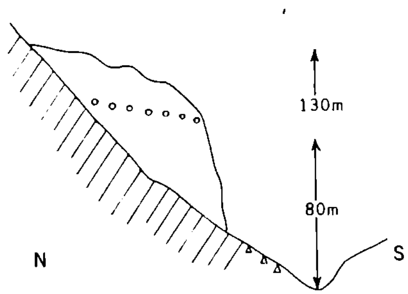


Fig. 4-74. Transverse profile of the Zagaro Gol valley at Point, August 18, 197.

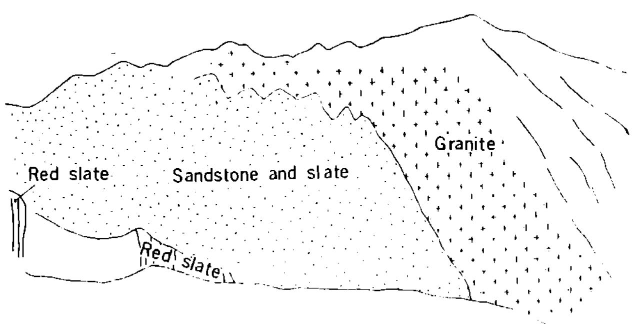


Fig. 4-75. Westward view from the Dok Shāl camp. Aug. 18, 1957.

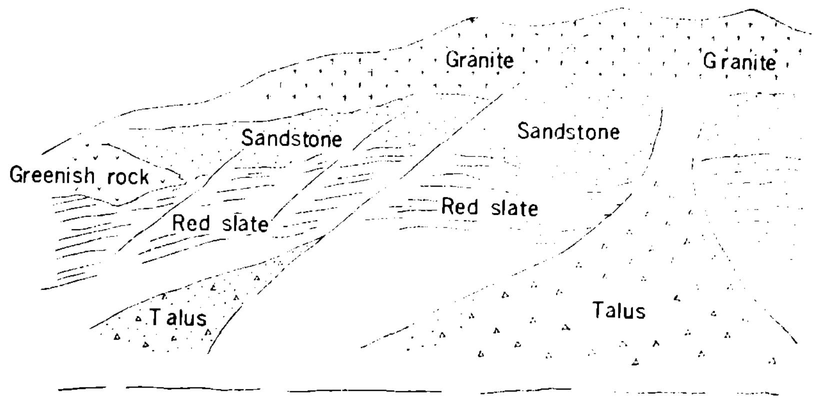


Fig. 4-76. Northward view from the Dok Shal camp. August 18, 1957.

case of the ground moraine occupying the main valley on the west side of Zagar An, the present stream flows on the north side of the said ground moraine. Though there are moraine walls in the tributary valleys on both sides of Zagar An, the actual glaciers seem to be restricted in the branch valleys on the west side of Zagar An, and the moraine walls in the branch valleys on the east side of the said pass are located higher than those on the west side (Fig. 4-70).

The district along the route from the Bahushtaro camp to the Dok Shāl camp is composed of the Darkot group which is the westward extension of the group of the district along the route between the Ano Gol and the Bahushtaro camps. The Darkot Group in the former district mainly consists of black slate with the intercalation of one or two conspicuous red purple slate beds, 50-100 m thick, and lenticular limestones and rarely green calcareous phyllite. Though somewhat sinuous, the general strike of the Darkot group is E-W. The bed is nearly vertical, dipping north or south.

On August 18, we proceeded from the Dok Shāl camp to Mastuj, an administrative centre on the left bank of the Yarkhun river. (Fig. 4-71). The distance from Dok Shāl to Masuj is 22 km, the height above sea level of Mastuj being 2,275 m. Owing to the short of time, however, the geological surveying along the route between Chapali and Mastuj was not done on this day. A part of the surveying mentioned above, that is between Mastuj and Chunji was tried on August 21.

Part 2. Geology of the Upper Swāt and the Eastern Hindu Kush

The geological system in the Upper Swāt and the Eastern Hindu Kush is tabulated in descending order as follows.

Age	Eastern Hindu Kush	Upper Swāt
Pleistocene	8) Terrace deposits	8′) Terrace deposits
Tertiary	7) Granite of Ghizar river	
EarlCretaceousy	6) Yasin group of Yasin 5) Green series of Ghizar valley	
	4) Granite of Shunji Gol	4′) Granite in the vicinity of Kalām
Permian and Carboniferous	3) Darkot group of Darkot	? 3′) Kalam group in the vicinity of Kalām
Unknown		2) Gneissose granite of Ushū Gol
Unknown		1) Gneiss of Unshū Gol

(1) Gneiss of Ushū Gol is biotite- or biotite-hornblende-gneiss with marked foliation. The age of this gneiss is unknown, but it is apparent that it is older than (2) gneissose granite with numerous large porphyroblasts of felspar of Ushū Gol, because the former is cut by the latter. There is no direct contact between (3') and (1) or (2).

(3') Kalām group in the vicinity of Kalām consists of hornfels and phyllite. Though it is apparent that the Kalām group is a metamorphic formation affected by the granite on the southeast side (4'), the age of the Kalām group is unknown. The Kalām may be contemporaneons with the Darkot group. It may be early Mesozoic. In my the writer's surveyed area, the Kalām group is not known elsewhere.

The name of (3) Darkot group was given by IVANAC, TRAVES and KING in 1956 to the sediments and metamorphics of the Upper Palaeozoic age, which crop out between the Darkot village and Darkot pass to the north of Yasin, though the formation was first remarked by HAYDEN in 1915. The formation between the Yasin group and the Karakoram granodiorite south of the Darkot village was assigned to the Darkot group by IVANAC and others.

4) Granite of Shunji Gol is overlain unconformably by the Green series (5) and is cut by a dyke of volcanic rock leading to the latter. (4) Granite in the vicinity of Kalām may correspond to (4) granite of Shunji Gol.

(5) Green series is a thick formation composed of green pyroclasts and volcanic lavas associated with limestones and other sediments. As to the geological age of the Green series, we have obtained a limestone pebble with coral fossil *Thamnastria matsushitai* Eguchi on the right bank of the Ghizar river, downstream Shamran. This fossil-bearing limestone pebble must have been derived from the Green series of the southern mountains, consequently the earliest Cretaceous age of the Green

series may be inferred.

The Cretaceous beds were first discovered by HAYDEN in 1914 at Yasin, and the fossis collected by him therefrom were afterwards described by DOUVILLÉ. After the War II the beds were again surveyed and the fossils therein were collected by IVANAC, TRAVES and KING in 1951 who gave the name of the Yasin group (6) to the lower Cretaceous beds. A. DESIO also visited Yasin in 1954 and 1955, making clear the stratigraphic sequence of the Cretaceous and collecting the molluscan, coral and foraminiferal fossils therefrom.

(6) Yasin group consists of light grey limestone, red shale, green slate, grey sandstone and green conglomerate and in addition, according to Ivanac and others, tuff and lava. The Yasin group seems to be underlain conformably by the Green series.

The Yasin group as well as the Green series has been intruded by (7) granite of the Ghizar valley. The exact age of this granite 7) is unknown, but it may be Tertiary.

The geological structure of the Eastern Karakoram and the Upper Swāt is characterized by the zonal arrangement of rock formations including granites which are inferred in some cases to be separated by strike or nearly strike high-angle faults (partly reversed) from each other. One of these faults runs from the south of Mastuj to the north of Yasin, separating the Darkot group on the north side from the Yasin group and the Green series on the south. The writer should like to give to it the name of the Naz Bar fault. All the formations are folded. The folding is generally unsymmetrical and closed.

Notice. Concerning the distribution of the Yasin group, the readers are requested to refer to Figs. 4-55 and 4-64, not to the Geological Map annexed to this volume.

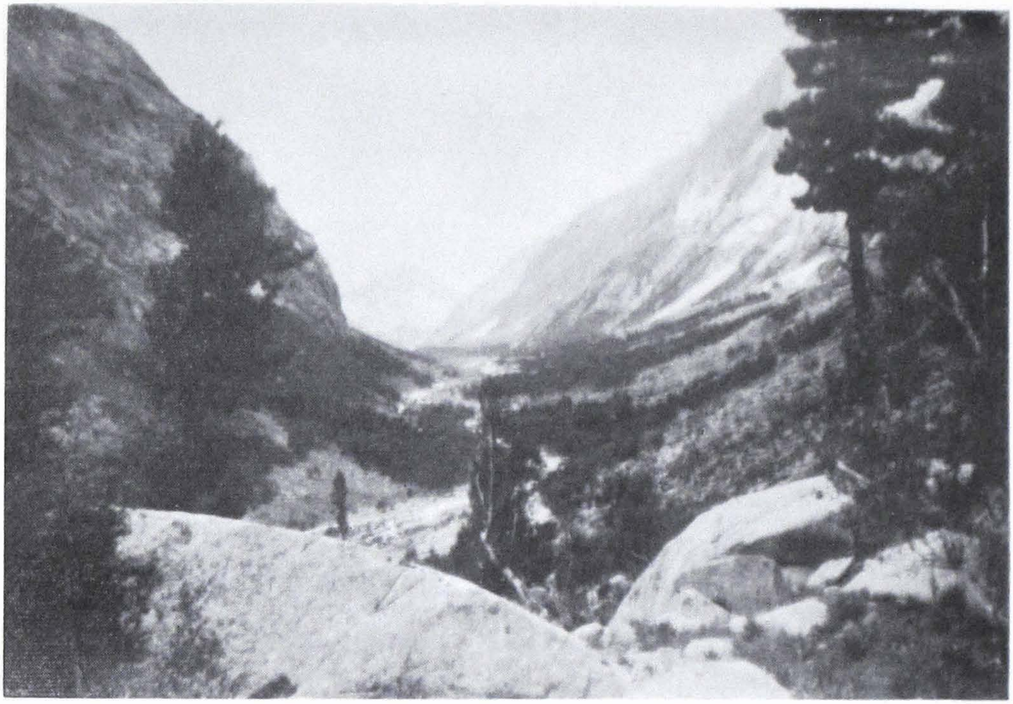


Fig. 1. Northwest view of the Upper Swat U-shaped valley as seen from the neighbourhood of the Diwangar camping place. July 22, 1957.

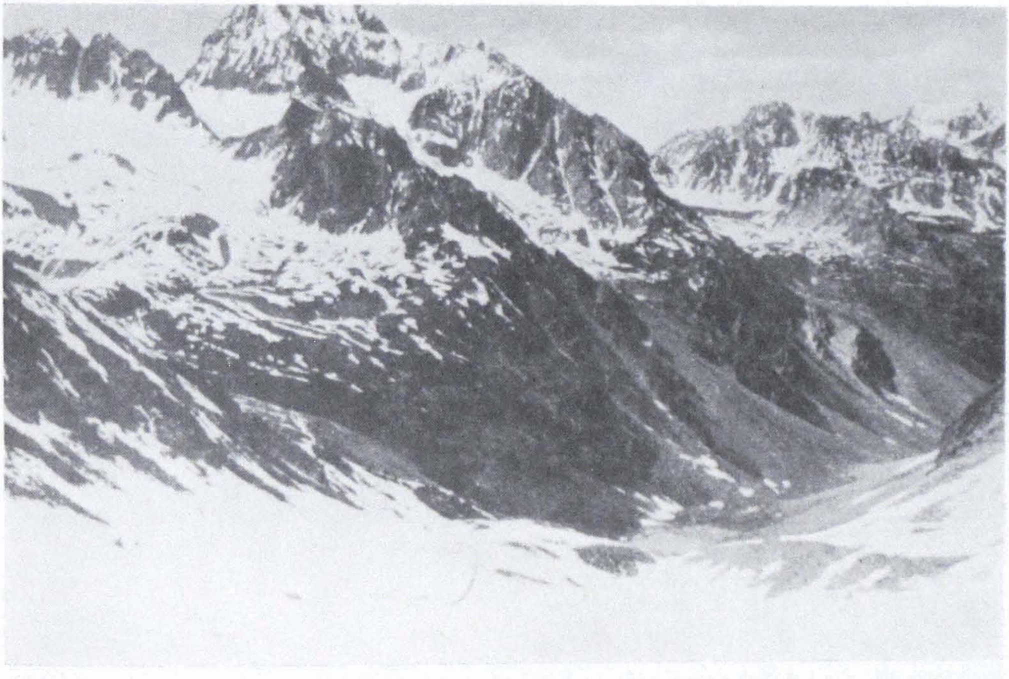


Fig. 2. Ciques and the U-shaped valley in the north of the Dadarili Pass as seen from the Pass. July 24, 1957. (Photo. by F. Okitsu)

Fig. 3. Glaciated and polished bed rock at the mouth of the valley of Shunji Gol as seen from the Ghizar camping place. July 29, 1959.

Fig. 4. Striated surface of the bed rock shown in Fig. 3. July 29. 1957.

5. Summary of the Results of the Geological Researches in the Expeditions 1956 and 1957

By Susumu MATSUSHITA and Kazuo HUZITA

Each rock zone recognized in the surveyed area is separated by so great faults, that it is very difficult to state the detailed stratigraphical relationships among them. The fossil assemblages found in the Yasin valley, however, suggest the geologic age of the Darkot group and of the Yasin group at least. Moreover, the discovery of the fossil corals from the Green series has thrown light upon the determination of its age, which had been unknown up to that time. Some researchers have tentatively correlated the Green series with the Panjal Trap in the Kashimir basin. Although there are many problems about the geologic ages of the granitic rocks, the probable positions in the table of the rock division are determined as shown in the following. The jointed area between the Eastern Hindu Kush and the Western Karakoram is called "Syntaxial area" in this chapter, which includes the Yasin and the Ishkuman areas.

Division of geological sequence in the Western Karakoram and the Eastern Hindu Kush

Division of the Area / Age	Eastern Hindu Kush and Upper Swāt	Syntaxial area	Western Karakoram	No. of division
Unknown; probably Tertiary	Granite of Ghizar valley	Granite of Gupis and Gakuch	Pegmatite dyke near Dusso	(6)
Early Cretaceous		Yasin group of Yasin		(5)
	Green Series of Ghizar river	Green Series of Gupis and Gakuch	Green and black phyllite of Tormik and Chalt	(4)
Unknown	Granite of Shunji Gol	Granite of Karambar	Granite of Baltoro	(3)
Perminan and Carboniferous	Darkot group of Mastuj	Darkot group of Darkot and Ishkuman	Calcareous rock and conglometrate of Chalt. Slate and limestone of Gasherbrum	(2)
Unknown	Gneiss of Upper Swāt	Injection gneiss of Gakuch	Injection gneiss and mica-shist of the Indus and Braldu	(1)

Stratigraphy

1) *Gneiss of Upper Swāt* This gneiss is widely exposed in the upper part of the Swāt valley and forms the watershed between the Swāt Kohistan and the Gilgit Agency. It is composed of biotite-hornblende-gneiss with distinct foliation and partly of white gneissose granite with numerous large porphyroblasts of felspar. Although the relationship with other rock bodies not confirmed, this gneiss is regarded as the oldest rock in the surveyed area, considering from its rock facies. The injection gneiss masses exposed on a small scale near Gakuch or between Jaljulit and Gupis probably correspond to this gneiss.

2) *Darkot Group* The Darkot group named by IVANAC, TRAVES and KING in 1956 comprizes the sediments and metamorphics of the Upper Palaeozoic age, which crop out between the Darkot village and the Darkot Pass. The formation exposed between the Yasin and the Umalsit villages has been assigned to the Darkot group. It is composed chiefly of black slates, quartzites and limestones intercalated with conglomerates or conglomeratic sandstones.

Along the Yasin valley, Fusulina limestones were found near Darband and Sanshi. The metamorphic effects on the Darkot group seem to increase eastwards. The phyllites intercalated with limestones and conglomerates occupying the south of Imit are believed to be the eastern extension of the Darkot group. In the area between Chalt and Nilt, Hayden reported that the rocks of the Budalas hill-side consist of a calcareous series dipping at high angle to the north and are overlain by crushed conglomerate, and that above Chalt, the valley of the Hunza river follows the strike, and has been cut out along a crushed anticline. A crystalline limestone is seen on both sides of the river, and appears to be overlain by the conglomerate series. These series also may belong to the Darkot group. This group was confirmed to extend as far as Mastuj in similar facies to that of the type locality.

3) *Granite of Shunji Gol* A granitic rock mass which is overlain unconformably by the Green series has been found in Shunji Gol, a right bank tributary of the Ghizar valley. This mass is composed of hornblende-granite or hornblende-biotite-granite, and has been injected by dyke rocks belonging to the Green series. There is no granite of which such a clear relationship with the Green series could be confirmed except that of Shunji Gol. However, there is a possibility that the so-called "Karakoram Granodiorite", which continues far from Baltoro to Batura and constructs the highest backbone of the Karakoram range, intruding into the Palaeozoic formations, may be contemporaneous with this granite of Shunji Gol.

4) *Green Series* This is a thick formation consisting of basic volcanic lavas and green pyroclasts associated with limestones and other sediments. This series typically develops along the Ghizar river and its northern tributaries, the lower half

of the Ishkuman and Yasin valleys.

The eastward extension of this series which could be traced along the Naltar valley is represented by green pillow lava found at the south of Chalt. It constructs Mt. Rakaposhi and then reaches the Tormik valley, where the effect of metamorphism increases considerably. The tendency that the grade of metamorphism becomes higher eastwards is remarkable in this series just like in the case of the Darkot group.

As to the geological age of the Green series, some reseachers have assigned to the Triassic, correlating it to the Panjal Trap in the Kashimir basin. A limestone block containning coral fossil, *Thamnastria matsushitai* EGUCHI, however, has been obtained near Shamran on the right bank of the Ghizar river, which must have been derived from the Green series of the southern mountains, so that the earliest Cretaceous age of the Green series may be inferred.

5) *Yasin Group* The distribution of the Yasin group is confined to the vicinity of Yasin and to the south bank of the Naz Bar valley. It consists of light grey limestone, red shale, green slate, grey sandstone and green conglomerate, in addition. It is not easy to determine the stratigraphical relation between the Green series and the Yasin group, because the geological structure in the neighbourhood of the Yasin village is complicated. The Yasin group may be inferred to be underlain conformably by the Green series, however, although the reseachers who correlate the Green series to Panjal Trap have suggested the unconformable relation between them. If the writers' opinion might be correct, the Yasin group would be be regarded as a formation occupying the uppermost horizon of the Green series.

6) *Granite of the Ghizar valley* The Green series and probably the Yasin group as well have been intruded by the granite of the Ghizar valley along the Ghizar and Gilgit rivers. This zone is regarded as the northern border of the granite batholith constituting the southern mountain terraine of the Ghizar-Gilgit river.

The age of intrusion of this granite cannot be determined precisely, but it may be Tertiary. Though the western Karakoram correlative of this granite is not known, the Rb-Sr age of a muscovite-pegmatite cutting a biotite-gneiss near Dusso on the right bank of the Braldu river is 27×10^6 years.

Geological Structure

The geological structure of the surveyed area is characterized by the zonal arrangement of rock formations including granites which are inferred in some cases to be separated by strike or nearly strike high-angle fault (partly reversed) from each other.

(Replace the first 3 lines on p. 92 by the following lines.)

One of these faults runs from the south of Mastuj, through the north of Yasin, Phakor in the Ishkuman valley, Chalt and the Chogolungma glacier, to the Shigar valley, separating the Darkot group, phyllite with crystalline limestone or gneiss formation on the northern side from the Yasin group, the Green series and the green and black phyllite on the southern side.

6. Metamorphic and Plutonic Rocks of the Karakoram and Hindu Kush

By George KOJIMA*

Abstract

The specimens of metamorphic and plutonic rocks collected through the Expeditions of 1955, 1956, and 1957 to the Karakoram and Hindu Kush have been studied petrographically. The results are listed on the petrographic table in the Appendix. Based on the data of petrographic observation, the charts showing the metamorphic facies, the type of anatexis, preservation of basemental crystalline rocks in the area concerned have been constructed. From these charts, the zonal arrangement of the terrains with different characters in the NW-Karakoram and East Hindu Kush, together with the northern extension of the Nanga Parbat gneiss dome, has been discussed. The distribution and the petrographic character of plutonic rocks show intimate relationship with the geotectonic division of the basement.

Contents

I. Introduction

The area comprising the Northwest Karakoram, the East Hindu Kush, and the Upper Swāt represents the key position of the Great Himalayan syntaxis. Whereas fairly amount of knowledge has hitherto been accumulated in the peripheral areas of the district in question through the painstaking surveys of precursors, as introduced by Prof. MATSUSHITA in the preceding pages of this volume, the main portion of the district has been left almost untouched until now. Prof. MATSUSHITA and Prof. HUZITA, who attended the Expeditions of 1955, 1956, and 1957, collected a number of rock specimens from the routes during their reconnaissance surveys. They have left most of those specimens to the petrographic study of the author. Unfortunately, the present author has not been able to have a chance to visit the district, and, for that reason, he can hardly realize the true extent of respective rock type in the field. Although petrographic examination on those specimens has not been completed, preliminary results are shown in the petrographic table attached as the appendix to this paper.

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It seems quite difficult or even hazardous for a person, who has only studied separate specimens in the laboratory without his own observation in the field, to discuss on the geological problems of such extensive area with complex structure as the district under consideration. However, a vast extent of the area covered with the locality points of rock specimens allured the author to construct several charts showing the distribution of some petrological deductives, such as metamorphic facies, extent of anatexis, preservation of crystalline rocks of the basement, and rock types of plutonic intrusives, which should have any bearing on the development of the Himalayan orogen. The author wishes these charts would contribute to understanding the complex nature of the orogen and to focusing the future survey in the district.

The author wishes to express his sincere gratitude to Prof. MATSUSHITA of Kyoto University and Prof. HUZITA of Osaka City University, who kindly informed the author of the geology of the district.

II. Metamorphic Behaviours

To construct the chart showing the distribution of metamorphic grade through an orogen is a fundamental task for understanding the thermal structure in the space of orogenesis. This kind of work has been tried in several orogens in the world, and, in particular, the distribution of metamorphic grade over comparatively extensive area has been made clear in Scotland and the Penninic Alps, the latter of which is quite important in the present case, because it relates to the Alpine orogenesis to which the area in question belongs. In the Penninic Alps, E. NIGGLI (1960) has shown the distribution of several index minerals, such as stilpnomelane, chloritoid, alkali-amphibole, kyanite, and sillimanite. In making the chart, he selected those minerals as believed to have been recrystallized by the Alpine metamorphism. E. WENK (1962) has later drawn the isograds of the Alpine metamorphism on a different standpoint in the Lepontine Alps. The isograds are represented by lines of equal content of anorthite molecule of plagioclase in metamorphic carbonate rocks in the Mesozoic. His result is quite distinct, and he has succeeded in realizing the isothermal surface through the complicated structure with high relief.

In the northwestern part of the Himalayan mountain chain, no such work has been presented except in the Nanga Parbat district. P. MISCH, who participated in Willie MERKL's 1934 Expedition to Nanga Parbat, has reported on the metamorphism and synorogenic granitization of the district (1935, 1946, and 1949). In his recent paper (1964), he showed the distribution of metamorphic grade based on the assemblage of calc-silicate minerals, together with the occurrence of some index minerals, such as scapolite, kyanite, and sillimantie.

The author has selected from the rocks examined the critical assemblages of metamorphic minerals for defining the metamorphic facies as defined by ESKOLA

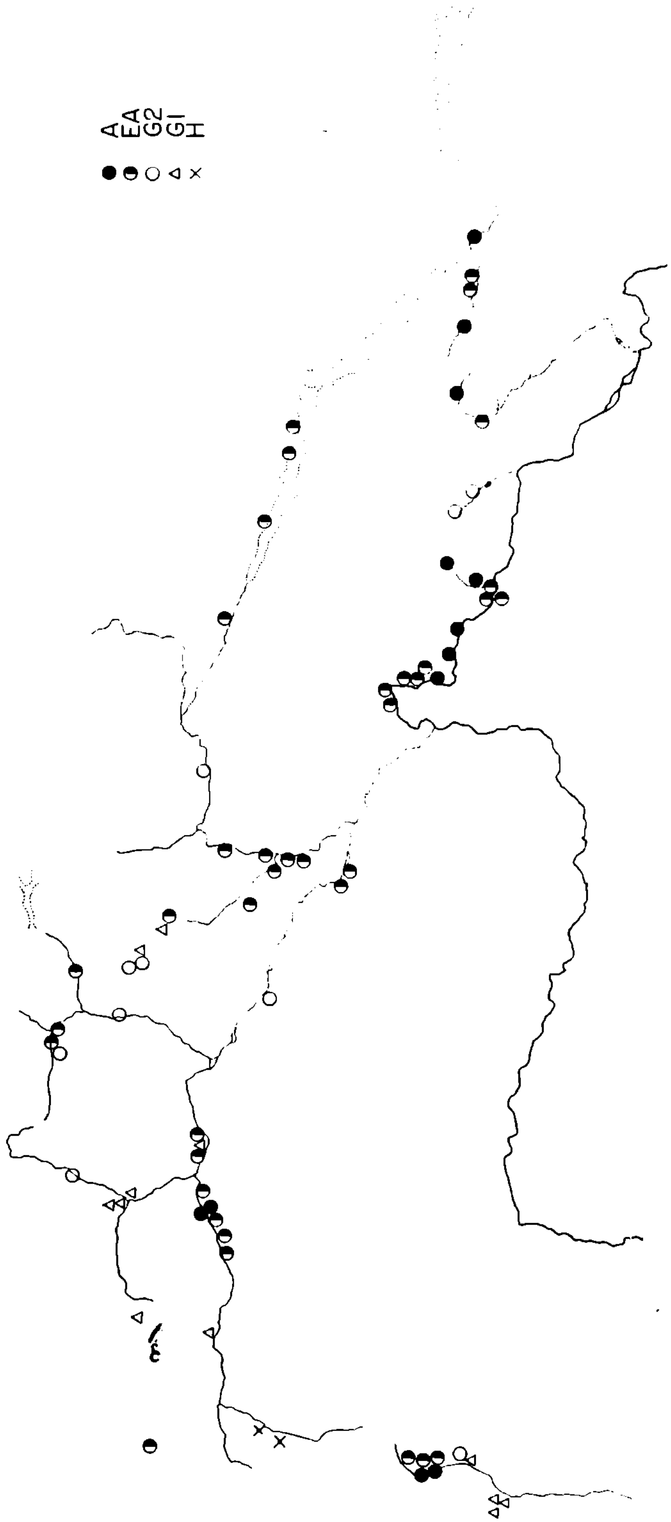

Fig. 1 Distribution of metamorphic facies
A: amphibolite facies, EA: epidote-amphibolite facies,
G2: greenschist facies (biotite-zone), GI: *ibid.* (chlorite-zone),
H: pyroxene-hornfels facies.

(1939), with the result as shown in Fig. 1. It is not possible for the present author to distinguish between different phases of mineralization connected with separate orogenic cycles. Accordingly, Fig. 1 should possibly contain metamorphic facies both of the Alpine cycle and the preceding ones.

Recently, H.-J. SCHNEIDER, who participated in the German-Austrian Himalaya-Karakoram Expedition in 1954, has reported on the tectonics and the igneous activity in NW-Karakoram (1957), and, later in 1960, on the development of geosyncline and related igneous activity from the Late Palaeozoic to the Early Mesozoic in the NW-Himalaya and -Karakoram. He has surveyed the Batura Glacier district to the north of Hunza and the area along the Hunza River, which runs across the central part of the area in question. SCHNEIDER has divided the area into six zones, namely, the zones V to I and the zone H, from the north to the south. The zone V is called the Tethys-Karakoram, consisting of non- or weakly metamorphic Upper Palaeozoic to Lower Mesozoic beds, representing the southern marginal part of the so-called "*Pamirische Scharung*" which has been affected mainly by the Variscan orogenesis. The zone IV, which occupies the main ridge of the Karakoram, Batura-Mustagh, represents the axial zone, consisting of the "Batura-Mustagh hornblende-granite" and the series of older gneisses (*Serie der alten Gneise*). The former comprises plutonic rocks ranging from postkinematic aplitic granite to dioritic hybrid, and is believed to correspond to the Transhimalayan granite (DAINELLI 1934). The zone III consists of crystalline schists, such as crystalline limestone, carbonate-garnet-amphibolite, garnet-biotite-schist, and quartzite. The zone II has been named the "*Chalt-Schieferserie*", in which basic igneous materials are predominating. The zone I, consisting of hornblende-gneiss and granitic rocks, is correlated to the same members of the zone II. The zone H is represented by the formation of hornblende-gneiss of the Gilgit district, which has been regarded by SCHNEIDER as the northern extension of the outer mantle of the Nanga Parbat gneiss dome.

As to the age of the deformation, metamorphism, and igneous activity of the NW-Karakoram, SCHNEIDER presented the following scheme in his former paper (1957). The initial volcanism, represented by the basic volcanics of the Chalt series and basic intrusives on the south of Chalt, occurred in the Later Mesozoic, then the Karakoram main granitic rocks were intruded during the orogenic movement, accompanied by migmatization. The Karakoram main folding followed. Finally, posttectonic young aplitic granite was intruded. The age of the Himalayan main orogenesis of the Nanga Parbat district has been assigned to the Oligocene. However, in his later paper (1960), SCHNEIDER has regarded basic rocks of the zone II (*Chalt-Schieferserie*), together with the formations of crystalline schists and gneisses in the zones I and III, as equivalent to the fossiliferous Upper Palaeozoic and Early Mesozoic in the Tethys-Karakoram (the zone V). His revision seems to be based on the newly confirmed stratigraphic fact in the Yasin district that the formation of Lower Cretaceous overlies the basic volcanics of the zone II (IVANAC *et al.* 1956, DESIO 1959).

Taking account of these stratigraphic facts, though sporadic, in and near the area in question, we should expect the presence of both metamorphic and plutonic rocks related to different phases of geotectonic development, even from the Pre-Cambrian to the Alpine orogenesis.

In the eastern half of the area, SCHNEIDER's zoning can be traced towards the drainage basins of the Indus and the Braldu River. Epizonal crystalline schists derived from basic igneous rocks with intercalated carbonate beds are developed in the basin of the Tormik River. As KICK (1956) has reported the occurrence of green-rocks in the Chogo-Lungma Glacier basin to the northeast of Haramosh, the epizonal schists of the Tormik River basin must represent the southeastern extension of the Chalt series (the zone II). A conspicuous feature of the schists belonging to this series is the occurrence of porphyroblasts of biotite and carbonate mineral[1], the latter of which often shows large rhombs.

To the northeast of the zone of the Chalt series, separated by a tectonic line, there are distributed coarse-grained mica-schists and gneisses, often anatectic. This part of the area may corresponds to the zone III. Although sillimanite is found in some rocks, epidote is predominating.

The part of the area to the southwest of the greenrocks zone is rather puzzling. MATSUSHITA and HUZITA have found a remarkable anticlinal axis of NNE-SSW direction across the Indus between Shengus (No.31: the number refers to the locality in Fig. 5) and Chutran (No.35). The rocks of this anticlinal zone are mica-gneisses, often having sillimanite, and effect of anatexis is commonly observed. These petrographic features suggest that the gneisses of this part of the Indus represent the north-north-eastern extension of the Nanga Parbat gneiss dome.

To the west of this anticlinal zone, there develop hornblende-gneisses, often characterized by the presence of epidote. The rocks of this type are traced westward to Gilgit, showing a general strike of NW. Between this zone and the anticlinal zone of katazonal gneisses, a belt of gneiss-blastomylonites exists, which will be referred to in later pages. This mesozonal hornblende-gneiss zone may be correlated to the zone H in SCHNEIDER's section along the Hunza River.

To the east of the anticlinal zone, mostly mesozonal gneisses are developed. It cannot be decided whether the rocks belong to the zone I or the zone H.

In the western half of the area in question, it is difficult to follow SCHNEIDER's

1) Dr. T. NUREKI has kindly informed the author of the composition of carbonate porphyroblast in greenschist (No. 47_2). In a hydrochloric solution of the carbonate the following contents have been determined:

total Fe_2O_3	9.05%	CaO	27.70%
MgO	12.58%	MnO	5.57%

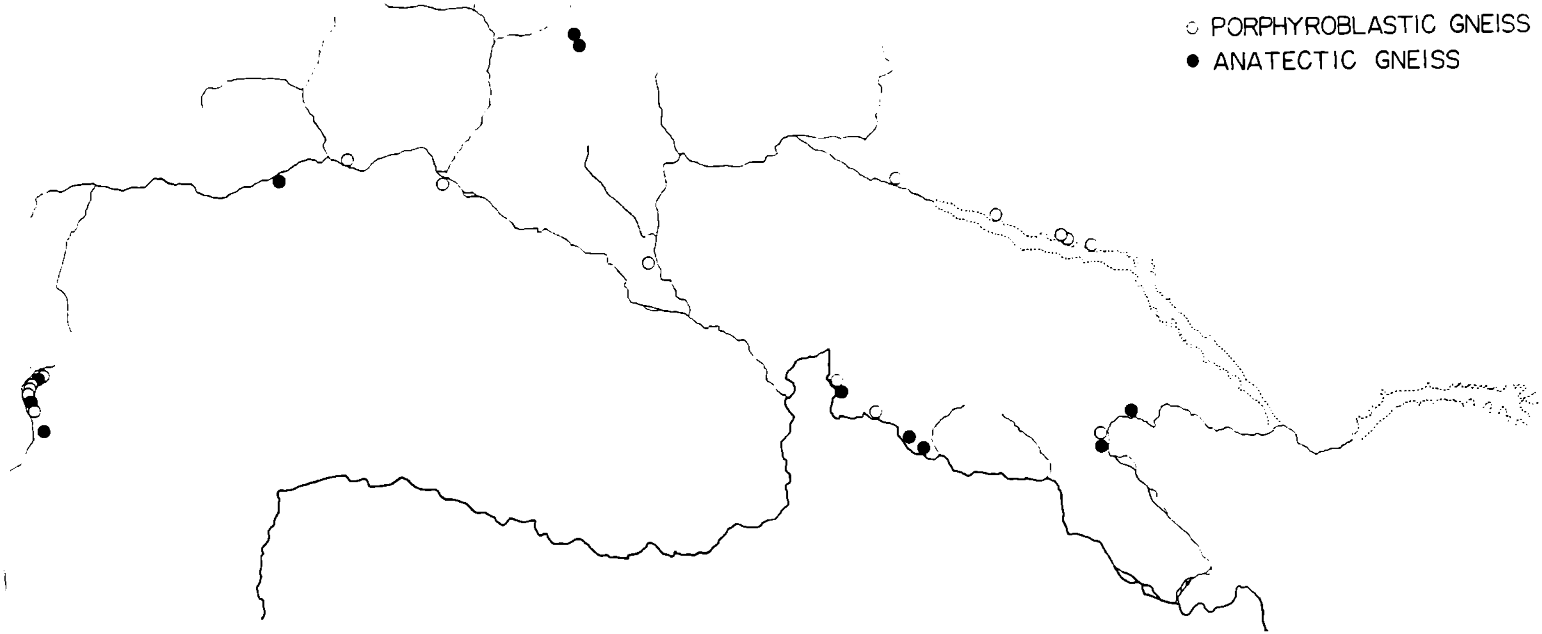

Fig. 2 Distribution of anatectic gneiss

Anatectic gneisses are divided into porphyroblastic gneiss and other anatectic gneisses, for convenience' sake, the latter of which include smetatectic and diatectic gneisses.

scheme of zoning. The epizonal schists or slates, characterized by the occurrence of biotite and carbonate porphyroblasts, can be traced from Chalt west-north-westward to the Ishkuman River (Nos. 226 and 227). In the Ishkuman River basin, the area to the north of the zone of Chalt series is occupied by ortho- and para-gneisses or their blastomylonites, which may be correlated to the zone III. Epizonal slates and semi-schists are distributed in the Yasin district. Along the Ghizar River, there develop amphibolites and blastomylonitic rocks derived from gneisses and granitic rocks. Gneisses and their blastomylonites are distributed also in the Upper Swāt, along with epizonal schists.

The extent of anatexis of gneisses in the area is shown in Fig. 2. Large scale anatexis has been reported by MISCH from the Nanga Parbat district. The same kind of anatexis is also observed in the anticlinal zone above mentioned. Apart from the axial zone of the Alpine metamorphism of the NW-Himalaya, anatectic gneisses are distributed through the area. The gneisses, either porphyroblastic or metatectic (as to the nomenclature see the appendix), of the basins of the Braldu River, the Hispar Glacier, and the Ishkuman River belong to the zone III. When the distribution of these anatectic gneisses is compared with that of metamorphic facies of Fig. 1, it will be revealed that the anatexis occurred under the condition of epidote-amphibolite facies in those regions outside the Alpine axial zone. Anatectic gneisses are also found along the Gilgit or Ghizar River. The gneisses of the Upper Swāt show the effect of anatexis.

III. Rejuvenation and Polymetamorphism of Crystalline Basement

As mentioned in the preceding chapter, there may be probably present older crystalline rocks, such as gneisses and granitic rocks, than those formed during the Alpine activity. Those rocks of the crystalline basement, affected by later deformation and metamorphism, must be represented by granitic or gneiss-blastomylonites, or, in the region of higher grade metamorphism, occur as orthogneisses and polygenetic gneisses (as to the nomenclature see the appendix). The distribution of the orthogneiss and blastomylonite is shown in Fig. 3.

The most remarkable occurrence of blastomylonites marks the boundary between the axial gneiss zone of the Alpine Himalaya and its western mantle, the Gilgit gneiss zone in the vicinity of Sassli along the Indus (Nos. 10-23). There develop blastomylonites derived from gneisses, such as garnet-bearing epidote-hornblende-gneiss, epidote-biotite-gneiss, and garnet-bearing mica-gneiss, which are the main members of the Gilgit gneiss. The grain-size of the blastomylonites increases from the northwest to the southeast, and they change into gneisses within the anticlinal zone. It should be noticed in this connection that orthogneisses are also found in the anticlinal zone. These facts suggest that, at least, some parts of

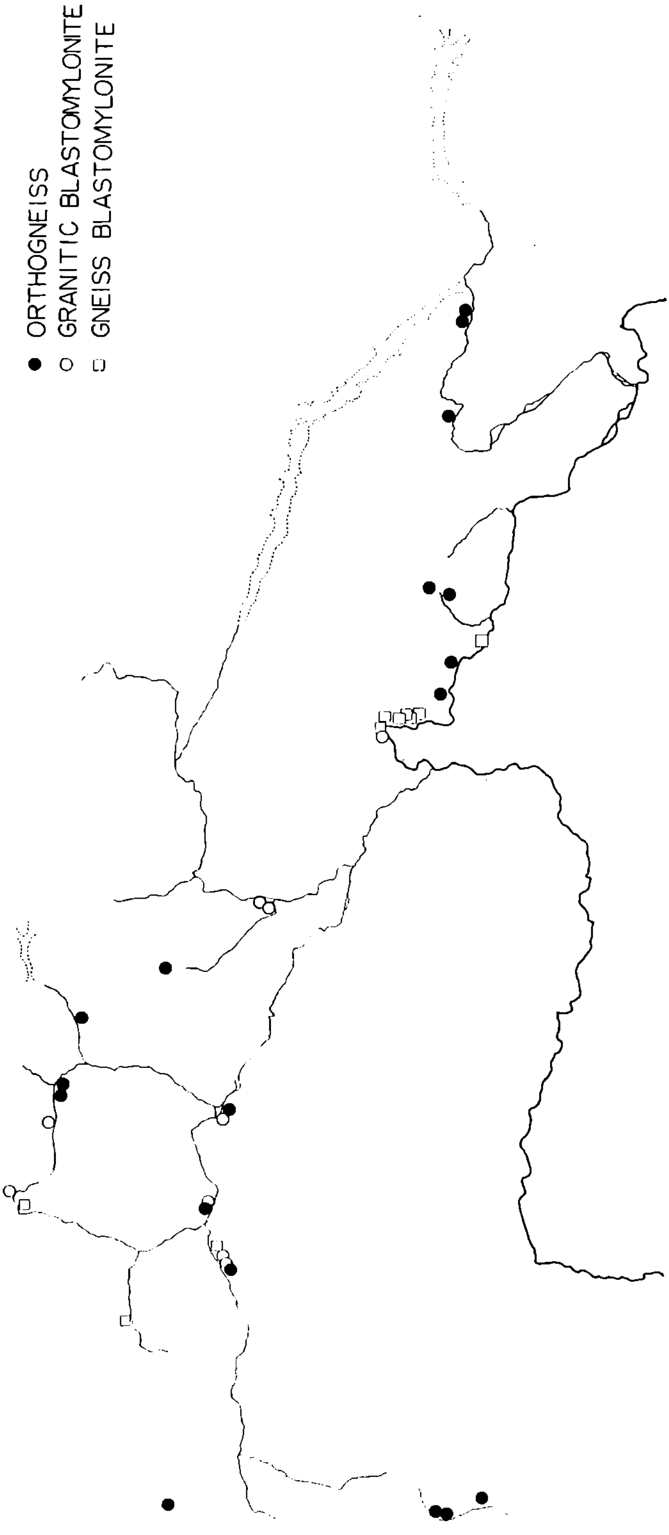

Fig. 3 Distribution of orthogneiss and blastomylonites

the axial gneisses must have been derived from pre-existing crystalline basement rocks, and, furthermore, that the Gilgit gneiss must be pre-Alpine.

It is of fundamental importance in elucidating the problem of the Himalayan syntaxis to follow the axial gneiss zone of the Nanga Parbat district as well as its western mantle towards the region of Gilgit and Ghizar. After MISCH (1949), the western mantle of the gneiss dome consists of the Pre-Cambrian Salkhala group and the volcanic formation of Cretaceous-Eocene, both affected by the regional metamorphism of the main Himalayan orogenesis. WADIA (1933) expressed the opinion that the whole area to the north of Gilgit is again composed of undoubted Salkhalas, while SCHNEIDER (1957) denied this opinion. In any case, the Gilgit gneiss occurring to the west of the anticlinal zone along the Indus differs in rock assemblage from the Salkhala, a group of black phyllites and slates with subordinate thin limestone bands, and occasional thin layers of quartzite and altered greenstone. Therefore, it can safely be said that the thermal front of the axial zone of Himalaya turns its trend to the north-north-east, leaving the zone of Tethys-Himalaya, into the terrain of crystalline basement.

The eastern margin of the anticlinal axial zone of the Indus is not evident. Among the specimens, the author has found only one specimen of blastomylonite derived from porphyroblastic gneiss (No.35). The metamorphic grade decreases from the west to the east, namely, from the amphibolite facies (sillimanite zone) to the epidote-amphibolite facies (Nos. 36-41). The rocks of the latter facies are garnet-bearing epidote-mica-gneiss and epidote-hornblende-gneiss, showing similarity to the Gilgit gneiss.

In the zone of gneiss and crystalline schist to the north of the zone of Chalt series, orthogneisses and blastomylonites are distributed. In the vicinity of Ishkuman, orthogneisses of granite and granodiorite origins are distributed. To the west of Ishkuman and near Darkot, blastomylonites derived from granite and metatectic mica-gneiss are found. It must be noticed that these orthogneisses and blastomylonites belong to the epidote-amphibloite facies, that is the predominating mineral facies of the northern gneiss and schist zone. Considering these facts, it can be said that, also in the northern zone (zone III), representing most probably pre-Alpine metamorphism, the rocks of crystalline basement are mingled with the Upper Palaeozoic-Lower Mesozoic rocks.

In the terrain to the south of the Chalt zone, orthogneisses and blastomylonites are also distributed. Near Nomal, to the south of Chalt, epidote-biotite-blastomylonites derived from trondhjemite and tonalite are found. These rocks belong to the zone I of SCHNEIDER. Along the Ghizar River, orthogneisses and blastomylonites derived from granite, granodiorite, and quartz-diorite are distributed. In the Upper Swāt, anatectic orthogneisses are found.

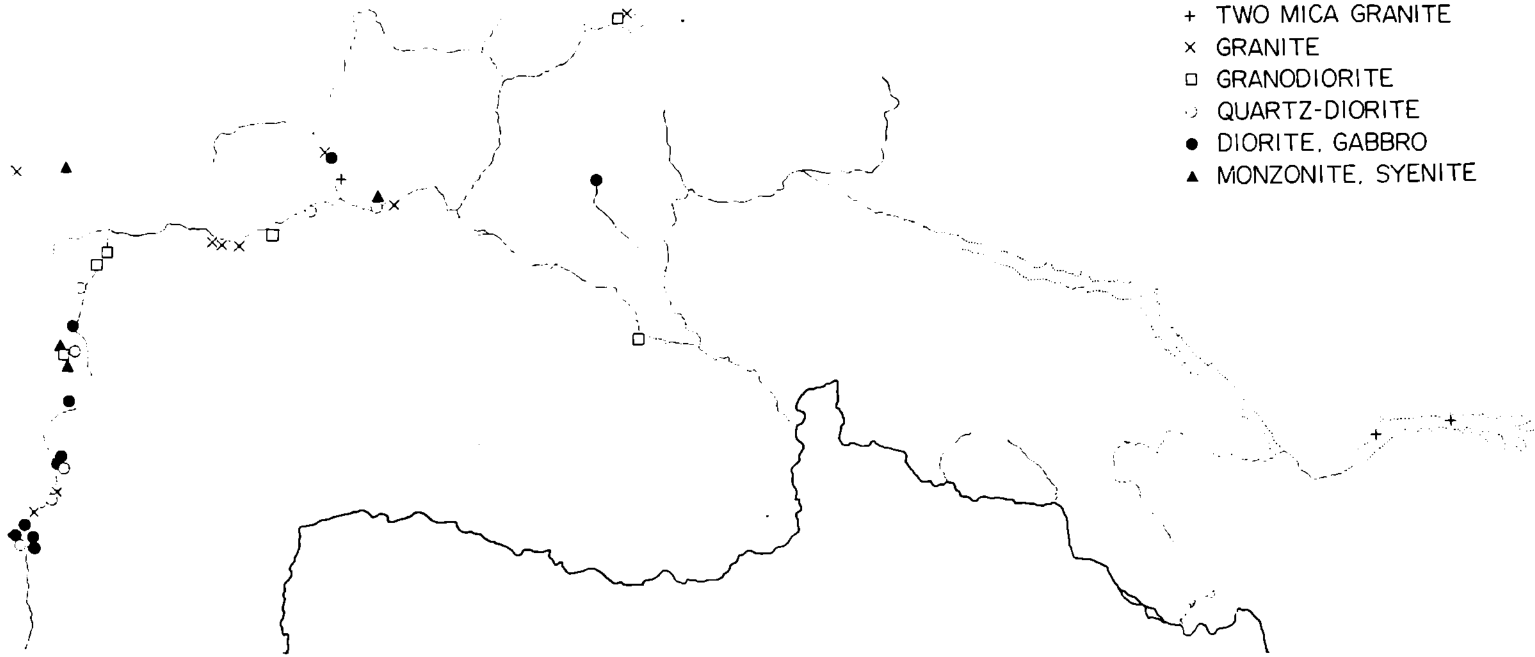

Fig. 4 Distribution of plutonic rocks

IV. Distribution of Plutonic Rocks

The distribution of massive plutonic rocks without directional structure is shown in Fig. 4. The distribution is also related to the geotectonic division: the massive plutonic rocks are rarely present within the crystalline basement region as well as in the Alpine axial zone. Two mica-granites in the districts of the Baltoro and the Karambar Glaciers may correspond to the posttectonic young granite in SCHNEIDER'S zone IV. In the regions of the Ghizar River, Shunji Gol, and the Upper Swāt, various types of plutonic rocks, including such basic members as diorite, gabbro, and monzonite, are distributed. Hornfels is developed around these intrusives, especially in the region of Shunji Gol. Retrogressive alteration is observed extensively in the rocks of the Upper Swāt.

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Appendix

Petrographic Table

Petrographic properties of main specimens of the rocks collected through the Expeditions in the western part of the Karakoram and the eastern part of the Hindu Kush with the Upper Swāt are shown in the following table. In the table are represented the presence of felsic minerals, characteristics of fabric elements such as schistosity, compositional banding, mineral lineation, and cleavage, grain-size, mineral facies of rocks metamorphosed on a regional scale, and comments relating to other petrographic properties and the origin in some cases.

The system of nomenclature of foliated rocks has not been established up to this time. The present author has named the foliated rocks after the scheme of the following table.

<table>
<tr><th>Mean grain-size (long diameter)
Original rock</th><th colspan="3">ca. 0.02 mm   ca. 0.5 mm</th></tr>
<tr><td>Acid to intermediate plutonic rocks</td><td>(original rock name)-mylonite</td><td>(original rock name)-blastomylonite</td><td>(main mafics names)-orthogneiss</td></tr>
<tr><td>Gneiss</td><td>gneiss-mylonite</td><td>gneiss-blastomylonite</td><td>(main mafics names)-polygenetic gneiss</td></tr>
<tr><td>Basic igneous rocks</td><td>(main mafics names)-semischist</td><td>(main mafics names)-schist
if hornblende is the most abundant:
(main mineral names)-amphibolite</td><td>(main mafics names)-gneiss</td></tr>
<tr><td>Impure calcareous rocks</td><td>ibid.</td><td>ibid.</td><td>ibid.</td></tr>
<tr><td>Calcareous rocks</td><td colspan="3">crystalline limestone</td></tr>
<tr><td>Siliceous rocks</td><td>(main mafics names)-quartz-semischist</td><td>(main mafics names)-quartz-schist</td><td>(main mafics names)-siliceous gneiss</td></tr>
<tr><td rowspan="3">Psammitic and pelitic rocks</td><td rowspan="2">(main mafics names)-semischist</td><td>(main mafics names)-schist</td><td>manily consisting of pyrogenetic minerals:
(mian mafics names)-gneiss</td></tr>
<tr><td colspan="2">containig much metamorphic minerals, with distinct schistosity:
(main mafics names)-schist</td></tr>
<tr><td colspan="2">with slaty cleavage; weak metamorphic differentiation:
(main mafics names)-slate</td><td></td></tr>
</table>

The degree and the characteristics of anatectic processes are distinguished and named after the following scheme:

Gneiss coarsened by the crystallization of much porphyroblasts---------*porphyroblastic gneiss*

Gneiss with coarse-grained quartzo-feldspathic parts--------------------*metatectic gneiss*

The following cases are distinguished after the shape of the quartzo-feldspathic parts and the inferred process of emplacement of them:

quartzo-feldspathic and melanocratic parts form layered structure:--*venitic gneiss*

quartzo-feldspathic parts penetrate the rock in irregular fashion:--*agmatitic gneiss*

quartzo-feldspathic parts have been formed by the injection of pegmatitic magma:--*migmatitic gneiss*

Gneiss almost completely changed to coarse-grained, plutonic-looking rock---------------------- -----------------------------------*diatectic gneiss*

Explanation of Abbreviations

Mineral names:

bi.	biotite	ca.	calcite
ch.	chlorite	clpy.	clino-pyroxene
ep.	epidote	ga.	garnet
ho.	hornblende	K-F.	K-feldspar
ky.	kyanite	mu.	muscovite or sericite
pl.	plagioclase	qu.	quartz
si.	sillimanite	st.	stauroltite
tr.	tremolite		

Fabrics:

Bp.	blastoporphyritic	M.	microcline structure
P.	perthite structure	Po.	porphyroblast

Schist. schistosity, *i.e.*, preferred orientation of inequidimensional crystals

Band. compositional banding

Lin. mineral lineation

Cl. cleavage (fracture-cl. and slaty cl.)

Grain-size: mean value of long diameter of grain, in mm.

Mineral facies:

A.	amphibolite facies	EA.	epidote-amphibolite facies
G2.	greenschist facies (biotite zone)	G1.	greenschist facies (chlorite zone)
H.	pyroxene-hornfels facies		

Parenthesis denotes the mineral facies of the original rock.

Symbols:

Felsic minerals

○ common △ rare × absent

Fabrics

○ distinct △ indistinct × none

Notes: 1) In the column of Name, -b. denotes -bearing.

2) Specimens Nos.1-125 with M6 and M9, Nos. 204-326, and Nos. 501-683 represent, respectively, the rocks collected in the Expeditions of 1955, 1956, and 1957. The specimens were cut into two pieces, of which one half is now preserved in the Institute of Geology and Mineralogy, Faculty of Science, Kyoto University, and another half in the Institute of Geology and Mineralogy, Faculty of Science, Hiroshima University.

No.	Name	Felsic Minerals			Fabrics				Grain-size	Mineral Facies	Comments
		Qu.	K-F.	Pl.	Schist.	Band.	Lin.	Cl.			
1	Ep-ho-bi-gneiss	○	×	○	△	×	△	×	0.5-2	EA	penetrated by ep-bi-aplite.
9	Ep-bi-ho-gneiss	○	△	○	○	△	○	×	0.5-2	EA	
10a	Ga-b. bi-granite-blastomylonite	○	○ M.	○	○	○	×	×	0.01 Bp. 1-5		blastoporphyritic biotite is brown, and neocrystallized green. striation on the schistosity surface.
10b	Ga-b. bi-ho-gneiss-blastomylonite	○	×	○	○	○	×	×	0.05 Bp. 1		venitic gneiss origin.
10c	Ep-bi-ho-gneiss-blastomylonite	○	○ M.	○	○	○	×	○	0.05 Bp. 1-2	(EA)	migmatitic gneiss origin.
12a	Ga-ep-bi-ho-gneiss-blastomylonite	○	○ M.	○	○	○	×	×	Bp. 1-2	(EA)	anatectic gneiss origin.
12b	Bi-Mu-gneiss-blastomylonite	○	×	○	○	○	×	×	Bp. 0.5-1		micaceous gneiss origin.
13	Mu-b.bi-gneiss	○	△	○	○	△	×	○	1		striation on the schistosity surface.
15	Ep-bi-b. crystalline limestome	△	×	△	×	○	×	×	0.05		
18a	Ep-b. ga-ca-bi-ho-gneiss-blastomylonite	○	×	○	○	○	×	○	0.1-0.2 Bp. 1	(EA)	impure calcareous orgin.
18b	Clpy-b. tr-crystalline limestone	×	×	○	○	○	×	×	0.5-1		mylonitic.
19	Ep-bi-gneiss-blastomylonite	○	△	○	○	○	×	△	0.01 Bp. 1	(EA)	striation on the schistosity surface.
21	Bi-ho-gneiss	△	×	○	○	△	○	×	1-3		
22	Ep-b. ga-mu-bi-gneiss-blastomylonite	○	×	○	○	○	×	○	0.01 Bp. 0.5-1	(EA)	
23	Ep-b. ga-bi-ho-gneiss-blastomylonite	○	○	○	○	△	×	○	0.01 Bp. 0.5-1	(EA)	porphyroblastic basic gneiss origin.
28	Ep-mu-b. ga-bi-gneiss, porphyroblastic	○	○ M.	○	○	○	×	×	0.5-1	EA	striation on the schistosity surface.
29	Mu-bi-gneiss, migmatiric	○	○ M.P.	○	○	○	×	×	1-3		

30	Si-mu-bi-gneiss	○	○ M.	○	○	○	×	×	1-3	A	fibrolite related to muscovite. penetrated by tourmaline-quartz vein.
31	Si-mu-bi-orthogneiss	○	○ M.	○	○	○	×	×	1-2	A	
32	Mu-b. bi-gneiss, porphyroblastic	○	×	○ Po.	○	○	×	×	1 Po.→10		
33	Si-mu-bi-orthogneiss	○	△	○	○	○	×	×	1	A	rich in fibrolite aggregates. distinct striation on the schistosity surface.
34	Thermal-metamorphic ga-bi-gneiss, metatectic	○	△	○ Po.-Bp.	×	○	×	×	0.1 Bp. 0.5-1		
35	Ga-mu-bi-gneiss-blastomylonite	○	○	○	○	○	×	×	0.2 Bp. 1-3		plagioclase and K-feldspar form "Augen". porphyroblastic gneiss origin.
36	Ep-bi-schist	○	×	○	○	○	○	×	0.5		leucocratic.
37	Ep-b. ho-gneiss	○	×	○	○	×	○	×	0.5-1	EA	
38	Ga-b. ep-mu-bi-gneiss	○	×	○	○	△	○	×	0.5-1.5	EA	leucocratic
39	Ga-ep-bi-gneiss, metatectic	○	×	○ Po.	○	○	×	×	0.5	EA	with plagioclase-quartz-muscovite-epidote vein. plagioclase forms "Augen".
40	Ga-bi-b. ep-ho-goneiss	△	×	○	○	×	△	×	1-3 ga→10	EA	
41	Bi-b. ga-ep-ho-gneiss	○	×	○	○	△	△	×	1-3	EA	
42	Mu-b. ga-clpy-bi-schist	○	△	○	○	○	×	×	0.1-0.3 ga→5	A	Sillimanite is included in garnet.
43	Si-b. ga-mu-bi-gneiss	○	×	○	○	△	×	×	0.5-2	A	
44	Ga-b. mu-bi-orthogneiss	○	○	○	○	△	×	×	0.5-1		striation on the schistosity surface.
46	Ga-clpy-mu-bi orthogneiss	○	○	○	○	○	×	×	0.3		striation on the schistosity surface.
47_1	Mu-b. ep-ch-ca-bi-schist	○	×	○ Bp.	○	×	×	×	0.05-0.5	G2	with porphyroblasts (rhombs) of carbonate mineral. basic volcanic origin.
47_2	Ep-ch-ca-mu-bi-schist	○	×	○	○	×	×	△	0.05	G2	with porphyroblastic rhombs of carbonate mineral. basic effusive origin.
47_3	Bi-b. ep-ch-ca-mu-schist	○	×	○ Bp.	△	×	×	×	0.05-0.1	G2	with porphyroblasts of biotite and carbonate mineral (rhombs). basic effusive origin.

No.	Name	Felsic Minerals			Fabrics				Grain-size	Mineral Facies	Comments
		Qu.	K-F.	Pl.	Schist.	Band.	Lin.	Cl.			
49	Crystalline limestone	×	×	×	○	○	×	×	1		striation on the schistosity surface.
50	Ca-b. ep-ch-mu-bi-schist	○	×	○ Bp.	△	△	×	×	0.02 Bp. 1-2 Po. 1	G2	with biotite porphyroblasts. basic effusive origin.
51	Ch-ca-mu-schist	○	×	○	○	△	×	×	0.03		with porphyroblastic rhombs of carbonate mineral. striation on the schistosity surface.
52	Ep-ch-ca-mu-schist	○	×	○ Bp.	○	×	×	×	0.02 Bp. 1-3	G1	with carbonate porphyroblasts. basic effusive origin.
53	Crystalline limestone	△	×	×	○	○	×	×	0.1		striation on the schistosity surface.
53′	Crystalline limestone	△	×	○ Bp.	○	○	×	×	0.05		calcareous tuff origin (?)
54	Crystalline limestone	△	×	×	○	△	×	×	0.5-1		striation on the schistosity surface.
55	Crystalline limestone	×	×	×	○	○	×	×	0.1		striation on the schistosity surface.
56	Crystalline limestone	×	×	△	○	○	×	×	0.05		weak striation on the schistosity surface.
58	Ep-b. bi-gneiss, venitic	○	○	○	○	○	△	×	1	EA	with feldspar "Augen". weak striation on the schistosity surface.
59	Mu-bi-gneiss, porphyroblastic	○	○ M.	○	○	○	×	×	1-3 Po.→5		with feldspar "Augen". striation on the schistosity surface.
60	Mu-b. si-ga-bi-gneiss, diatectic	○	○	○	△	○	×	×	1-3	A	fibrolite related to biofite.
62	Ga-mu-b. bi-orthogneiss	○	○	○	△	○	×	×	2-4		
64	Si-ga-mu-bi-schist	○	×	○	○	△	×	△	0.2-0.5	A	biotite attains to 1-2 mm, garnet to 5 mm as porphyroblast.
67	Mu-aplite	○	○	○	×	×	×	×	2-6		
71	Ga-ep-b. bi-ho-orthogneiss	○	×	○	○	○	△	×	1-2	EA	
73	Ga-ep-b. bi-orthogneiss	○	×	○	△	△	△	×	1-2	EA	

82	Ca-mu-bi-slate	○	×	○	×	×	×	○	0.02		boulder. slaty cleavage.
82′	Mu-bi-granite	○	○ M.	○	×	×	×	×	2-6		
84	Bi-pl-amphibolite	○	×	○ Bp.	○	○	△	×	0.02	A	
85 V	Ca-mu-bi-slate	○	×	○	×	△	×	○	0.1-0.3		slaty cleavage. boulder.
85 VI	Crystalline limestone	△	×	△	×	×	×	○	0.1		boulder.
85 VIII	Mu-bi-granite	○	○ M.	○	×	×	×	×	1-5		
90	Mu-siliceous gneiss	○	○ M.	○	○	○	△	×	0.1-0.3		
93	Si-ky-ga-st-mu-schist	○	×	○	△	×	○	×	2-5 ga-Po→10	A	
94	Ga-b. ep-bi-gneiss	○	×	○	△	×	×	×	0.2-0.5		
99	Bi-gneiss	○	○	○	○	○	×	×	1		
105	Ep-mu-bi-gneiss, porphyroblastic	○	○	○ Po.	○	○	△	×	1-4	EA	
110	Ep-b. mu-bi-gneiss, porphyroblastic	○	△	○ Po.	○	○	×	×	0.5 Po.→5	EA	
111	Ep-b. mu-bi-gneiss, prophyroblastic	○	○ M.Po.	○ Po.	○	×	×	×	0.2-0.5 pl-Po→5 K-F-Po→20	EA	
113	Ep-b. mu-bi-orthogneiss, porphyroblastic	○	○ M.Po.	○ Po.	○	△	×	×	0.1-0.5 pl-Po→3 M-Po→10	EA	
114	Ch-ca-mu-bi-slate.	○	×	○	○	×	×	△	0.05		boulder.
115	Ep-bi-ho-gneiss, porphyroblastic	○	○	○ Po.	○	△	×	×	0.2-0.5 pl-Po→5	EA	
123	Ga-ch-mu-bi-schist	○	×	○	○	×	×	×	0.02	G2	with biotite porphyroblasts (→2 mm).
125	Ep-ca-amphibolite	×	×	×	○	×	○	×	1	EA	
M6	Ma-b. bi-granite	○	○ M.P.	○	×	×	×	×	2-3		
M9	Ep-bi-ho-gneiss	○	×	○ Po.	×	×	△	×	0.3-0.5	EA	hornblende and plagioclase are glomero-porphyroblastic.

No.	Name	Felsic Minerals			Fabrics				Grain-size	Mineral Facies	Comments
		Qu.	K-F.	Pl.	Schist.	Band.	Lin.	Cl.			
204	Ep-bi-ho-gneiss, porphyroblastic	○	○ M.	○ Po.	○	△	△	×	0.2-0.5 Po. 4	EA	
205	Ep-b. bi-pl-amphibolite	×	×	○	○	△	○	×	0.2	EA	
207	Ep-pl-amphibolite	○	×	○	×	×	×	×	0.1-0.3	EA	hornblende forms bundles ("Garben-schiefer). probably polymetamorphic.
207-1	Ep-bi-trondhjemite-blastomylonite	○	×	○ Bp.	○	△	×	×	0.1-0.3	EA	
208-1	Ep-bi-tonalite-blastomylonite	○	×	○ Bp.	○	△	×	×	0.1-0.3	EA	
208-2	Hornblendite-blastomylonite	×	×	△	×	×	×	×	0.2-0.5		
209	Bi-pl-amphibolite	×	×	○	○	△	○	×	pl. 0.1-0.2 ho. 0.5-1		
211-1	Ch-b. ep-bi-pl-amphibolite	△	×	○	○	×	○	×	0.05-0.1	EA	hornblende tends to form bundles.
211-3	Ep-bi-pl-amphibolite	×	×	○	○	△	○	×	0.2	EA	
212	Ch-ca-mu-bi-slate	○	×	○	△	○	×	○	0.01		biotite forms porphyroblasts. slaty cleavage. original lamination preserved.
213	Ep-bi-orthogneiss	○	○ M.P.Bp.	○ Bp.	○	△	×	×	0.5 Bp. 2-5	EA	
213-3	Ch-b. ca-mu-schist	○	×	○	○	△	×	○	0.05	G1	
214	Bi-ho-doirite	△	△ M.	○	×	×	×	×	3-5		monzonitic.
219	Ch-ca-mu-bi-slate	○	×	○	×	○	×	○	0.01	G2	biotite and calcite form porphyroblasts. slaty cleavage. original lamination pre-served.
220-1	Ca-b. ch-mu-bi-slate	○	×	○	×	×	×	○	0.02	G2	biotite and calcite form porphyroblasts. slaty cleavage.
220-2	Ch-ca-mu-bi-slate	○	×	○	×	△	×	○	0.01	G2	biotite is glomeroporphyroblastic. slaty cleavage.
221	quartzite	○	×	△	×	×	×	×	0.2		quartzitic sandstone origin (?)

221-2	sandstone	○	×	○	×	×	×	○	0.05	G1	
226-1	Ch-ca-b. mu-bi-slate	○	×	○	×	×	×	○	0.01	G2	biotite forms prophyroblasts. slaty cleavage.
226-2	Ch-ca-mu-bi-slate	○	×	○	×	○	×	○	0.01	G2	biotite forms porphyroblasts. slaty cleavage.
227	Chloritoid-ch-ca-mu-slate	○	×	○	×	×	×	△	0.01		calcite forms porphyroblastic rhombs. penetrated by qu-ca-mu-vein.
231-1	Bi-ho-granodiorite	○	○ M.	○	×	×	×	×	3-5		
231-2	Ep-b. bi-ho-granite	○	○ M.P.	○	×	×	×	×	2-5		
232	Mu-bi-gneiss, venitic	○ Po.	×	○ Po.	○	○	×	×	0.2 Po. 1-2		
233	Mu-bi-gneiss, venitic	○	×	○	○	○	△	×	0.3-0.5		
235	Ca-b. zoisite-bi-ho-gneiss	○	×	○	×	×	×	×	0.5-1		mafics tend to form clots (10 mm).
237	Ep-b. mu-bi-orthogneiss	○	○ M. Bp.	○ Bp.	○	△	×	×	0.5 Bp. 1-5	EA	granite origin.
239	Mu-b. ep-bi-ho-orthogneiss	○	○ M. Bp.	○ Bp.	○	△	×	×	0.5 Bp. 3-5	EA	granodiorite origin.
240	Ep-mu-bi-orthogneiss	○	○ P. Bp.	○ Bp.	○	△	×	×	0.2 Bp. 2-10	EA	granite origin.
240-2	Bi-b. ep-ch-mu-schist	○	×	○	×	△	×	○	0.05	G2	
241	Ch-ca-mu-bi-siliceous slate	○	×	○	×	△	×	○	0.1		
247	Granite-blastomylonite	○	○ Bp.	○ Bp.	○	×	×	△	0.05		
248	mu-ca-slate	○	×	○	×	○	×	○	0.1		
249	Ch-ca-mu-semischist	○	×	○	○	○	×	○ MF.	0.01		conjugate micro-fold.
250	Granite-blastomylonte	○	○ M. Bp.	○ Bp.	△	×	×	×	0.02 Bp. 1-10		
252	Mu-bi-gneiss-blastomylonite	○	○ M. Bp.	○ Bp.	○	○	×	×	0.05 Bp. 1		metatectic mica-gneiss origin.

No.	Name	Felsic Minerals			Fabrics				Grain-size	Mineral Facies	Comments
		Qu.	K-F.	Pl.	Schist.	Band.	Lin.	Cl.			
258	Ch-b. mu-bi-slate	○	×	○	×	×	×	○	0.02	G2	slaty cleavage.
263	Ch-b. calcareous slate	△	×	△	×	×	×	○	0.01-0.1	G1	slaty cleavage.
263-2	Ch-ca-mu-slate	○	×	○	×	×	×	○	0.01	G1	slaty cleavage.
264	Ch-b. mu-calcareous slate	△	×	△	○	×	×	△ MF.	0.01-0.1	G1	
267	Ch-ca-mu-semischist	○	×	○	○	○	×	△ MF.	0.01	G1	
270	Ga-bi-ho-gneiss	○	×	○	○	○	×	×	0.2 ga.→2 ho.→5		affected by retrogressive alteration of G1. garnet and hornblende form diablasts. plagioclase is calcic.
271	Ga-cordierite-mu-bi-gneiss-blastomylonite	○	×	○	○	○	×	○ MF.	0.2 (co.)→8		cordierite has been changed to pinite. striation on the schistosity surface.
271-2	Cordierite-mu-bi-gneiss	○	×	○	○	△	×	△ MF.	0.2		cordierite has been changed to pinite. striations on the schistosity surface.
278-1	Bi-granodiorite	○	○ M. Po.	○	×	×	×	×	2 M→8		
279-2	Ch-ca-mu-semischist	△	×	○	○	△	×	×	0.01		weak striation on the schistosity surface. tuff origin.
281-1	Bi-granite	○	○ M. Po.	○	×	×	×	×	4-8		
281-1	Bi-ho-gabbro	×	×	○	×	×	×	×	1-4		inclusion in granite.
285-1	Clpy-b. bi-ho-quartz-diorite	○	△	○	×	×	×	△	0.5-1		having bi-pl-amphibolite as an inclusion. slightly sheared.
285-3	Bi-b. clpy-ho-microgabbro	△	△	○	×	×	×	×	0.5-1		hornblende forms clots (10 mm). altered retrogressively.
285-4	Clpy-bi-ho-quartz-monzonite	○	○ M. P.	○	×	×	×	×	1-5		
286	Ep-ca-bi-ho-schist	×	×	○	○	○	×	×	0.05	EA	calcareous origin.
287	Clpy-bi-ho-schist	×	×	○	○	×	△	×	0.02-0.05		calcareous origin.

288	Bi-granite	○	○ P.	○	×	×	×	×	1-4		
294	Ca-mu-bi-schist	○	×	○ Bp.	○	×	×	×	0.02-0.05		andesitic rock origin.
295	Clpy-bi-ho-microgabbro	×	×	○	×	×	×	×	1-2		hornblende froms porphyroblasts (20 mm). inclusion in a granitic rock.
296	Bi-b. clpy-ho-microgabbro	×	×	○	△	△	△	×	0.1-0.2		hornfelsic texture.
299	Bi-granite-blastomylonite	○	○ M. Bp.	○ Bp.	○	△	×	×	0.05 Bp. 1-4		
301	Bi-ho-orthogneiss, porphyroblastic	○	○ M.P.Po.	○ Po.	△	△	×	×	0.2-0.5 Po. 2-5		
305-1	Clpy-bi-ho-microgabbro	○	×	○ Bp.	×	×	×	×	pl. Bp. 1-5 ho. 1-2		inclusion in a granitic rock.
305-2	Two py-bi-ho-microgabbro	△	×	○ Bp.	×	×	×	×	0.5-1		inclusion in a granitic rock.
306-1	Bi-schist	○	×	○	○	△	×	×	0.05-0.1		
306-2	Ch-mu-b. ep-bi-schist	○	×	○	○	○	×	×	0.05	G2	
308	Clpy-ho-microgabbro	×	×	○	×	○	×	×	0.1-0.2		granoblastic with mafic clots. inclusion ?
312	Bi-ho-microgabbro	×	×	○	△	×	×	×	0.1-0.2		granoblastic with biotite clots.
320	Ep-bi-pl-amphibolite	△	×	○	○	○	○	×	pl. 0.02 ho. 0.1-0.3	EA	
321	Bi-ho-granodiorite	○	○ Po.	○ Po.	△	×	×	×	2-3		
324	Si-cordierite-ga-bi-schist	○	×	○	○	○	△	×	0.1-0.3 ga. 5		garnet forms porphyroblasts along seams.
326	Ch-ca-mu-schist	○	×	×	○	△	×	×	0.2		
—	Ep-bi-ho-granadiorite-blastomylonite	○	○ M. Bp.	○ Bp.	○	×	×	×	0.02 Bp. 1-4		
501	Two py-bi-quartz-gabbro	○	×	○	×	×	×	×	1		
502	Two py-bi-gabbro	△	×	○	×	×	×	×	1		rhombic pyroxene has been altered to bastite.
503	Bi-hc-gneiss	×	×	○	○	×	×	×	1		altered retrogressively.

No.	Name	Felsic Minerals			Fabrics				Grain-size	Mineral Facies	Comments
		Qu.	K-F.	Pl.	Schist.	Band.	Lin.	Cl.			
503′	Ho-gneiss	×	×	○	○	×	△	×	1		hornblende forms porphyroblasts (10mm).
504	Olivine-clpy-ho-gabbro	×	×	○	×	×	×	×	2-4		kelyphitic border (spinel-amphibole) between plagioclase and mafics. clinopyroxene attains to 15 mm.
505	altered porphyrite	△	×	○	×	×	×	×	<0.01		containing ch, ep, and ca.
506	Ca-b. ch-mu-schist	○	×	○	○	△	×	×	0.02	G1	
507	Ca-b. ch-mu-schist	○	×	○	○	△	×	×	0.02	G1	reddish in colour.
509	altered tuff-breccia	○	×	○	○	×	×	×	<0.01	G1	ch, ca, and mu-bearing.
510	altered tuff	○	×	○	×	×	×	×	0.01		containing ch, ca, and mu.
511	altered clpy-bi-ho-quartz-diorite	○	×	○	×	×	×	×	1-2		sheared, and ep, ch, and mu have been formed.
512	altered bi-ho-gneiss	○	×	○	×	×	×	×	0.5 Po. 2-4		biotite and hornblende form porphyroblasts.
513	altered clpy-bi-ho-diorite	○	×	○	×	×	×	×	1-2		ep, ch, and mu have been formed.
515	altered volcanic	○	×	○	×	×	×	×	0.03		containing ep, ch, and mu.
516	silicified meta-sediment	○	×	○	△	×	×	×	0.02		ep, ch, and mu have been formed.
517	bi-granite	○	○ M. Po.	○	×	×	×	×	pl. 2 M.→10		
518	spilitic rock	×	×	○	×	×	×	×	<0.01		alternated with siltstone.
520	altered ho-bi-quartz-diorite	○	×	○	×	×	×	×	1-2		biotite has been completetely altered.
521	altered bi-granite	○	○	○	×	×	×	×	2-5		
522	altered volcanic	×	×	△	×	×	×	×	<0.01		containing pseudomorphs of phenocrysts. mu, ep, and ch have been formed.
523	Ch-ca-mu-semischist	○	×	○	○	○	×	×	0.01	G1	pelitic origin.

524	Mu-b. ep-bi-aplite	○	×	○	×	×	×	×	1-2		rich in plagioclase.
525	altered porphyrite	×	×	○	×	×	×	×			ep, ch, ca, and mu have been formed. containing plagioclasec laths (0.2 mm).
526	altered porphyry	△	○	○	×	×	×	×			containg plagioclase phenocrysts.
527	bi-aplite	○	○	○	×	×	×	×	0.05-0.3		containing plagioclase megacrysts (5 mm).
528	Ep-bi-schist	○	×	○	○	○	×	×	0.01		
529	Bi-pl-amphibolite	×	×	○ Bp.	×	×	×	×	0.3		with plagicclase phenocrysts (→10 mm). porphyritic rock origin.
530	Ho-bi-qu-pl-rock	○	△	○ Bp.	×	×	×	×	0.1-0.3		with basic inclusion. porphyritic rock origin.
532	Ca-b. talc-schist	○	×	○ Bp.	○	○	×	×	0.01		rhomboid pseudomorphs composed of iron oxyde.
533	Ch-bi-b. ep-mu-schist	○	×	○ Bp.	○	○	×	×	0.02	G2	tuff origin.
535	Mu-bi-orthogneiss, metatectic	○	○ Po.	○ Po.	△	×	×	×	0.5 Po. 2-5		
537	Bi-ho-gneiss	○	×	○ Po.	×	×	×	×	0.3		bi forms poikiloblasts (5 mm).
538	Clpy-ho-bi-quartz-diorite, contaminated	○	×	○	×	×	×	×	1-2		heterogeneous. with inclusions of bi-pl-amphibolite.
539	Ep-b. bi-ho-quartz-diorite	○	×	○ Po.	×	×	×	×	0.2 Po.→6		assimilated part of basic inclusion.
540	Bi-pl-amphibolite	×	×	○	×	×	×	×	0.2-0.5		granoblastic. basic inclusion (?).
541	Clpy-b. bi-ho-gabbro	×	×	○	×	×	×	×	1		hornblende partly changed to colourless amphibole.
542	Ho-gabbro	○	×	○ Po.	×	×	×	×	0.1 ho. Po.→7 pl. Po.→2		assimilated part of amphibolite.
544	Bi-ho-lamprophyre	×	×	○	×	×	×	×	0.1		panidiomorphic.
545	Bi-gneiss	○	○	○ Po.	×	×	×	×	0.03-0.2 Po. 1-2		biotite forms poikiloblasts. K-feldsper is rich in metatect.
546	Ep-bi-ho-qneiss, porphyroblastic	○	○ Po.	○ Po.	○	○	×	×	0.03-0.1 Po. 1-3	EA	

No.	Name	Felsic Minerals			Fabrics				Grain-size	Mineral Facies	Comments
		Qu.	K-F.	Pl.	Schist.	Band.	Lin.	Cl.			
547	Bi-ho-qneiss, metatectic	○	×	○	△	△	×	×	1-3	A	mafics form clots. hornblende is poikiloblastic.
548	Bi-pl-amphibolite	×	×	○ Bp.	×	×	×	×	0.03	A	relics of phenocrysts and laths of plagioclase. hornblende-porphyrite origin.
549	Ep-b. bi-ho-gneiss, porphyroblastic	○	×	○ Po.	×	×	×	×	1-3	EA	probably orthogneiss of quartz-diorite. biotite and hornblende form poikiloblasts.
550	Clpy-b. ho-microgabbro	×	×	○	△	×	×	×	0.5-1		basic hybrid.
551	Bi-ho-orthogneiss, porphyroblastic	○	○ M. Po.	○	○	×	×	×	1-3 M.→10		
553	Bi-ho-orthogneiss, porphyroblastic	○	○ M.P.Po.	○	△	×	×	×	0.3-1 M.→10		
554	Tourmaline-pegmatite	○	○ M.P.	○	×	×	×	×			
555	Ep-b. bi-ho-gneiss, migmatific	○	○ Po.	○	○	△	×	×	0.5-2 K-F. 5	EA	
556	Bi-ho-gneiss, porphyroblastic	○	○	○ Po.	○	○	×	×	0.2-2 pl. Po. 3		
557	Mu-bi-aplite	○	○ M.	○	×	×	×	×	0.5-1		
559	Clpy-ho-diorite	△	×	○	×	×	×	×	1-2 ho.→5		
561	Clpy-ho-monzonite	×	○ M. Po.	○	×	×	×	×	M.→2 ho.→4		
562	Clpy-b. ho-monzonite	△	○ M. Po.	○	×	×	×	×	ho.→8 M.→40		with large microcline porphyroblasts.
654	Bi-ho-quartz-diorite	○	△	○	×	×	×	×	1 ho.→20		biotite and hornblende form poikiloblasts. basic hybrid.
565	Bi-ho-granodiorite	○	○ M.	○	×	×	×	×	2-4		
567	Aegirine augite-b. bi-ho-syenite	×	○ M.	△	×	×	×	×	M.→20		

568	Orbicular rock	×	×	○	×	×	×	×	Pl. 5-10		consisting of ep, ch, ho, mu, and pl. plagioclase is glomeroblastic, growing radially.
569	Ho-lamprophyre	×	○	○	×	×	×	×	0.1		with phenocrysts of plagioclase and brown hornblende.
570	Ep-ho-rock	△	×	△	×	×	×	×	0.5-1		
571	Bi-ho-microgabbro	△	×	○ Bp.	×	×	×	×	0.1		granoblastic. basic inclusion (?)
572	Bi-ho-driorite	△	×	○	×	×	×	×	1-2 ho.→5		
573	Meta-tuff-breccia	×	×	○	×	×	×	×	0.01		containing ep, ch, and bi.
576	Bi-ho-microgabbro	×	×	○ Bp.	×	×	×	×	0.1-0.2		contact with ho-quartz-diorite.
577	ho-b. clpy-hornfels	△	×	○	×	×	×	×	0.05-0.1	H	
579	Bi-ho-quartz-diorite	○	△	○	×	×	×	×	1-3		
581	Ga-ep-ho-clpy-hornfels	○	×	○	×	×	×	×	0.05	H	plagioclase is calcic.
581′	Bi-granodiorite	○	M. ○	○	×	×	×	×	1-3		
584	Altered bi-b. ho-granodiorite	○	P. ○	○	×	×	×	×	1-3		
585	Altered porphyrite	×	○	○	×	×	×	×	0.2		ep-ch-bearing.
587	Altered plagioporphyry	○	○	○	×	×	×	×	0.05		ep-ch-baring.
590	Altered fuff	×	×	○	×	×	×	×	0.01		pe-ch-ca-mu-bearing.
591	Altered tuff	×	×	○	×	×	×	×	0.01		ch-ca-bearing.
592	Altered quartz-porphyry	○	×	○	×	×	×	×	0.1		quartz and plagioclase occur as phenocrysts.
593	Altered porphyrite	×	×	○	×	×	×	×	0.01		ep, ch, ca and mu have been formed. plagioclase forms phenocrysts.
594	Altered diabase	×	×	○	×	×	×	×	0.01		ch and ca have been formed. laths of plagioclase are observed.
597	Mu-b. ep-ch-schist	△	×	○	○	○	×	×	0.02	G1	tuff origin.

No.	Name	Felsic Minerals			Fabrics				Grain-size	Mineral Facies	Comments
		Qu.	K-F.	Pl.	Schist.	Band.	Lin.	Cl.			
602	Altered basalt	×	×	○	×	×	×	×	Phenocryst 1-5		with clpy phenocrysts. ep, ch, ca, and fibrous amphibole have been formed.
603	Bi-granite	○	○	○	×	×	×	×	1-2		ep, ch, ca, and mu have been formed.
605	Fine-grained bi-granite	○	○	○	×	×	×	×	2		biotite occurs as aggregates.
608	Bi-granite	○	○ P.	○	×	×	×	×	→10		
609	Bi-pl-amphibolite	×	×	○	×	×	×	×	0.2		doleritic texture preserved. thermally metamorphosed.
610	Ga-ep-clpy-ho-bi-hornfels	×	×	○ Bp.	×	×	×	×	0.02		thermally metamorphosed basic tuff.
611	Thermally metamorphosed basalt	×	×	○	×	×	×	×	0.02		plagioclase and clinopyroxene occur as phenocrysts (1-5 mm).
614	Qu-latite	○	○	○	×	×	×	×			ep, ch, ca, and mu have been formed.
615	Bi-b. ep-pl-amphibolite	△	×	○ Bp.	○	△	×	×	0.02 Bp. 1	EA	
616	Ep-actinolite-schist	×	×	×	○	○	×	×	0.1		
617	Ep-bi-ho-microdiorie	×	×	○ Bp.	×	×	×	×	0.02-0.05		inclusion (?)
617′	Bi-ho-granodiorite	○	○ M. Po.	○	×	×	×	×	1-3 M.→10		
619	Ep-pl-amphibolite	○	×	○	○	○	×	×	0.05	EA	with quartz-epidote layers.
620	Pl-hornblendite	×	×	○	×	×	×	×	ho.→10		
621	Bi-ho-gneiss, metatectic	○	×	○ Po. Bp.	○	○	×	×	0.2 Po. 1-3		
622	Ep-b. bi-ho-orthogneiss.	○	○ M. Bp.	○ Bp.	○	×	×	△	0.05-0.5	EA	blastoporphyritic microcline attains to 1 cm. granodioritic.
623	Bi-ho-aplite-blastomylonite	○	○ M. Bp.	○ Bp.	○	×	×	△	0.02	EA	ep, bi, and mu have been formed.
624	Bi-pl-amphibolite	×	×	○	○	○	○	×	0.2	A	

625	Bi-ho-granodiorite-blastomylonite	○	○ M. Bp.	○ Bp.	○	○	×	×	0.02 Bp. 1-2		granodiorite hybrid origin.
626	Bi-b. clpy-ho-pl-rock	×	×	○	×	△	×	×	0.1-0.5	A	
627	Bi-ho-quartz-diorite	○	×	○	×	×	×	×	2		containing bi-pl-amphibolite. contamination facies.
628	Ep-bi-ho-gneiss-blastomylonite	○	○	○	○	○	△	○	0.05	EA	anatectic ho-gneiss origin.
630	Ga-clpy-ca-pl-rock	×	×	○	×	×	×	×	0.02-0.2 ga.→20		
631	Graphite-ch-mu-schist	○	×	○	○	△	×	△	0.02	G1	microcorrugation on the schistosity surface. pelitic origin.
635	Bi-ho-quartz-diorite-blastompylonite	○	○	○ Bp.	○	×	△	×	0.05-0.1		associated with bi-pl-amphibolite.
636	Ep-b. bi-ho-orthogneiss, porphyroblastic	○	○ M.P.Po.	○ Po.	○	△	×	×	0.5 Po. 2-5	EA	
637	Bi-b. mu-granite	○	○ M.P.	○	×	×	×	×	1-2 M.→5		
643	Calcareous semischist	△	×	△	○	△	×	×	0.02		
647	Ch-ca-mu-slate	○	×	○	△	×	×	×	0.01		calcareous silt-stone origin.
649	Clpy-ch-semischist	△	×	○	×	×	×	○	<0.01	G1	volcanic texture preserved.
675	Altered bi-quartz-monzonite	○	○ M. Po.	○	×	×	×	×	1-2 M.→10		ch, ca, and mu have been formed.
676	Ep-ho-bi-orthogneiss	○	○ M.	○	○	△	×	×	1-5	EA	
678	Mu-b. ch-ca-slate	○	×	○	△	○	×	×	0.01		
682	Ho-b. bi-granite	○	○ M.P.	○	×	×	×	×	1-3 M.→10		
683	Mu-bi-schist	○	○ M.	○	○	○	×	△	0.2		

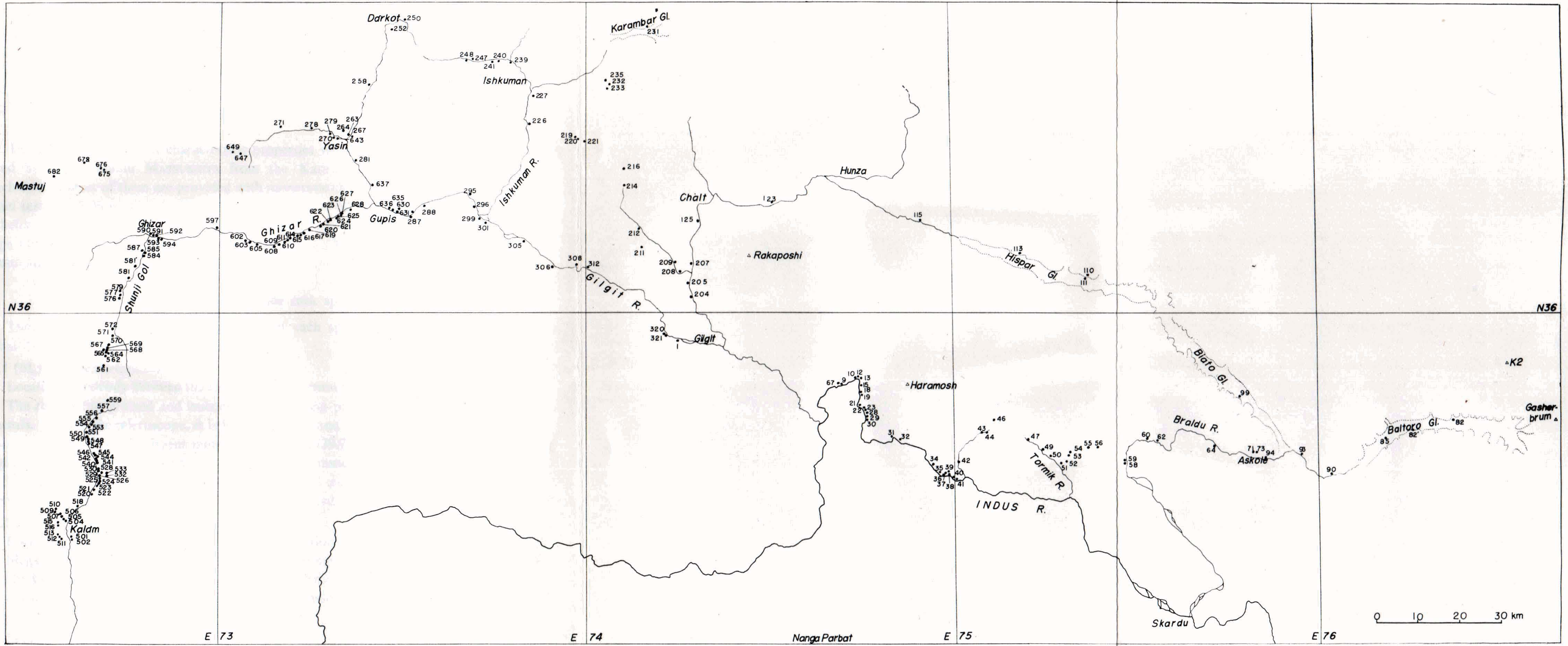

Fig. 5 Locality map of specimens examined

7. On the Chemical Compositions of the Granitic Rocks Collected from the Karakoram and Hindu Kush Ranges

By Yasuo UKAI and Yasuhiro KIMURA

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The chemical and other characteristic properties of seven granitic rocks collected by Prof. Susumu MATSUSHITA from the Karakoram and Hindu Kush conclude that most of them are provided with numerous characters of metamorphic origin instead of those of orthomagmatic origin. Some of the rock specimens are so heterogeneous and restricted in size that they have been inadequate for the preparation of thin section and for chemical analysis. The results of the writers' investigations are described as follows.

Microscopic observation of the rock specimens

The outlines of microscopic observation of each specimen which were preliminarily analyzed chemically are as follows.

No.1 (M_2) Two-Mica-Granite

Locality: Halfway between the Indus-Gilgit junction and Parri, Gilgit Agency.

The rock is fine-grained and leucocratic, containing pink garnets as accessory minerals. Under the microscope, it is holocrystalline and heterogeneous in texture to some extent. The constituent minerals are quartz (39.7%), microcline (28.3%), plagioclase (24.2%, oligoclase, An ≒ 20), biotite (3.2%), muscovite (1.8%), myrmekite (2.7%), garnet (0.1%) etc. Quartz shows undulated extinction, the myrmekite being observed in the interstice between microcline nad plagioclase.

No.2 (M_2) Biotite-Granite

Locality: Halfway between the Indus-Gilgit juntion and Parri, Gilgit Agency.

Megascopically, it is fine-grained and leucocratic but in some cases it contains the streaks of melanoclatic minerals. Under the microscop, it consists of quartz, microcline, biotite, plagioclase (oligoclase, An ≒ 25), associated with zircon.

No.3 (517) Biotite-Granite

Locality: Jangalgam near Kalām, Upper Swāt.

Megascopically, it is a medium-grained granite consisting of quartz, microcline, perthite, greenish biotite, plagioclase (oligoclase, An ≒ 25-30), myrmekite and being accompanied by sphene, allanite and zircon as accessory minerals in pretty amount.

No.4 (82) Two-Mica-Granite

Locality: Urdokas on the left bank of the Baltoro Glacier.

It is medium-grained. Essential minerals are quartz, microcline feldspar, biotite, muscovite, and plagioclase (oligoclase, An≒20).

No.5 (104) Biotite-Granodiorite

Locality: Last Moraine, the Upper Hispar Glacier.

It is a coarse-grained rock. Under the microscope, it contains quartz (31.0%), plagioclase (37.4%) (Andesine, An≒38-42), biotite (20.6%), microcline (7.3%), sphene (0.6%) and is accompanied with sericite and calcite as secondary minerals (3.1%). Quartz shows undulated extinction and flakes of biotite often bend.

No.6 (552) Biotite-Amphibole-Quartz-Diorite

Locality: Diwangar, the Upper Swāt Valley, Swāt.

It is coarse-grained. Microscopically, it consists of palgiocalse (oligoclase, An≒23-28), green amphibole, biotite, microcline, perthite and contains sphene, myrmekite as accessory minerals.

No.7 (580) Quartz-bearing Biotite-Amphibole-Diorite

Locality: North of a small lake in Shunji Gol, Gilgit Agency.

It is coarse-grained and homogeneous. Under the microscope, it consists of plagioclase (64.2%, andesine An≒35-45), amphibole (21.4%), biotite (7.5%), magnetite (4.3%), quartz (2.2%), sericite (0.4%) and apatite.

Chemical Compositions of the Granitic Rocks

Table 1. Chemical Compositions of the Granitic Rocks

	1	2	3	4	5	6	7
	(M_2)	(M_4)	(517)	(82)	(104)	(552)	(580)
SiO_2	72.31	71.92	71.32	70.79	63.28	62.40	54.73
TiO_2	0.23	0.47	0.98	0.23	1.32	0.68	0.61
Al_2O_3	15.19	15.25	13.55	16.15	18.26	17.75	18.72
Fe_2O_3	0.42	0.30	0.49	0.38	1.89	1.77	4.85
FeO	0.97	0.67	2.91	1.37	3.27	3.11	4.66
MnO	0.06	0.11	0.09	0.03	0.15	0.49	0.80
MgO	0.34	0.24	0.58	0.45	1.97	1.65	3.44
CaO	2.43	2.12	2.69	1.75	4.66	4.43	7.72
Na_2O	3.37	3.01	2.79	4.25	2.71	2.79	3.69
K_2O	3.40	3.58	3.43	4.25	2.11	4.26	0.47
H_2O+	0.50	1.54	0.20	0.71	0.10	0.26	0.62
H_2O-	0.09	0.24	0.06	0.06	0.59	0.22	0.23
P_2O_5	0.22	0.06	0.30	0.15	0.15	0.27	0.20
Total	99.53	99.51	99.39	100.57	100.46	100.08	100.74

The chemical compositions of each specimen have been analysed by general analytical method and alkali components determined by means of flame photometer.

Variation Diagram

The normal variation diagram (Fig.1) prepared from Table 1 shows the high content of Al_2O_3 and good similarity to the metamorphic rocks of Tanto type granite in Aichi Prefecture classified by Prof. S. Shibata. Especially in alkali components, the average ratio, $Na_2O:K_2O$ of the six specimens excepting No.580 specimen is 3.15%:3.51%.

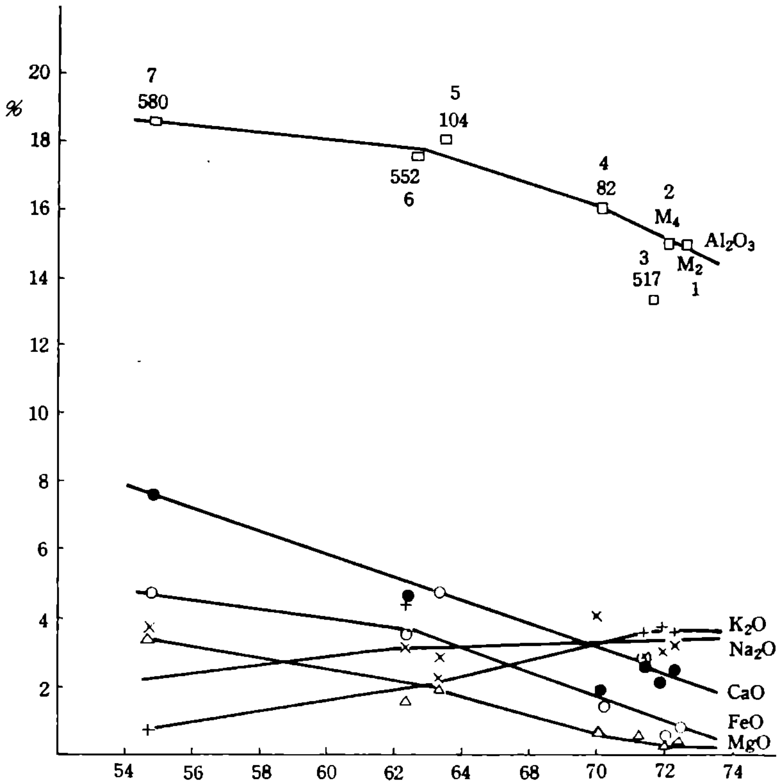

Fig. 1. Variation Diagram of the Granitic Rocks

It is the characteristic of these rocks that the amount of K_2O is higher than that of Na_2O and the content of CaO is higher than that of a common granite.

Norm Calculation and Niggli Value

To inquire the chemical characters of these rocks, Norm values have been calculated from the above chemical data referring to Niggli value.

Three component variation diagram of feldspar is shown in Fig. 2, indicating the different behaviour from that of a normal magmatic differentiation process;

Table 2. Norm Calculation

		1 M₂		2 M₄		3 517		4 82		5 104		6 552		7 580	
SiO_2		72.31		71.92		71.32		70.79		63.28		62.40		54.73	
		Mol.	wt.	Mol.	wt.	Mol.	wt.	Mol.	wt.	Mol.	wt.	Mol.	wt.	Mol.	wt.
Q		0.561	33.66	0.590	35.40	0.578	34.68	0.408	24.48	0.424	25.44	0.271	16.26	0.146	8.76
C		0.018	1.84	0.029	2.96	0.010	1.02	0.015	1.53	0.029	2.96	0.006	0.61	—	—
F	or	0.036	20.02	0.038	21.13	0.036	20.02	0.046	25.58	0.022	12.23	0.046	25.58	0.005	2.78
	ab	0.055	28.82	0.048	25.15	0.045	23.58	0.069	36.15	0.044	23.06	0.045	23.58	0.060	31.44
	an	0.040	11.12	0.035	9.73	0.042	11.68	0.029	8.06	0.084	23.35	0.076	21.13	0.118	32.80
Salic total			95.46		94.37		90.98		95.80		87.04		87.16		75.78
P	wo	—	—	—	—	—	—	—	—	—	—	—	—	0.017	1.97
	en	0.009	0.90	0.006	0.60	0.016	1.60	0.011	1.10	0.049	4.90	0.041	4.10	0.086	8.60
	fs	0.009	1.19	0.017	2.24	0.025	3.30	0.013	1.72	0.018	2.38	0.030	3.96	0.037	4.88
M	mt	0.003	0.70	0.002	0.46	0.003	0.70	0.003	0.70	0.012	2.78	0.011	2.55	0.031	7.19
	il	0.003	0.46	0.006	0.91	0.013	1.98	0.003	0.46	0.016	2.43	0.009	1.37	0.008	1.22
A-ap		0.001	0.34	0.001	0'34	0.002	0.67	0.001	0.34	0.001	0.34	0.002	0.67	0.001	0.34
Femic total			3.59		4.55		8.25		4.32		12.83		12.65		24.20
Total			99.05		98.92		99.23		100.12		99.87		99.81		99.98
	or		27		31		29		32		15		28		3
	ab		42		40		37		47		30		27		33
	an		31		29		34		20		55		45		64

Table 3. Niggli value

	1	2	3	4	5	6	7
Si	385	388	366	345	234	228	149
qz	168.5	176.8	166.2	110.1	75.6	48.4	6.6
al	47.6	48.6	40.9	46.5	39.8	38.0	30.0
fm	9.6	11.3	19.4	10.5	27.0	24.8	36.8
C	13.7	12.3	14.8	9.4	18.6	17.3	22.6
alk	29.1	27.8	24.9	33.6	14.6	19.9	10.6

as increases its acidity, the content of Or component diminishes and that of Ab component increases.

Cation Number

To investigate the characteristics of mutual chemical components, cation

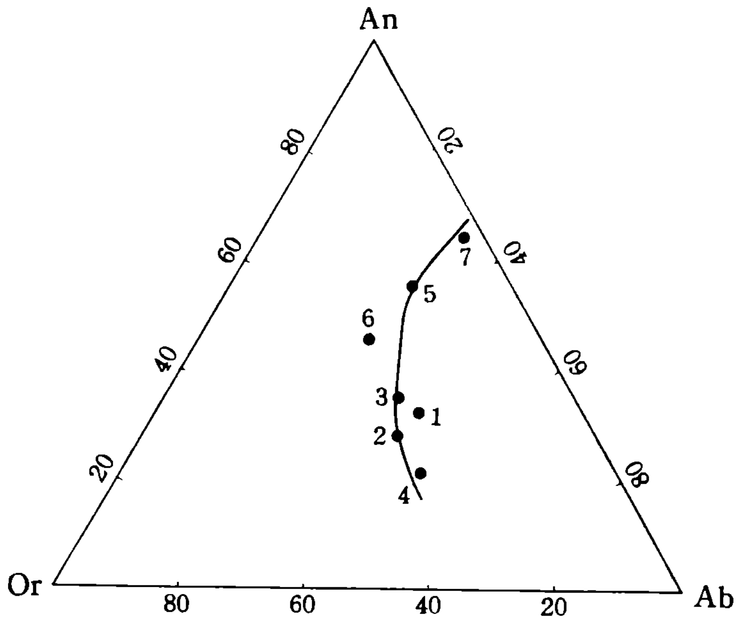

Fig. 2. 3-Component diagram of feldspar

Table 4. Cation Number

	Si	Al	Fe	Fe	Mn	Mg	Ca	Na	K	Ti	P	O
1	34.1	8.1	0.3	0.8	0.1	0.2	1.8	2.5	2.9	0.1	0.1	49.0
2	34.4	8.3	0.2	0.5	0.1	0.2	1.6	2.3	3.0	0.3	0.0	49.1
3	33.6	7.3	0.3	2.3	0.1	0.4	1.9	2.1	2.9	0.6	0.2	48.3
4	33.1	8.6	0.3	1.1	0.0	0.3	1.3	3.2	3.5	0.1	0.1	48.5
5	29.6	9.7	1.3	2.6	0.1	1.2	3.3	2.0	1.8	0.8	0.1	47.5
6	29.3	9.4	1.3	2.4	0.4	1.0	3.2	2.1	3.6	0.4	0.2	46.7
7	25.6	9.9	3.4	3.7	0.6	2.0	5.5	2.7	0.4	0.4	0.1	54.3

Table 5. Combination of three components

	(Na K Ca) A			Total (Ca Fe Al) B			(Mg Ca Al) C			(Ca Al Na+K) D			Total (Mg Ca Fe) E			Total (Ca Fe Na+K) F		
1	35	40	25	16	10	74	2	18	80	12	53	35	7	58	35	22	13	65
2	33	44	23	15	7	78	2	16	82	11	55	34	8	64	28	21	9	70
3	30	42	28	16	22	62	4	20	76	13	52	35	8	39	53	20	29	53
4	40	44	16	12	12	76	3	13	84	8	52	40	10	43	47	14	15	71
5	28	25	47	20	23	57	9	23	68	20	58	22	14	39	47	30	35	35
6	24	40	36	20	23	57	7	23	70	18	51	31	12	41	47	26	29	45
7	31	5	64	24	32	44	11	32	57	30	54	16	14	38	48	35	45	20

Table 5. (Continued)

	(Mg Ca Na+K) G			Total (Mg Fe Al) H			Total (Fe Al Na+K) I			(Mg Al Na+K) J			Total (Mg Al Na+K) K			(Hg Al Si) L		
1	3	24	73	2	12	86	8	55	37	2	49	39	3	16	81	0.5	19.1	80.4
2	3	23	74	2	8	90	5	58	37	2	60	38	3	11	86	0.5	19.3	80.2
3	5	26	69	4	25	71	17	49	34	3	57	40	5	32	63	1.0	17.7	81.3
4	4	16	80	3	14	83	8	52	40	2	55	43	4	16	80	0.7	20.5	78.8
5	14	40	46	8	26	66	22	56	22	8	66	26	13	44	43	3.0	24.0	73.0
6	10	32	58	7	26	67	20	50	30	6	58	36	9	36	55	2.5	23.7	73.8
7	19	52	29	11	37	52	35	49	16	13	66	21	17	58	25	5.3	26.4	68.3

numbers have been calculated, component variation diagrams among 12 elements being studied.

From the investigation of 3 composition diagram among 12 elements, only the variation diagrams of (C) (Mg, Ca, Al) and L (Mg, Al, Si) are similar to those of common igneous rocks, but those of the other 10 kinds of 3 composition diagram are different from those of igneous rocks.

Namely more acidic members (1), (2), (4), of (B), (E), (F) and more basic members (5), (7) of (D), (G), (H), (K) deviate from those of igneous rocks. The content of Al component of (I) is higher than that of igneous rocks and the results of (J) (Mg, Al, Na+K) show the similar trend to that of metamorphic rocks investigated by J.Green. In the case of (A), the trend of the competent rocks deviates from the general trend of igneous rocks.

Conclusion and Aknowledgement

From the detailed microscopic and chemical investigations, it should be considered that most of these rocks were produced through the granitization of sedimentary rocks.

We express our hearty thanks to Prof. Susumu MATSUSHITA for his offering us his precious specimens for study and it is our unexpected fortune to contribute to his scientific expeditions. We are indebted to the advice of Dr. Michitoshi MUKAE of the Hiroshima University.

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2. V. MARMO: Am. Jour. Sci., Vol. 253 (1955)

(A) (Na, K, Ca) System

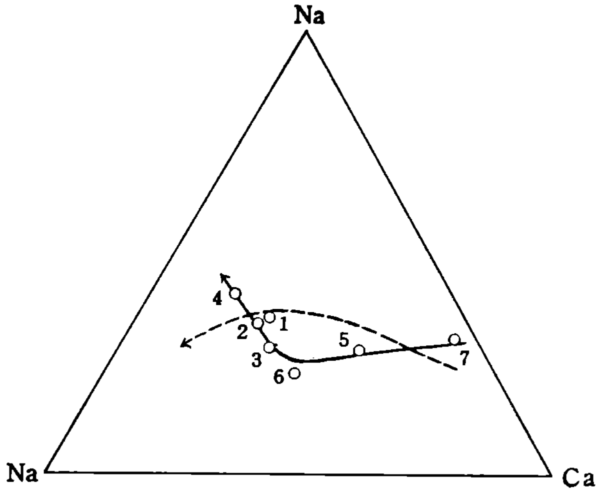


Fig. 3-1. (Na, K, Ca)

As the SiO_2 content, increases the content of K is nearly invariable or decreases against the increases of Na reversely to the general trend of common ingneous rocks.

——→ variation course of the competent rocks

----→ variation course of the common igneus rock

(B) (Ca, total Fe, Al) System

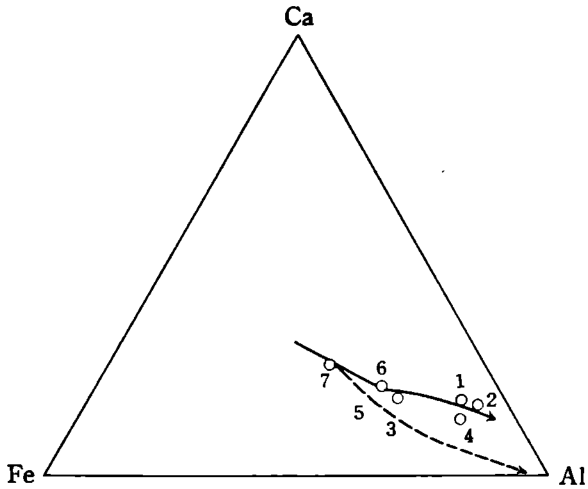


Fig. 3-2. (Ca, Fe, Al)

The acidic rocks marked (1) (2) and (4) deviate from the common igneous rock and this fact is indebted to the higher content of Ca, Al components.

These rocks are characteristic also in the other 3 componentdia-grams as stated below.

(C) (Mg, Ca, Al) System

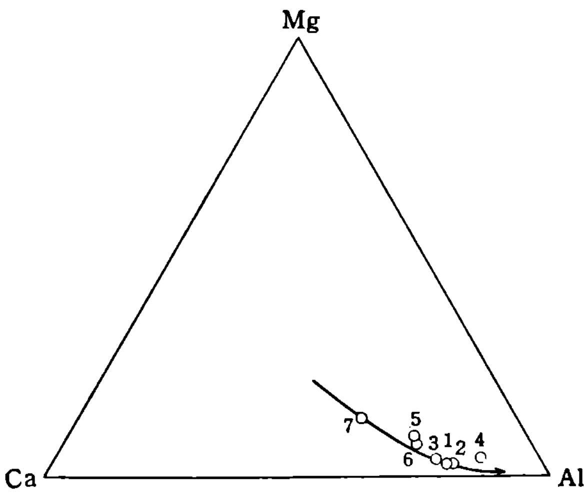


Fig. 3-3. (Mg, Ca, Al)

In this 3 component diagram, its variation trend is similar to that of igneous rocks.

(D) (Ca, Al, Na+K) System

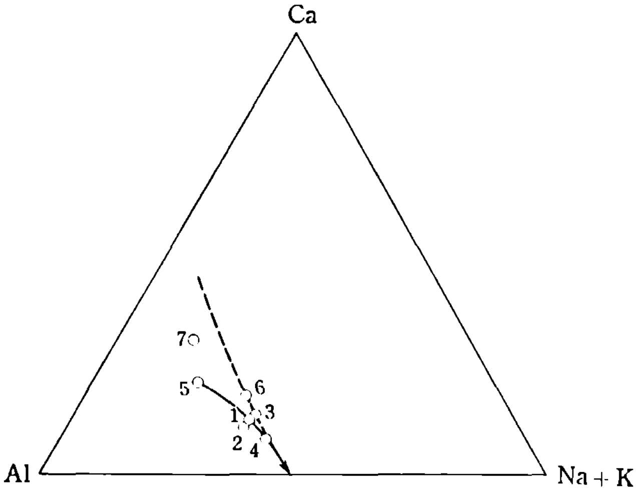


Fig. 3-4. (Ca, Al, Na+K)

In this 3 component diagram, its variation trend is similar to that of igneous rocks but those of more basic members deviate from the general trend according to the higher content of Al.

(E) (Mg,Ca, Fe) System

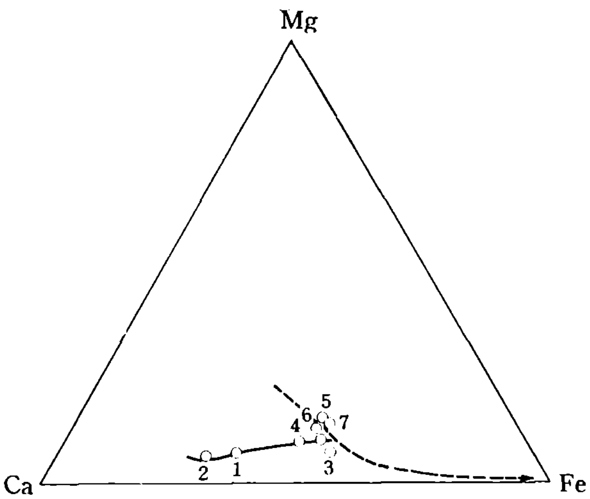


Fig. 3-5, (Mg, Ca, Fe) System

The rocks marked (1), (2) and (4) deviate exceedingly from the common igeous rocks as described in (B) section. These facts due to the lower content of Mg and higher content of Ca and are characteritis of metamorphic rocks.

(F) (Ca, Fe, Na+K) System

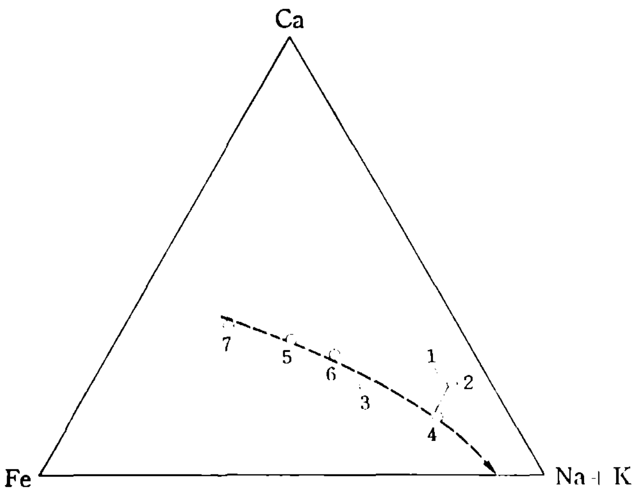
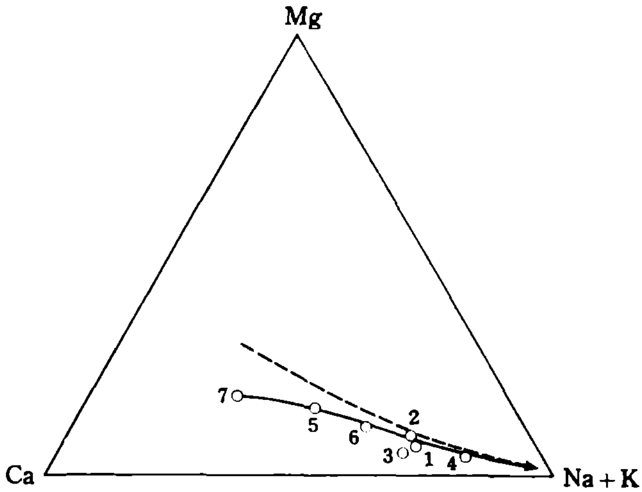


Fig. 3-6. (Ca, Fe, Na+K) System

The rocks marked (1), (2) and (4) deviate from igneous rocks as in the cases of (B), (E), but the other rocks are nearly similar to the igneous rocks.

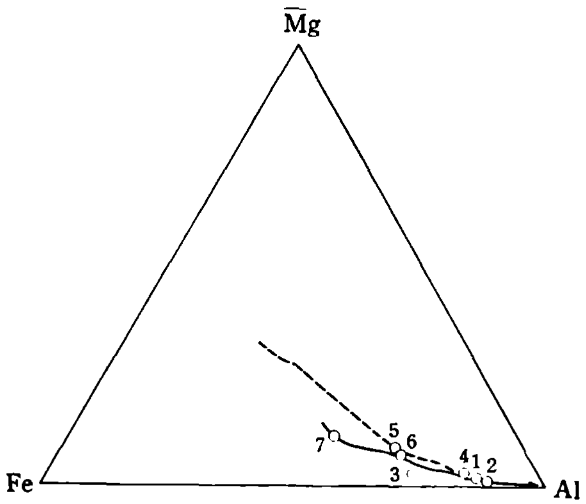
(G) (Mg, Ca, Na+K) System



Generally speaking, the trend of the rocks under consideration is nearly similar to that of igneous rock. but the content of Mg component is lower and that of Ca is higher, so the rocks marked (3), (5), (6) and (7) deviate to some extent from igneous rocks.

Fig. 3-7. (Mg, Ca, Na+K) System

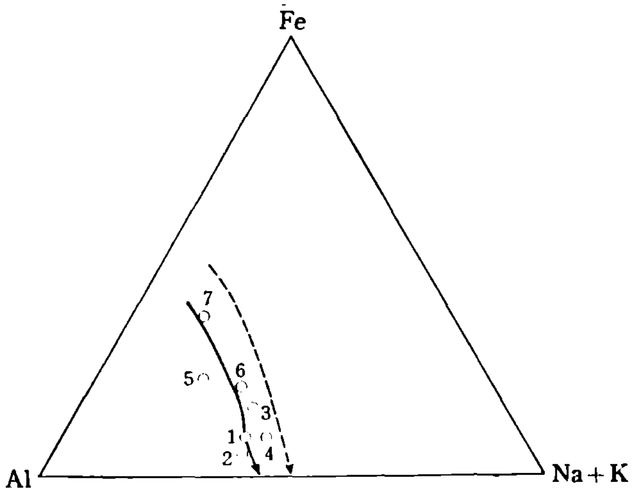
(H) (Mg, Fe, Al) System



As in the case of (G), their trend deviates from that of igneous rocks to some extent to the lower content of Mg.
But except (7), it pursues after the normal course.

Fig. 3-8. (Mg, Fe, Al) System

(I) (Fe, Al, Na+K) Ssytem



The content of Al component is higher than that of igneous rocks, so the trend deviates from the general course.

Fig. 3-9. (Fe, Al, Na+K) System

(J) (Mg, Al, Na+K) System

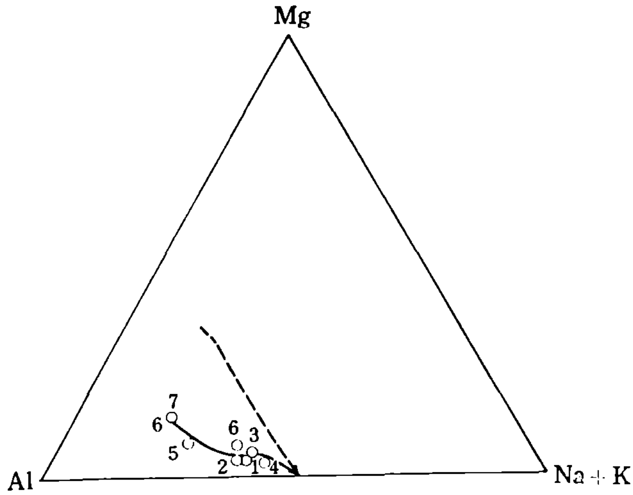


Fig. 3-10. (Mg, Al, Na+K) System

General trend of this system is exceedingly different from that of igneous rocks and shows a good correspondence with the results of the research of metamorphic rocks by J. Green. Namely as increases the content of SiO_2, the composition ratio approaches to that of igneous rocks.

(K) (Mg, Fe, Na+K) System

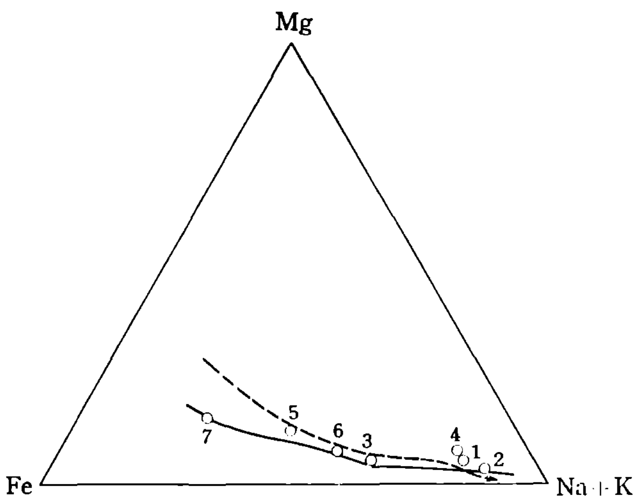


Fig. 3-11. (Mg, Fe, Na+K) System

As in the cases of (G), (H), the trend of more basic rocks deviates to some extent from that of igneous rocks but that of more acidic rocks is similar to that of igneous rocks.

(L) (Mg, Al, Si) System

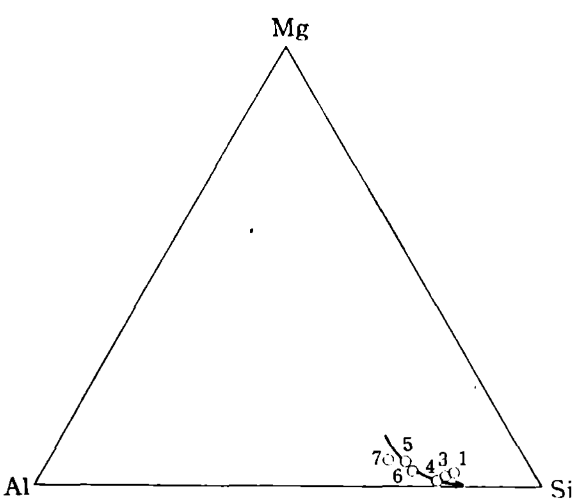


Fig. 3-12. (Mg, Al, Si) System

In this composition system, both igneous and sedimentary rocks show nearly the same variation diagrams, so it is impossible to discriminate the distinctive feature of metamorphic rocks from that of igneous rocks.

8. Cretaceous Corals from the Eastern Hindu Kush

By Motoki EGUCHI*

Occurence of the lower Cretaceous corals in the Yasin Group, of the Gilgit Agency was recorded by Mr. R.O. BRUNSCHWEILER[1] in 1951. The following species were listed by him.

Eugyra cf. *neocomiensis* de FROMENTEL
Calamophyllia cf. *racilis* BLAINNIVLLE
Thecosmilia sp.
Isastrea cf. *regularis* de FROMENTEL
Montastrea sp.

Besides. H. DOUVILLE[2] in 1926 recorded several fossils; among them new occurrence of the following two genera of corals were added by BRUNNSCHWEILER; namely,

Thecosmilia sp.
Montastrea sp.

The geological age of the Yasin Group is according to R.O. BRUNNSCHWEILER Barreminan-Aptian, being comprising a species of rudiste, *Horiopleura* cf. *lamberti* (MUN.-CHAT.), common in the lower Cretaceous of the Pyrenees.

Fortunately two specimens of fossil corals were collected by the member of the geological Research in the Karakoram and Hindu Kush[3] in 1957, chief geologist, Dr. S. MATSUSHITA kindly entrusted to me for study of material.

Among them one is the characteristic Cretaceous genus *Eugyra* and the conferrable specis of the geontype *E.* cf. *cotteaui* de FROMOENTEL.

Genus *Eugyra* de FROMENTEL 1857 is according to J.W. WELLS[4] (1956) a synomym of genus *Myriophyllia* d'ORBIGNY 1849. While the genotype of the latter is *Meandrina rastellina* MICHELIN, from the Upper Jurassic of Europe and has lamellar columella like the similer genus *Dendrogyra*. Diagnosis of *Myriop-*

* Tohoku University, Sendai.
1) R.O.BRUNSCHWEILER, 1951, Lower Cretaceous fossils of the Yasin Group, Gilgit Agency.Rec. Geol. Sur. Pakistan, Vol. 8, pt. 2, p. 27
2) H.DOUVILLE, 1926, Rec. Geol. S.India, Vol. LVIII, pt. 4
3) S.MATSUSHITA, 1958, Research Expedition for Swat and Hindu Kush. p. 208, 209 (in Japanese)
4) J. W. WELLS, 1956, Screratinia in Coelenterata, (R.C.MOORE, Treatise on Invertebrate Paleontology,) p.372

hyllia by WELLS; "Meandroid colonies produced by intratentacular polystomodaeal budding; series directly united by walls. Septa short. Columella lamellar, continuous, discontinuous, or absent. U. Jur.-L.Cret. Eu.-Afr.-N. Am.-S. Am" and he has figured *M. angustata* (d'ORBIGNY) from the U. Jur. (Lusit.). Port. The latter has no columella as usual *Eugyra.* I have no chance to observe the type specimen of the latter genus, judging from the fugure, *M. angustata* (d'ORBIGNY) has no columella, and in this respect more like *Eugyra* while *M. reastellina* has lamellar columella and like *Dendrogyra* EHRENBERG. I have no confidence to identify the jurassic and cretaceous species of so-called *Dendrogyra* with the recent species of *Dendrogyra.*

Our specimens of *Eugyra* from the japanese lower Cretaceous are confined to the same characteristisc with de FROMENTELS origninal description.

So far as I can observed several species of *Eugyra,* hitherto described comes from the Cretaceous, especially abundant in the Lower Cretaceous of the The thys region.

The genus *Thamanasteria* LESAUVAGE[5] 1823 is chiefly known from the Jurassic to the Cretaceous, and several species were recorded from various localities of the world by several authors, although some of them are doubtfully identified or with wider sense of the diagnosis of that genus. The species here after describe is quite new to science, but there are some similarities with several species of the Cretaceous and also Jurassic.

Occurrence of genus *Eugyra* may show the lower Cretaceous age of the Yasin Group of the Gilgit Agency.

In the occasion, I wish to express my sincere thanks to Prof. S. Matsushita for his kind offer of material and literatures, and also due to Mr. K. Mori of the Institute of Geology and Paleontology, Tohoku University, Sendai, for his assistance.

Description of Species

Genus *Eugyra* de FROMENTEL 1857

Genotype; *Eugyra cotteaui* de FROMENTEL, Neocomian of Gy-l'Eveque,

Yonne, France.

Eugyra cfr. *cotteaui* de FROMENTEL

Plate I, fig. 1 & 2

5) M.Eguchi, 1951, Mesozoic Hexacorals from Japan, Sc.Rep. Tohoku Univ. Sendai, Japan, Ser., Vol. 24, p.29

Compare;

Eugyra cotteaui de FROMENTEL, 1857, Descript. pol. foss. étage Neocomien, p.31, pl.III, fig. 4, 5
" " de FROMENTEL, 1859, Etude pol. foss., p.154.
" " de FROMENTEL, 1869, Paléont. franc. Crét. p.448, pl.CIII, fig.2
" " KOBY, F., 1894, Polyp crét., p.20, pl.V, fig. 2
Eugyra cotteaui de Angelis d'OSSAT, 1905, Fauna corallina del piso Aptense de Cataluna, Mem. R. Accad. Sc. Barcelona, vol. V, no. 5, Ep. Tere. p. 8
" " de Angelis d'OSSAT, 1905, Coralli del calcare di Venassino. Atti della R. Acad. delle Scienze. Fisiche e Matematiche, Ser. 2, vol. XII, no. 16, p.35.
" " FELIX J. 1914, Anthozoa Palaeocretacea, Foss, cat., Pars 5, p.15
" " DIETRICH, W.O. 1926, Steinkorallen des Malms und der Unterkreide im südlichen Deutsch-Ostafrika. Palaeontographica, supplement VII, p.65, pl. VII, fig.10
" " BATALLER, J.R., 1937, La fauna corallina del Cretàcic de Catalunya i regions limitrofes, d'ARXIUS de l' Escola Superior d'Agricultura, Nova Ser,. vol. III fasc. 1, p.85, 86
" " BATALLER, J.R., 1945, Segunde supplemento a "La fauna corallina del Cret. de Catalunya i regions limitrofes. Anales de la Escuela de Peritos Agricolas y Superior de Agricultura y de los Servicios Técnicos de Agricultura. vol. V, p.328
Eugyra cfr. *cotteaui* de FROMENTEL, EGUCHI M., 1951, Mesozoic Hexacorals from Japan. Sc. Rep. Tohoku Univ. Sendai, Japan, Geol., vol. XXIV, p. 12, p. I, fig. 12, pl. II, fig. 1

Description; Corallum massive, convex on both upper and lower surfaces, forming somewhat irregular spindle shaped mass; mesuring 95 × 55 × 92 mm, it may be more larger, being broken off the other half before observed. Corallites in series; series meandorid or parallel and usually short on upper surface; often centre of calice is marked by convergently arranged septa, and some isolated calices are also observed. Valley 2-2.5 mm wide, rarely 3 mm. Some 6-8 septa diverge at centre of calice and septa are thick and equal in size, with entire margin, numbering 3-4 within a space of 2 mm. Dissepiments tabular and parallel to the upper usurface, slightly convex upwards, 6-7 per 2 mm. No columella.

Remarks.-Although much worned, above described characteristics are observed on both surface and slices. The inner structure is almost indistinctly destroid by recrystallization of calcite. The present specimen is safely be identifiable with *Eugyra* cfr. *cotteaui* from the several localities of the Hiraiga and Moshi sandstone of the Miyako series[6] (Lower Cretaceous of Japan), and also *Eugyra cotteaui* DE FROMENTEL from the Urgonian of Europe.

Eugyra cotteaui is a species of wide distribution in the lower Cretaceous of the Tethys area; the known localities are Gy-l'Eveque (Yonne), France, several localities in Catalonia, Morteau in Switzerland; Tendaguru district in East Africa; Yasin, Pakistan and Japan.

Eugyra neocomiensis de FROMENTEL[7] is another allied species, but has more

6) M.EGUCHI, 1951, op. cit., p.87
7) E.de FROMENTEL, 1857, Déscription des Polypiers Fossiles de l'Etage Neocomien, p.31, pl.III, fig. 6-7

delicate septa and thin wall with long radial valley of calicular series. *E.* cfr. *neocomieniss* de FROMENTEL was listed by R.O. BRUNNSCHWEILER[8], in his paper, but not described.

Locality: Yasin, Gilgit Agency, Pakistan-occupied Kashmir.

Coll. F. OKITSU on Aug. 8, 1957. No 641 (Kyoto University).

Horizon: Yasin group (Lower Cretaceous).

Genus *Thamnasteria* LESAUVAGE, 1823

Genotype; *Thamnasteria dendroides* (LAMOUROUX), Bajocian of Caen, France.

Thamnasteria matsushitai, n. sp.

Pl. I, fig. 3 & 4.

Description; Corallum thamnasterioid, exceeding 7 cm in diameter and 1.5 cm in thickness. Corallites 2.5-4.0 mm in diameter, more or less circular in cross-section, not regular in arrangement. Septa confluent and form subparallel septocostae. Number of septa in each corallite indistinct (some 16-24), but septocostae rather closely set, 8-10 per 5 mm. Distance between the centers of corallites ca 4-5 mm within a series. Columella rudimentary. (Styliform).

Remarks: The single specimen at hand shows resemblance to *Thamnasteria blaburensis* GEYER[9] of the upper Jurassic of Europe in one hand but can be distinguished from the latter by having narrower dis tances between each center of corallites and more or less larger corallites. *Thamnasteria major* BECKER[10] of the Nattheim beds of Europe is another ally, but can be distinguished by having fewer septa. *Thammasteria tendagurensis* DIETRICH[11] from the lower Cretaceous of East Africa is also an allied species, but the latter has more closely setted corallites and more aboundant septocostae (12 per 5 mm). The marginal part of the corallum is very similar to the present species.

Locatities: Rawat to the east of Shamran on the Ghizar River, Gilgit Agency, Pakistan occupied Kashmir.

Coll. R.A. Khan TAHIRKHELI on July 30, 1957. No. 606 (Kyoto University).

Horizon: Green series (Lower Cret aceous).

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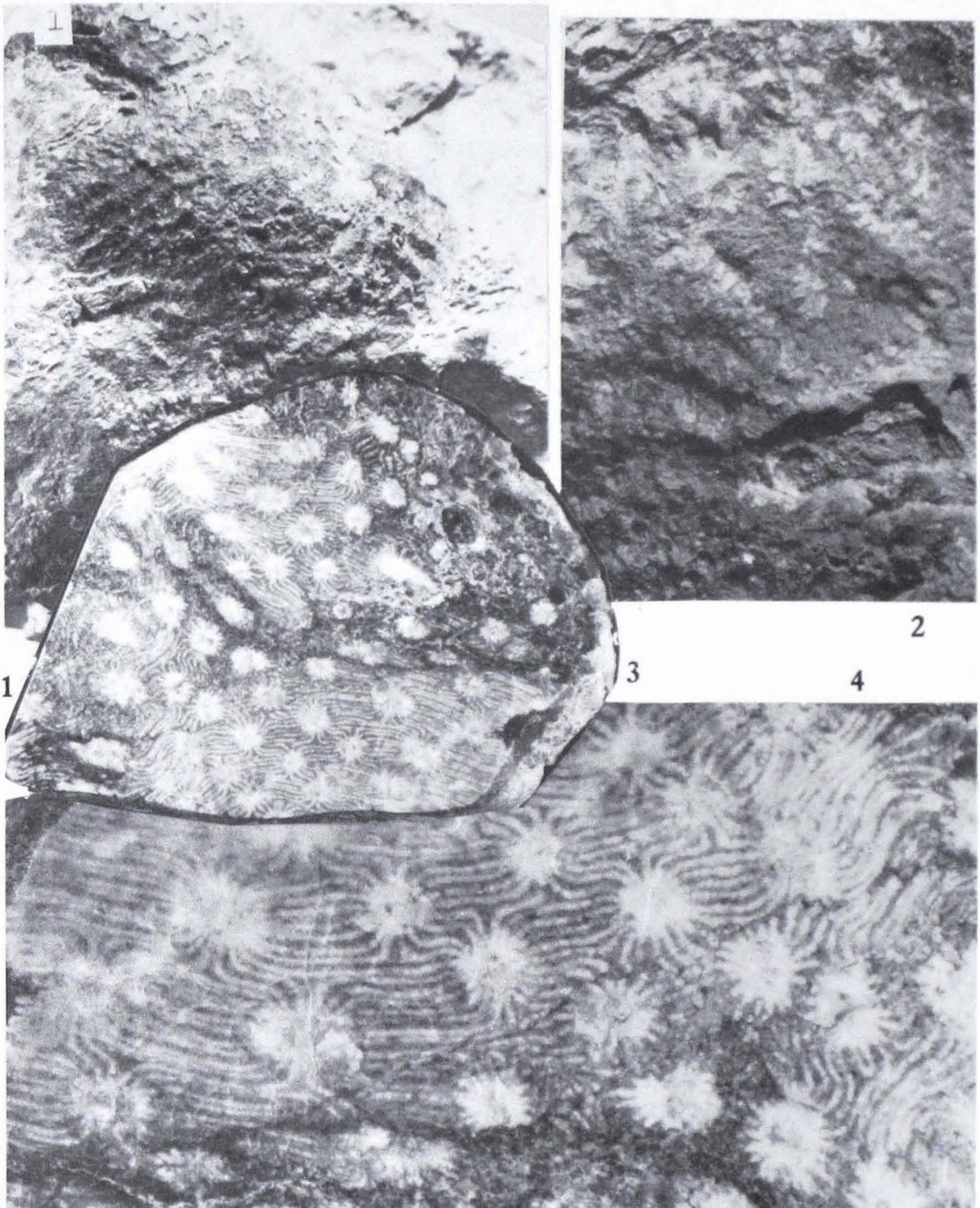
Explanation of Plate I

Fig. 1. *Eugyra* cfr. *cotteaui* de FROMENTEL, nat. siz. Weathered surface of a colony. No. 641 Loc. Yasin, Gilgit Agency, Pakistan-occupied Kashmir. Coll. F. OKITSU Aug. 8, 1957.

Fig. 2. *Eugyra* cfr. *cotteaui* de FROMENTEL, a part of fig.1, enlarged.

Fig. 3. *Thamnasteria matsushitai* n.sp., nat. siz. Polished surface of a colony. No.606 Loc. Rawat to the east of Shamran on the Ghizar River, Gilgit Agency, Pakistan occupied Kashmir. Coll. R.A.Khan TAHIRKHELI. July 30, 1957.

Fig. 4. *Thamnasteria matsushitai* n.sp., a part of Fig. 3, enlarged.



M. EGUCHI: Cretaceous Corals

9. Some Lower Cretaceous Molluscan Fossils from Yasin, West Pakistan*

By Koichiro ICHIKAWA** and Yasuo MAEDA

(With Plates I-VIII)

Nerineids and Rudists, collected from the Lower Cretaceous Yasin group at Yasin, Gilgit Agency, by K. HUZITA in 1956 and S. MATSUSHITA in 1957, were submitted to us for determination. This paper is a result of our study on them. We wish to express our sincere thanks to Prof. S. MATSUSHITA (Kyoto University) and Prof. K. HUZITA (Osaka City University) for the opportunity of the present study.

After the original manuscript of this paper had been once completed, one of us (K. ICHIKAWA) had an opportunity of studying DOUVILLÉ's (1926) original specimens, kept in the Geological Survey of India, Calcutta***. Some results of the palaeontologic examination could be supplementarily added to the original manuscript. For kind arrangement and fascilities, given during the course of the study in Calcutta, we wish to extend our sincere gratitude to Dr. B. C. ROY (Director General of the Geological Survey) Mr. M.V.A. SASRTY, Mr. P.P. SATSANGI and other staff of the palaeontologic division of the Survey.

Previous Works

(1) HAYDEN (1915) reported the occurrence of the "Upper Cretaceous" "Hippurite limestone" in the cliffs immediately behind the Rest House at Yasin on the right bank of the river. His collection was later examined by H. DOUVILLÉ (1926), who described the following molluscan species:

Horiopleura haydeni DOUVILLÉ, 1926
Praeradiolites gilgitensis DOUVILLÉ, 1926
Nerinea coquandi D'ORBIGNY, 1842

Besides, *Orbitolina bulgarica*, *O.* cf. *discoidea*, *Rhabdophyllia* cf. *gracilis*, *Eugyra* cf. *neocomiensis*, *Isastrea* cf. *regularis* were also reported from the same locality. Based on them, he pointed out a marked affinity of the Yasin fauna with the Lower Cre-

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*** Geological Survey of India, Reg. No. 13031-13043.

taceous fauna of the Mesogean Europe. A development of *Horiopleura* was especially noted.

(2) IVANAC, TRAVES & KING (1956) reported on the Cretaceous rocks near Yasin, which they named as the Yasin group. From their collection, made in 1951, BRUNNSCHWEILER (1956) identified and listed the following molluscan species:

Horiopleura haydeni DOUVILLÉ
Horiopleura cf. *H. haydeni* DOUVILLÉ
Horiopleura cf.*H. lamberti* (MUNIER-CHALMUS)
Nerinea cf. *N. coquandi* D'ORBIGNY
Ptygmatis n.sp.

Besides, *Eugyra* cf. *E. neocomiensis*, *Calamophyllia* cf. *C. gracilis*, *Thecosmilia* sp., *Isastrea* cf. *I. regularis*, *Montastrea* sp. were also listed. Thus he confirmed the Lower Cretaceous (Barremian-Aptian) age of the Yasin group.

(3) DESIO (1959) discussed about the Cretaceous beds between Karakorum and Hindu Kush Ranges, based on his survey in 1954 and 1955. In this paper he gave a description of the Cretaceous sequence in the Yasin district and listed the following species from Yasin, which were studied by his collaborators:

Horiopleura haydeni DOUVILLÉ
Praeradiolites gilgitensis DOUVILLÉ
Adiozoptyxis coquandiana (D'ORBIGNY)
Adiozoptyxis renauxiana (D'ORBIGNY)
Nerinea vogtiana DE MORTILLET
Nerinea desioi FARIOLI MIRELLI
Rhabdophyllia cf. *gracilis* DE FROM.
Isastrea cf. *regularis* DE FROM.
Orbitolina discoidea GRAS.

Among them, rudists and nerineids were studied by ROSSI RONCHETTI & FARIOLI MIRELLI (1959) and FARIOLI MIRELLI (1956). They were collected from the "Westdale of Yasin Rest-House". The occurrence of *Horiopleura* is restricted to the Aptian-Albian of the European-African-South Asiatic Tethyan sea, if a questionable occurrence in the Cenomanian of South Mexico is excluded (cf. DECHASEAUX, 1952, p.338). It appears to be more frequent in the Aptian. Species of nerineids such as *A. coquandiana*, *A. renauxiana* and *N. vogtiana*, are generally found associated with rudists, orbitolinids and corals in the Urgonian facies of the Barremian-Lower Aptian age. Comparing the Yasin assemblage with the Aptian ones of some other regions in the Tethys, they attributed the Yasin fauna to the Aptian and probably the Lower Aptian.

Notes on the Present Collections

The specimens before hand belong to one or other of two collections, namely:

A. Specimens, collected by K. HUZITA and others in 1956. from talus blocks at Loc. A, the road-side on the right bank of the Naz Bar (River), about 1.5 km west of Yasin Rest House (Point A in Fig. ~~00~~ 4-5 in p. ~~000~~ 21 of this volume). The blocks are of large dimension (See Plate I) and are presumed to have been derived from the southern cliff. The matrix is grey silty impure limestone. In a few slabs, containing *Plesioptyxis matsushitai*, it is highly calcareous coarse sandstone. The specimens belong to the collection of the Department of Geosciences, Osaka City University (OCU Reg. no. MM 555 ff.).

B. Specimens, collected by S. MATSUSHITA and others in 1957, at Loc. B, the Western Hill of Yasin, about 2.5 km west of Yasin Rest House (See Fig. ~~00~~ 4-5 in p. ~~000~~ 21 of this volume). Grey silty impure limestone. They belong to the collection of the Geological and Mineralogical Institute, University of Kyoto (KU Reg. no. FM 40001 ff).

A more detailed geological information about the collecting localities is given elesewhere in this volume (p. ~~000~~ 20). As shown by photographs in Plate I, nerineids and rudists were found crowded on the beds.

As a result of the present study, following species have been determined:

	Loc. A	Loc. B
Plesioptyxis matsushitai n. sp.	×	◎
Plesioptyxis huzitai n. sp.	◎	cf
Adiozoptyxis cf. *A. coquandiana* D'ORBIGNY	○	
Horiopleura haydeni DOUVILLÉ	○	
Horiopleura haydeni var.	○	

◎ Abundant; ○ common; × rare.

Among them, the first two species of nerineids, which are individually richly represented, are not exactly identifiable with the species hitherto reported from Yasin. Furthermore, individually dominant species are different between Locs. A and B. These facts suggest that several types of molluscan assemblage are represented within the Yasin group even in the environment of Yasin.

Concerning the geological age, however, the assemblages, dealt with in this paper, may not be significantly different from those reported by previous workers, since *Horiopleura haydeni* and *Adiozoptyxis coquandiana* or its close ally occur in common. As discussed by ROSSI RONCHETTI & FARIOLI MIRELLI (1959), the Yasin fauna, as a whole, may be properly referred to the Lower Aptian and/or thereabout.

Description of Fossils

Family Nerineidae

Genus *Adiozoptyxis* DIETRICH (1914) 1925

DIETRICH, 1914, p. 141
DIETRICH, 1925, p. 108
COX, 1954, p.12

Type-species:--*Nerinea polymorpha* GEMMELLARO, 1865 (Tithonian, Italy).

Diagnosis:--Shell moderately stout, often large, with broad umbilicus; whorls low, strongly concave to flat, smooth or tuberculate, with an angular adaxial projection forming a helix within the umbilicus. Details of aperture unknown. Three internal folds present (2,0,1,0 or 1,1,1,0). (Tithonian to Senonian) (from COX, 1954).

Remarks:-- COX (1954) discussed about the availablity of the generic name *Adiozoptyxis*.

Adiozoptyxis cf. *A. coquandiana* D'ORBIGNY, 1842

(Plate IV, Figures 1-3)

Nerinea coquandi D'ORBIGNY—DOUVILLÉ, 1926, p.353-355, text-fig. 9.
Compare:
Nerinea coquandiana D'ORBIGNY, 1842, p.75, pl. 156, figs. 3, 4.
Nerinea (*Diozoptyxis*) *coquandiana* D'ORBIGNY—COSSMANN, 1907, p. 12, text-fig. 3, pl. 2, figs. 1-4.
Nerinea (*Diozoptyxis*) *coquandiana* D'ORBIGNY—COSSMANN, 1916, p.14, pl.1, figs. 27-28.
See DIETRICH, 1925, p.130 for full synonymy upto 1925.

Material:--Six specimens (OCU MM 555-560) and several fragments.

Remarks:--The specimens before hand are more or less strongly compressed secondarily. Compared with the original illustration of *A. coquandiana* D'ORBIGNY (1842), the present specimens bear apparently less prominent annulation along the abapical marginal zone of each whorl and less distinct tubercles on the annulation, although these may be partly due to the ill-preservation of the surface feature of the Yasin specimens. The flank of the whorl is concave as in the typical form of this species, but in a giantic specimen (Pl.IV, Fig.2) the concavity becomes not so remarkable. This fragmentary specimen is more than 210 mm high in preserved portion and may have been about 300 mm high when restored. This size appears to be usually not attained by typical representatives of this species. In these respects the Yasin specimens are compared, but not identified with *A. coquandiana*.

With respect to the apparent indistinctness of tubercles on the annulation (based on observation of the actual specimens) and the comparatively large size, the specimen from Yasin illustrated by DOUVILLÉ (1926, op. cit.) is regarded as being conspecific with the present material. In DOUVILLÉ's specimen (Geol. Surv.

India, Reg. no. 13036) the breadth of the whorl in the preserved part is about 47-50 mm (not strongly compressed). The textfig. 9 in DOUVILLÉ (p.355) is about 1.18 times magnified. It may be therefore not so large as our largest specimen. The annulation is strong as in our specimens of comparable dimension.

Concerning the internal characters, one columellar, one parietal and one palatal fold can be recognized both in DOUVILLÉS' and our specimens. The parietal fold is located close to the columellar wall. Their general configuration is, although often secondarily deformed, essentially the same as that of *A. coquandiana* and *A. renauxiana*.

Occurrence:--Abundant in HUZITA's collection from Loc. A.

Family Nerinellidae

Genus *Plesioptyxis* PČELINCEV, 1954

PČELINCEV, 1954 (not seen); 1960, p. 124.

Type-species:--*Nerinea fleuriausa* D'ORBIGNY, 1842, p. 85, pl.160, figs. 6,7 (Cenomanian, France).

Remarks:--*Plesioptyxis* is closely related to *Multiptyxis* PČELINCEV, 1953 and may eventually be regarded as a subgenus of *Multiptyxis*. PČELINCEV (1960) referred them to the Family Nerinellidae PČELINCEV, 1960. According to him, *Plesioptyxis* is known from Cenomanian to Senonian, while *Multiptyxis* ranges from Tithonian to Cenomanian. Since generic assignment of some related nerineid species appears to be much confused in the present state, much stress is not laid upon the above-quoted known range of *Plesioptyxis*.

Plesioptyxis matsushitai ICHIKAWA & MAEDA, n. sp.

(Plate II, Figures 1-4)

Description:--Shell of moderate size, very high-spired, with more than 16 (probably more than 22) whorls; anomphalous; median spkire angle about 13°; apical angle a little larger; early part of the shell slightly cyrtoconoidal. Spiral whorls with a blunt elevation along the junctional zone which bears very inconspicuous suture. Two rows of indistinct tubercles near the median of the whorl and along the base of the whorl. Whorl section subquadrate, wider than high, base of whorl gently inclined, not markedly projected downward, judging from sectioned specimens. Six (or seven) internal folds present; two columellar folds, the abapical one (c_1) well incised; two parietal folds, the abaxial one (p_2) shallowly incised; one (or two) palatal fold, the weakly sinuate adapical one only sometimes perceptible in gerontic stages, and one incipient basal fold.

Material:--More than twenty specimens (KU FM 40001-40013; OCU MM 562) and other fragmentary specimens. The holotype is KU FM 40001 (Pl. II, Figs. la-c).

Observations:--The apical and the basal parts of the holotype specimen (Height of the preserved part: 92 mm) are lacking, but the missing parts can be supplemented by observation on several additional specimens. In gerontic stages, represented by some specimens (KU FM 40002, 40005 etc.), the height of the whorl attains to 12 mm. When restored, the number of whorls may even exceed 22 and the shell may become more than 150 mm high.

The internal structure of the whorl is well preserved in the holotype, which, however, does not show the mode of the external sculpture, due to weathering and/or surface erosion. The external sculpture is not well preserved on most specimens, but is barely discernible in a few specimens (See Pl.II, Fig.3). In the gerontic stages, some tubercles on the base of whorl appear to become irregularly prominent.

Comparison:--This species resembles "*Nerinea*" *fleuriausa* D'ORBIGNY, the type species of *Plesioptyxis*, from the Cenomanian of France in general external configuration and in the advanced condition of the internal folds, but differs from it in the presence of a spiral row of indistinct tubercles near the middle of the whorl and in that the columellar folds are not so deeply incised as in the latter species.

It somewhat resembles "*Nerinea*" *desioi* FARIOLI MIRELLI (1956, p.133, fig.1) from Yasin, but differs from it in the larger spire angle and in the whorl section which is more depressed. Furthermore the abaxial parietal fold (p_2) is more distinctly incised. This fold, although enumerated in the description of "*N.*" *desioi*, is generally much weaker than that of *P. matsushitai*, judging from the illustration.

It appears to resemble also *Multiptyxis airigulensis* VOGT (cf. PČELINCEV, 1960, pl. 15, fig.1; GOLOVINOVA & KOSMUITCHENKO, 1960, p. 153, pl.5, figs.5a,b) from the Valanginian of Krimea. This is the type-species of *Multiptyxis*. But the former appears to have more advanced internal folds than the latter.

Occurrence:--Abundant in Loc. B. In HUZITA's collection from Loc. A this species is rather rare. A specimen (OCU MM 562) from Loc. A is contained in coarse sandy calcareous matrix. Specimens from Loc. B are found in silty or fine sandy impure limestone.

Plesioptyxis huzitai ICHIKAWA & MAEDA, n. sp.

(Plate III, Figures 1-4.)

Description:--Shell of large size, turriculate, very high-spired with probably more than 30 whorls; anomphalous; median spire angle about 6-8°. Spiral whorl concave at the flank and annular at the junctional zone. Whorl section obliquely subquadrate with considerably inclined and adaxially downward projected base. Six (sometimes five) internal folds present; two columellar folds, the abapical one (c_1) well incised; two parietal folds, the abaxial one (p_2) shallowly incised; two palatal folds, the adapical one (l_2) represented only by a slight sinuation or sometimes not recognizable; basal fold usually not present, sometimes only vaguely marked as a slight sinuation in later whorls of gerontic specimens.

Material:--About ten specimens were freed from the matrix (OCU MM 564-572) (Loc. A) One specimen (KU FM 40014) from Loc. B is comparable with this species. The holotype is OCU MM 564 (Pl.III, Figs. la-c).

Remarks:--The holotype is 107 mm high, but its apical and basal portions are not preserved. Judging from the presence of several much larger specimens, this species is presumed to have become more than 250 mm high with more than 30 whorls. In later whorls of some larger specimens, for example OCU MM 572, the inclination of the base of whorl section is not so strong as in typical specimens.

The mode of the surface ornament is unknown due to the unfavorable state of preservation. In several specimens the suture is more or less distinctly incised on the annulated zone, but it is unknown whether this is a feature of the very external surface of the shell or not.

Comparison:--This species differs from *P. matsushitai*, described above, in the presence of a distinct annulations externally and in the much more obliquely inclined whorl section with more distinct tendency to downward projection of the axial part. The latter difference becomes, however, indistinct in some larger specimens, with the external aspect of *P. huzitai*, whose whorl sections approach that of *P. matsushitai*.

In general aspect of the shell and of the internal characters it resembles "*N.*" *desioi* (op.cit.) very much, but the former differs from the latter in a little stronger annulation of the shell and in the scarcely developed basal fold.

Externally, this species may be thought to be allied to "*Nerinea*" *vogtiana* DE MORTILLET (synonymy in DIETRICH, 1925, p.121), but the internal folds are much more complicated in the former than in the latter (cf. COSSMANN, 1907, text-fig.2). They are evidently not congeneric each other.

Occurrence:--Abundant in HUZITA's collection from Loc. A. One comparable specimen in MATSUSHITA's collection from Loc. B.

Family Caprotinidae

Genus *Horiopleura* (MUNIER-CHALMUS, 1882) DOUVILLÉ, 1889

Type-species:--*Monopleura lamberti* (MUNIER-CHALMUS in HÉBERT, 1867, nomen nudum), *Horiopleura lamberti* MUNIER-CHALMUS in DOUVILLÉ, 1889 (p.639), (Aptian-Albian, Pyrenee).

Horiopleura haydeni DOUVILLÉ, 1926

(Plate V, Figure I; Plate VI, Figures Ia-b; Plate VII, Figures Ia-b; Plate VIII, Figures Ia-b)
Horiopleura haydeni DOUVILLÉ, 1926, p 350, text-figs 3-6; plate 13, figs 2 only.

Description of the present material:--Shell of large size, ponderous, valve margin irregularly shaped, but generally roundly subtrigonal or roundly subquadrate. Attached valve obliquely subconical, much more convex and larger than the free valve.

The attached valve with very prominent umbo; its apical portion located much remote from the dorsal margin of the valve commissure, generally irregularly undulated as a marking of cicatrix. The surface generally covered by distinct striae of growth and occassionally by weak rugose undulation. One narrow hinge tooth 3b* on thick hinge plate, located between the two teeth of the counter valve.

The free valve less convex with the low, much less elevated umbo. The surface with concentric markings. Two hinge teeth; a large prominent cardinal tooth "AII" markedly projected antero-dorsally into the cavity of the counter valve; another much smaller tooth "PII" at the postero-dorsal side of "AII", subhorizontal and partly overlapped by the narrow 3b of the counter valve. Behind "PII" an elongate platform of the posterior adductor scar, which separates the posterior accessory cavity from the principal cavity of the shell.

Material:--Three large specimens and several others (OCU MM 573-576). Two of them are double-valved. ~~The holotype is a left valve (OCU MM 573) with the maximum length ca 130 mm and the maximum inflation ca 60 mm~~.

Remarks: The specimens before hand are more or less deformed in various directions. The interior of the shell was developed for two specimens. One of them is illustrated (Pl. VIII, Fig. la).

The identification of the present form gave some difficulty. A glance at the well preserved attached valve, illustrated in Pls. V and VI, gave us an impression that this might represent the left valve because of the apparently rolling aspect of the umbonal region. In this case our form would become quite unrelated to the Caprotinids such as *Horiopleura*.

After a close comparison with the DOUVILLÉ's original specimens, it could be assured that the present form is identical with *H. haydeni*. The apparent "rolling of umbo" in our specimen, just mentioned, is presumed to be a result of a subsequent deformation of the shell surface slightly below the cicatrix. The true apical portion is generally located within the cicatrix and is now obscured. The analogous aspect of the deformation can be observed also in one of DOUVILLÉ's specimen (pl. 13, fig.2), although the side-view of this specimen was not given by DOUVILLÉ.

* Elements of dentition are named here after DOUVILLÉ.

Concerning the radial furrows on the attached valve, a wide range of variation can be observed. Among DOUVILLÉ's specimens text-fig. 3 (holotype) and pl.13, fig. 2 represent the typical form with hardly developed radial furrow, while the specimen in pl. 13, fig.3 is regarded as a varietal form, characterized by comparatively narrow and much elevated umbo and by two radial broad furrows on the surface.

It appears to be not advisable to separate the latter form specifically from the former.

Most of the specimens at hand belong to the typical form while several specimens belong to the varietal form (See below). One of our specimens illustrated in Pls. VII and VIII appears to be an intermediate form. It bears one indistinct broad radial furrow (See Pl. VIII, Fig. 1b)

Occurrence:--Loc. A.

Horiopleura haydeni var.

Horiopleura haydeni DOUVILLÉ, 1926, pl. 13, fig. 3 only.

Material:--OCU MM 578 and several fragmentary specimens

Remarks:--The attached valve is provided with two broad radial depressions.

Occurrence:--Loc. A.

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PLATES I–VIII

Explanation of Plate I

Fig. 1. Photograph showing the mode of occurrence of *Plesioptyxis huzitai* in a large block at Loc. A.

Fig. 2. Photograph showing the mode of occurrence of rudists and nerineids in another block at Loc. A. The two photographs were taken by K.HUZITA on the 13th September, 1956.

In Plates I-VIII, following abbreviations are used with respect to the repository of the illustrated specimens:

OCU Department of Geosciences, Osaka City University

KU Geological and Mineralogical Institute, Kyoto University.

Informations about Locs. A and B are given in p. 139 of the text.

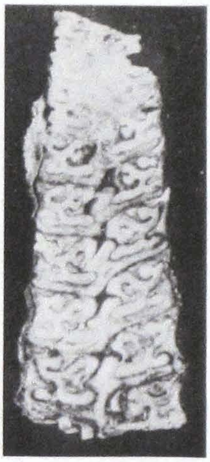
1

2

Explanation of Plate II

Plesioptyxis matsushitai ICHIKAWA & MAEDA, n. sp.
Figs. 1a-c. Holotype (KU Reg. no. FM 40001). 1a-b, ×1; 1c (part of 1b) ×2. Loc. B.
Figs. 2a-b. Part of a larger specimen (KU Reg. no. FM 40002). 2a × 1; 2b × 2. Loc. B.
Fig. 3. (KU Reg. no. FM 40003). × 1. Loc. B.
Fig. 4. (OCU Reg. no. MM 562). × 1. Loc. A.

1a

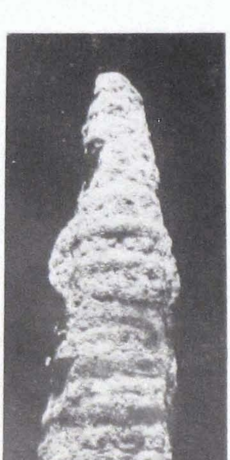


1b

1c

2a

2b



3

4

Explanation of Plate III

Plesioptyxis huzitai ICHIKAWA & MAEDA, n. sp.

Figs. 1a-c. Holotype (OCU Reg. no. MM 564). 1b-c are section of the abapical part of 1a, parallel to the plane of this plate. 1a-b, × 1; 1 b-c × 2. Loc. A.

Fig. 2. (OCU Reg. no. MM 565). × 1. Loc. A.

Figs. 3a-b. A larger specimen, somewhat compressed (OCU Reg. no. MM 572). × 1. Loc. A.

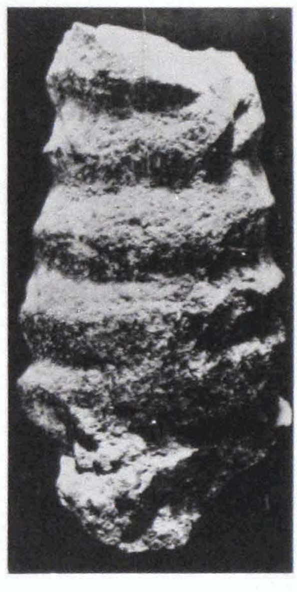
Figs. 4a-b. (OCU Reg. no. MM 567). × 1. Loc. A.

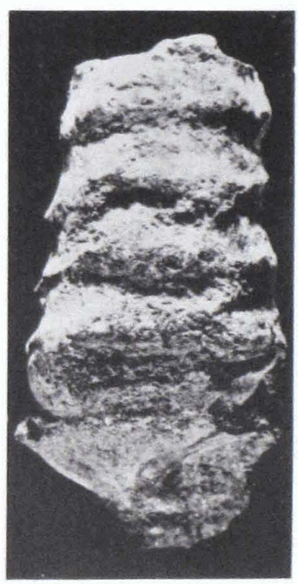

1a

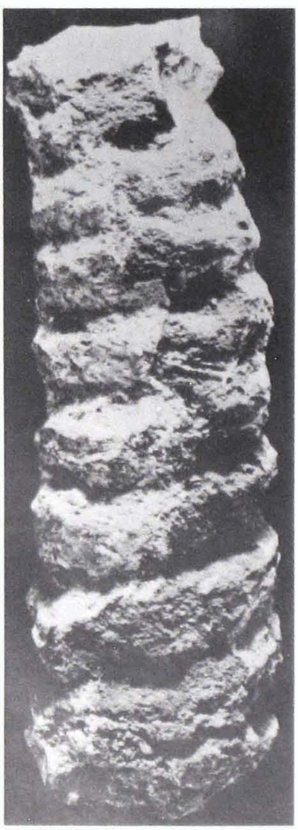

1b

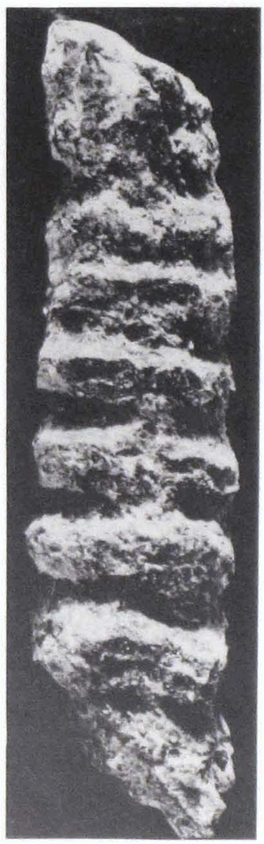

1c


2


4a


4b


3a


3b

Explanation of Plate IV

Adiozoptyxis cf. *A. coquandiana* D'ORBIGNY

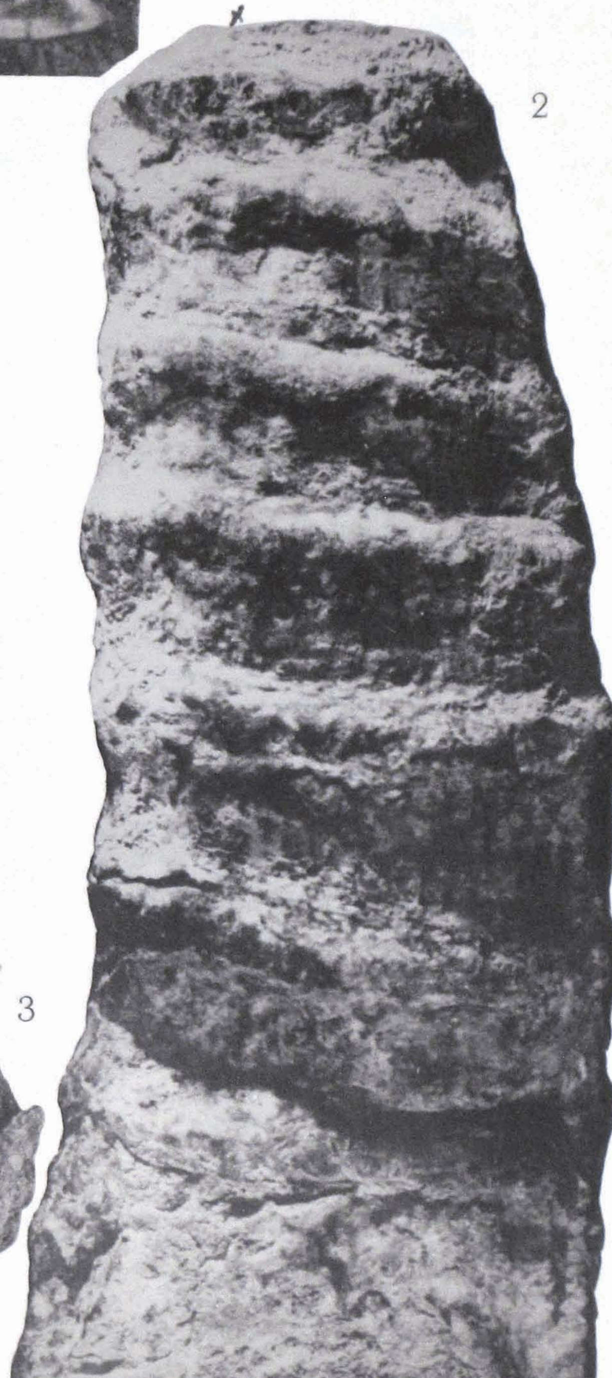
Figs. 1a-b. (OCU Reg. no. MM 556). 1a × 1; 1b (part of 1a) × 2. Loc. A.

Fig. 2. A giantic specimen, strongly flattened in the direction perpendicular to the plane of this plate (OCU Reg. no. MM 555). × 1. Loc. A.

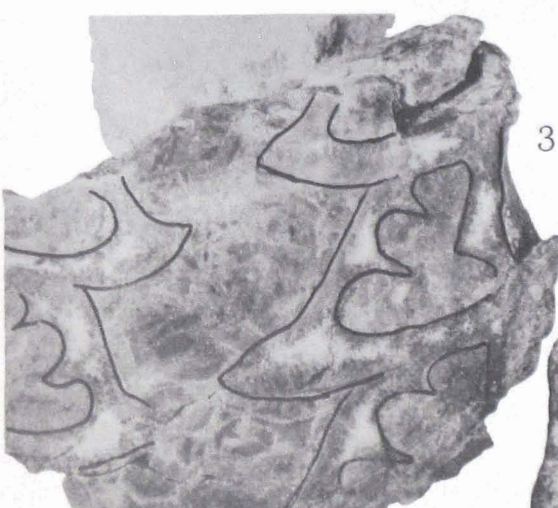
Fig. 3. Fragment of another giantic specimen, deformed. (OCU Reg. no. MM 557). × 1. Loc. A.

1b

1a



2



3

Explanation of Plate V

Horiopleura haydeni DOUVILLÉ

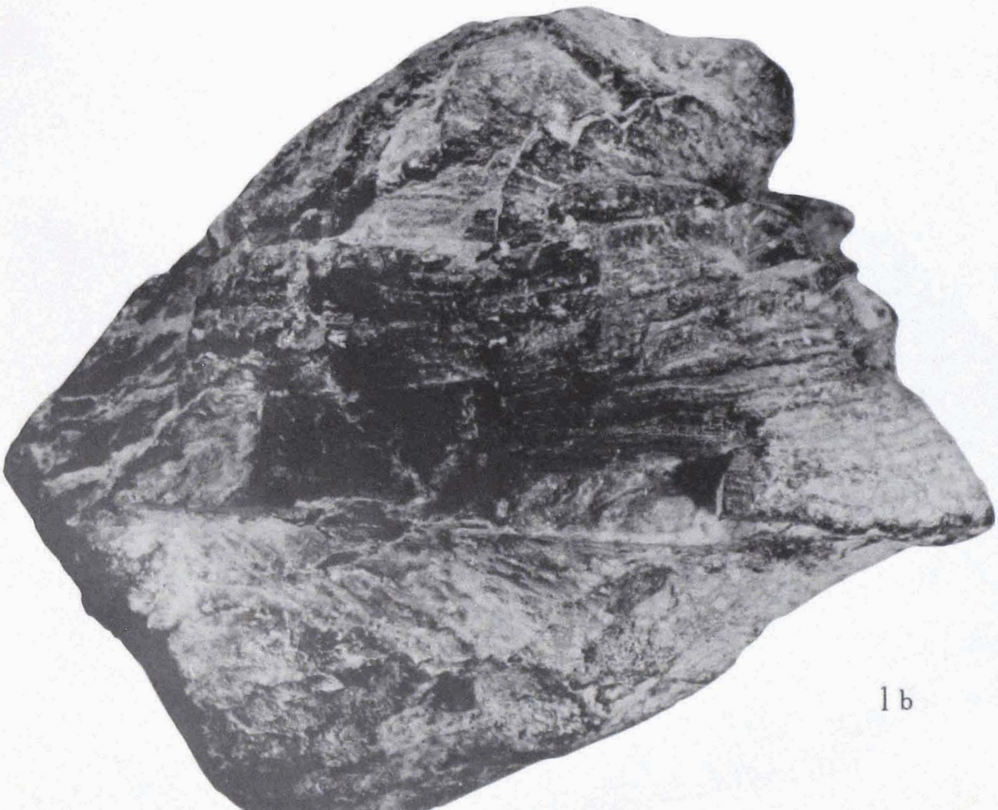
Fig. 1. An attached valve with deformed umbonal portion, ~~holotype~~ (OCU Reg. no. MM 574). See Plate VI for dorsal and front views. × 1. Loc. A.

Explanatoin of Plate VI

Horiopleura haydeni DOUVILLÉ

Figs. 1a-b. The same specimen as Pl.V, Fig.1, ~~holotype~~ (OCU Reg. no. MM 574). Dorsal (1a) and anterior (1b) views. The orientation of another valve (lower side of fig.1b) is not original. It is dislocated. ×1. Loc. A.

1a



1b

Explanatoin of Plate VII

Horiopleura haydeni DOUVILLÉ

Figs. 1a-b. A double-valved specimen (OCU Reg. no. MM 575). View from the free valve side (1a) and anterior view (1b). × 1. Loc. A.

1 a

1 b

Explanatoin of Plate VIII

Horiopleura haydeni DOUVILLÉ

Figs.1a-b. The same specimen as Pl.VII, Fig. 1 (OCU Reg. no. MM 575). Interior of the free valve (1a). The projected portion of the teeth (broad, strong "AII" and smaller "PII") is broken off. Dorsal view (1b). × 1. Loc.A.

1 a

1 b

10. Age Measurement of a Karakorum Rock

By Ichikazu HAYASE

The mineral was sampled near Dusso by Professor MATSUSHITA during the 1955 Karakorum expedition. According to his field observation, this pegmatite seems to intrude into gneiss which derived from Permo-Carboniferous sediment. This pegmatite contains orthoclase, muscovite and quartz. As this muscovite sample was the very fresh large crystals, ordinary separation processes—magnetic and heavy liquid separation—were adopted foi 60-150 mesh fractions. Under the polarized and binocular microscopes, this separated mica for dating purpose shows pure enough.

The muscovite Rb/Sr age and K/Ar age of this rock showed 28 million years and 4 million years respectively. Analytical procedures have been followed by the same method as that of Dr. L. T. Aldrich and, by courtesy of him, these experiments were carried out at the Department of Terrestrial Magnetism, Carnegie Institution of Washington and also at the Geological and Mineralogical Institute, Kyoto University, using Nier type mass spectrometers of gas and solid ion sources.

Constants used in this age determination are $\lambda_e = 5.80 \times 10^{-11} yr^{-1}$,

$$\lambda = 5.30 \times 10^{-10} yr^{-1},\ K^{40}/\text{total K} = 0.000119$$

for K^{40} atomic ratio,

$$\lambda_\beta = 1.39 \times 10^{-11} yr^{-1} \quad \text{for} \quad Rb^{87},\ Rb^{87}/\text{total Rb} = 0.283,$$

and for the calibration of common strontium, the ratio used is

$$Sr^{88} : Sr^{87} : Sr^{86} : Sr^{84} = 0.8283 : 0.0696 : 0.0967 : 0.0054$$

It is desirable to get concordant age for these two different dating methods—rubidium strontium and potassium agon, but the reason of this discordance between two (28 my and 4 my) seems to be derived from incomplete K /Ar age, because, at the biginning of argon extraction from muscovite by means of NaOH fusion method, some small fractions of muscovite scatter and fly up and the extraction of argon might be incomplete.

Though it is not a satisfactory result, we clearly confirmed from these measurements that the age of Dusso pegmatite is roughly 30 million years in age.

The data of Sr isotope, Rb^{87}, K and Ar^{40*} content are as follows:

Sample		Sr*	Million years
I	0.2499 g	0.0244 μg	27
II	0.2735 g	0.0275 μg	30

Rb^{87} 264μg/g sample

K 8.73 percent

Ar^{40*} 0.00252 μg, 0.00236 μg

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