ITALIAN EXPEDITIONS TO THE KARAKORUM (K²) AND HINDU KUSH

Prof. ARDITO DESIO Leader

I - GEOGRAPHY

Volume 1

I. GEOGRAPHICAL FEATURES OF THE KARAKORUM

by Ardito Desio

II. METEOROLOGICAL OBSERVATIONS OF DESIO'S 1954 EXPEDITION

by Francesca Petrucco

III. GEODETIC AND TOPOGRAPHIC SURVEY OF DESIO'S 1954 EXPEDITION

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SCIENTIFIC REPORTS

I

Geography

II

Geophysics

III

Geology - Petrology

IV

Paleontology - Zoology - Botany

V

Prehistory - Anthropology

ON BEHALF OF THE

ITALIAN NATIONAL COUNCIL OF RESEARCH

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I - Geography

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PREFACE

This volume is the ninth in the series of Scientific Reports of the Italian Expeditions to the Karakorum and Hindu Kush organized under Desio's leadership from 1953 to 1975. The list of contents of this collection, which is given at the beginning of each volume, gives the first subject as geography, which means that this volume should in fact have been published first. However, for a number of reasons which will be mentioned later, it is one of the last to be printed. Here below are the titles of the eight volumes already published.

II. – GEOPHISICS

Vol. 1: *Geophysics of the Karakorum* by Antonio Marussi, 1954.

III. – GEOLOGY – PETROLOGY

Vol. 1: *Geology and Petrology of Haramosh-Mango Gusor Area* by Bruno Zanettin, 1964.

Vol. 2: *Geology of the Baltoro basin* by Ardito Desio and Bruno Zanettin, 1970.

Vol. 3: *Geology of Central Badakhshan (North-East Afghanistan and Surrounding Countries)* Ardito Desio Editor, 1975.

Vol. 4: *Geology of the Shaksgam Valley, North-East Karakorum, Xinjang (Sinkiang)* by Ardito Desio, 1980.

IV. – PALEONTOLOGY – ZOOLOGY – BOTANY

Vol. 1: 1st part – *Fossils of Karakorum and Chitral* by M. Amiot, R. Ciry, N. Fantini Sestini, I. Premoli Silva, C. Rossi Ronchetti, P. Sartenaer, A. Vandercammen, A. Von Schuppé, C. Zanin Buri.

2nd part – *Results of the study of the entomological collection of the Karakorum and Hindu Kush (1954-1955)* by E. Gridelli and G. Müller with collaborators.

3rd part – *List of Spermatophyta collected in the Karakorum above 4000 m (1953-1954)* by L.H.J. Williams, 1965.

Vol. 2: *Fossils of North-East Afghanistan: Carboniferous fossils* by A. von Schouppé – *Triassic Fossils* by P. D.W. Barnard – *Jurassic fossils* by C. Rossi Ronchetti – *Cretaceous and Paleogene fossils* by A. Berizzi Quarto di Palo and I. Premoli Silva, 1970.

V. – PREHISTORY – ANTHROPOLOGY

Vol. 1: *Prehistoric research in North-Western Punjab – Anthropological research in Chitral* by Paolo Graziosi, 1964.

As can be seen from the list given above, not all the subjects planned were carried out in a uniform manner. This was the result of the fact that some of the research, such as the *geological work, was given precedence. In actual fact other work, such as the geophysical research, would have benefited from further elaboration in the scientific reports. It should be remembered with regard to this, that the only volume published on this subject refers principally to the results of the 1954 expedition, while the same research in fact also carried out geophysical research during the 1955 and 1961 expeditions. Only brief notes actually appeared on these expeditions though a further volume was to have been published on this subject. Again, in the Prehistory-Anthropology section, a second anthropological volume was planned on the population of the Hunza valley by Prof. Paolo Graziosi. Unfortunately in 1954, when he tried to reach me a month later, he was unable to obtain a permit to travel to the valley.*

I should like to point out that while the previous seven volumes of this series deal with the scientific results of my expeditions in the Karakorum and Hindu Kush area from 1953 onwards, the eighth book reports on an area I explored back in 1929 in the capacity of geographer and geologist of the Italian Geographical Expedition led by Aimone di Savoia-Aosta, Duke of Spoleto, and organized on behalf of the Italian Royal Geographical Society and the Milan City Administration. An official volume on this expedition was published in 1936 with the title "La Spedizione Geografica Italiana nel Karakorum — 1929. Storia del viaggio e Risultati Geografici".

The reason why I thought it appropriate to publish the volume on the valley Skaksgam lies in the fact that the geological results of the expedition had been mentioned very briefly in the 1936 volume, which was basically devoted to illustrating the geographical results. On the other hand, I was in fact the only geologist on that expedition and it was therefore my task to detail the results achieved in field, despite the fact that there was very little to add in the way of new discoveries as I stated in the preface to the above volume. This is why I decided to include in the collection a work which refers to an earlier expedition, than those I organized.

Starting from 1953, I organized and led several scientific explorations in the Karakorum and Hindu Kush and more precisely in 1953, 1954, 1955, 1961, 1962, 1973 and 1975. The last two had purely geological aims, while the 1954 expedition had two programmes to fulfil: a climbing programme which led to the first ascent of K^2, and a scientific programme which was carried out not only in the Baltoro glacier basin and in the Stak valley, an affluent of the Indus, but also in the territory, lying between the two.

The volumes so far published do not illustrate all the results of research carried out in that area. Owing to intense scholastic and scientific duties, nothing has been published on the far western area of the Karakorum and on the eastern side of the Hindu Kush though I and some collaborators have published preliminary reports. Some information, however, is included in the volumes dedicated to Paleontology.

I am now planning the tenth volume of this collection to be devoted to the results of *glaciological research carried out during my expeditions in that area of Central Asia which have so far only been occasionally and sporadically reported.*

The purpose of this volume is to report the results of observations and measurements of different types made mainly during the 1954 expedition. The geodetic and topographic measurements carried out by the captain (now general) Francesco Lombardi of the Italian Military Geographical Institute are of particular importance. The Institute was entrusted with the task, and theirs is the merit of drawing up the four topographic maps included in this volume.

I considered it useful to include the meteorological data as a contribution to knowledge of the climate of the region as recorded day by day at the base camp of K^2 and in the surrounding areas during the months of May, June, July and August of 1954, principally at an altitude of 5000 m. The data was processed by dr. Francesca Petrucco during her undergraduate studies under the direction of Prof. Silvio Polli, professor of Technical Physics and Climatology of the University of Trieste.

Before concluding this preface I should like to thank all those who have collaborated on this volume, in particular the authors of the two chapters mentioned above and the Italian National Council of Researches and the Finmeccanica which contributed to financing this volume.

Ardito Desio

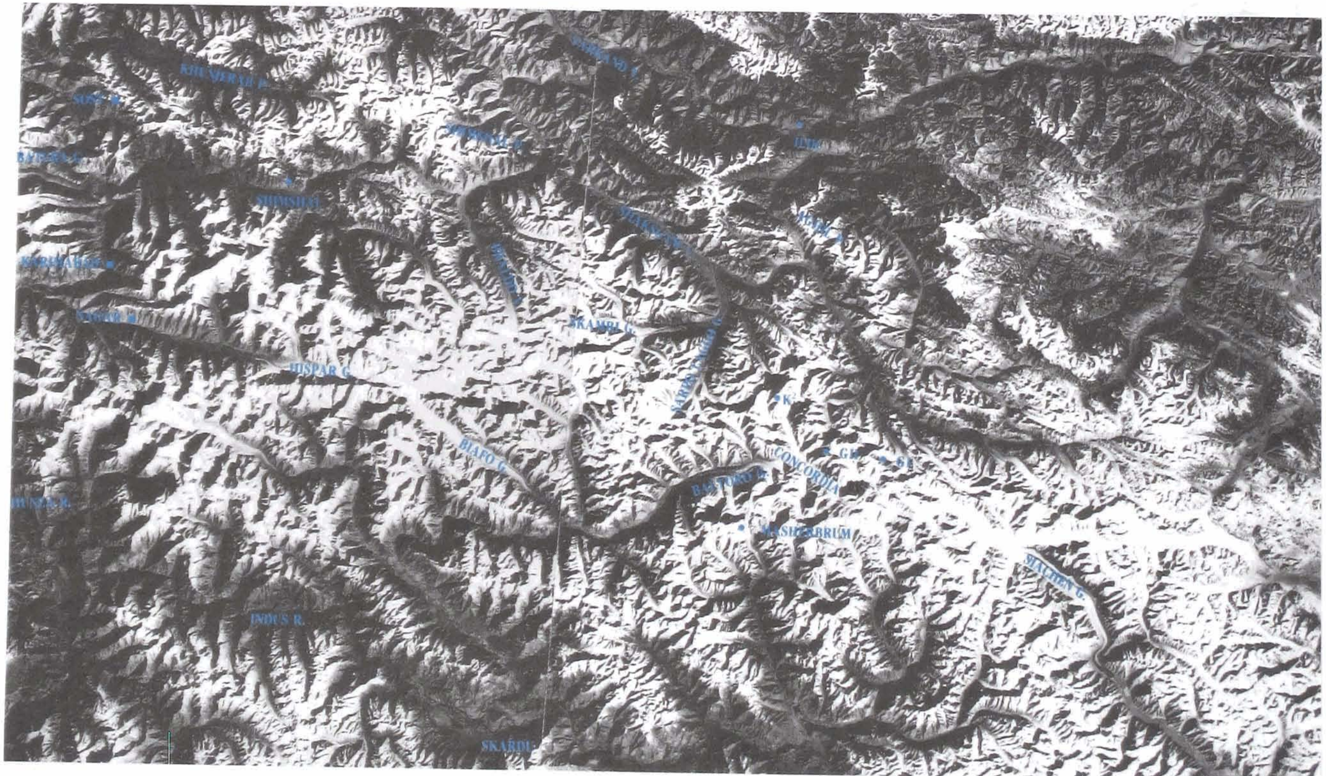
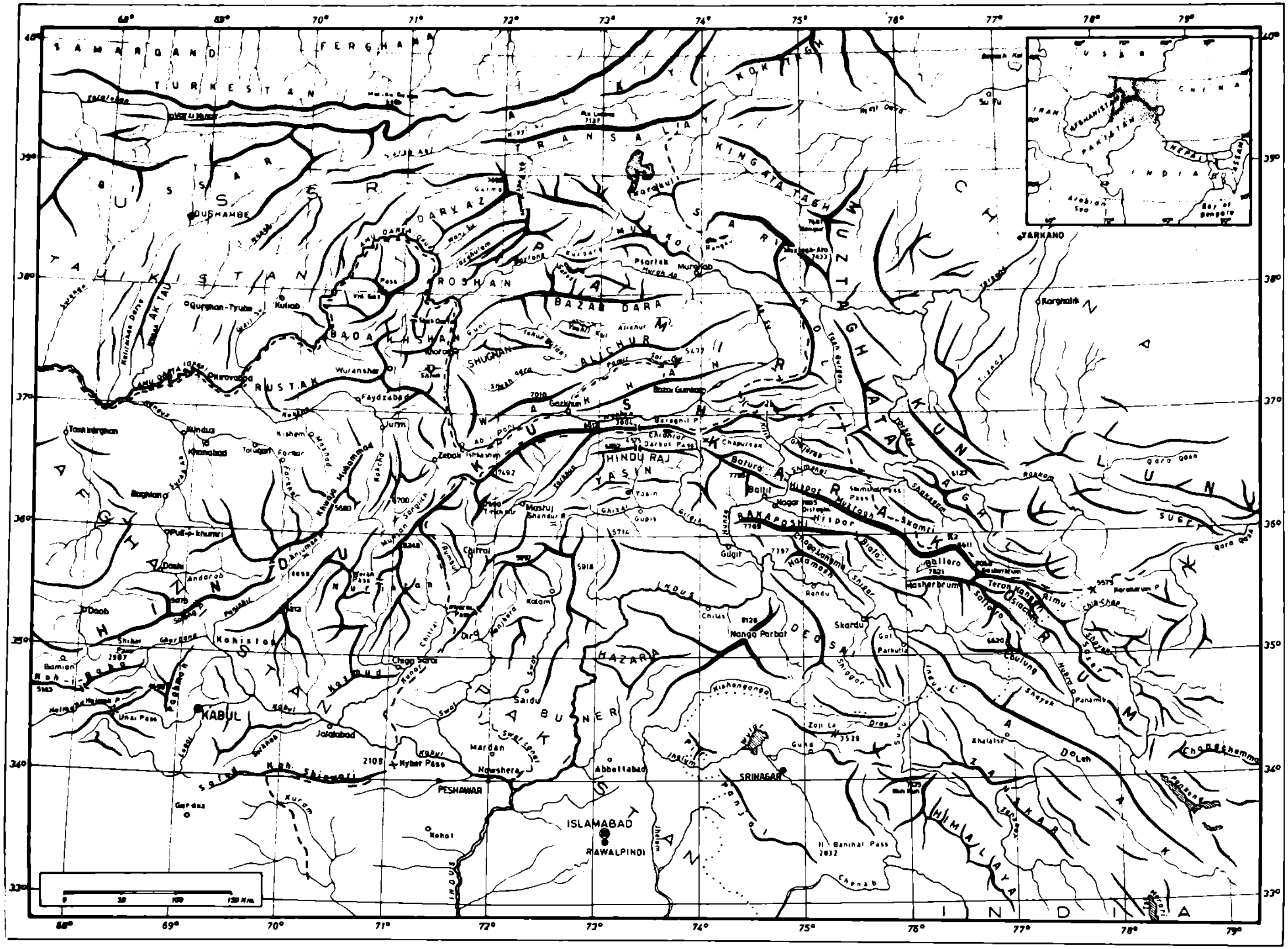


PLATE I STEREOPHOTOGRAM A_{45} – *The Central and Eastern Karakorum on a composite ERTS Satellite Imagery.*



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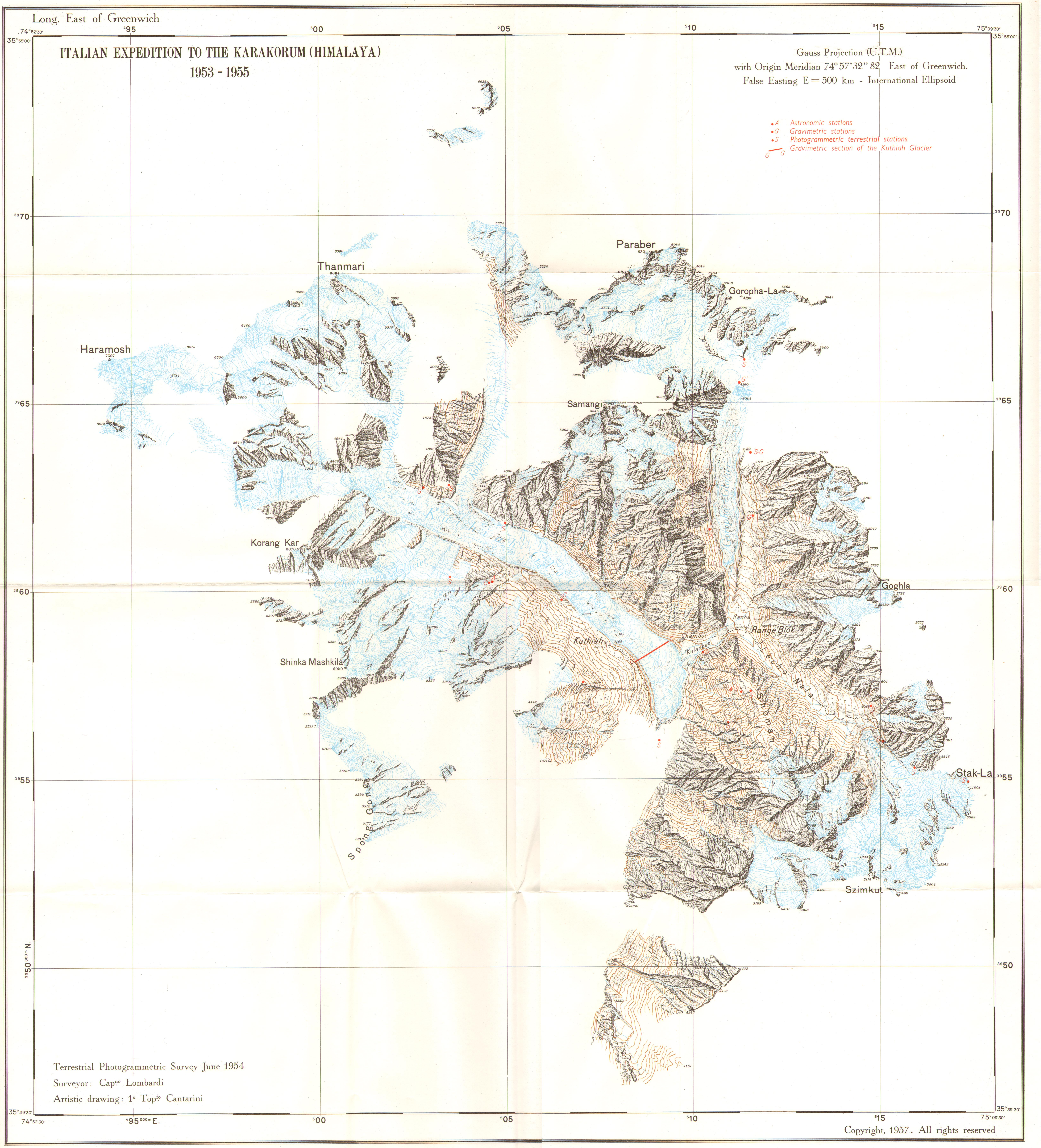
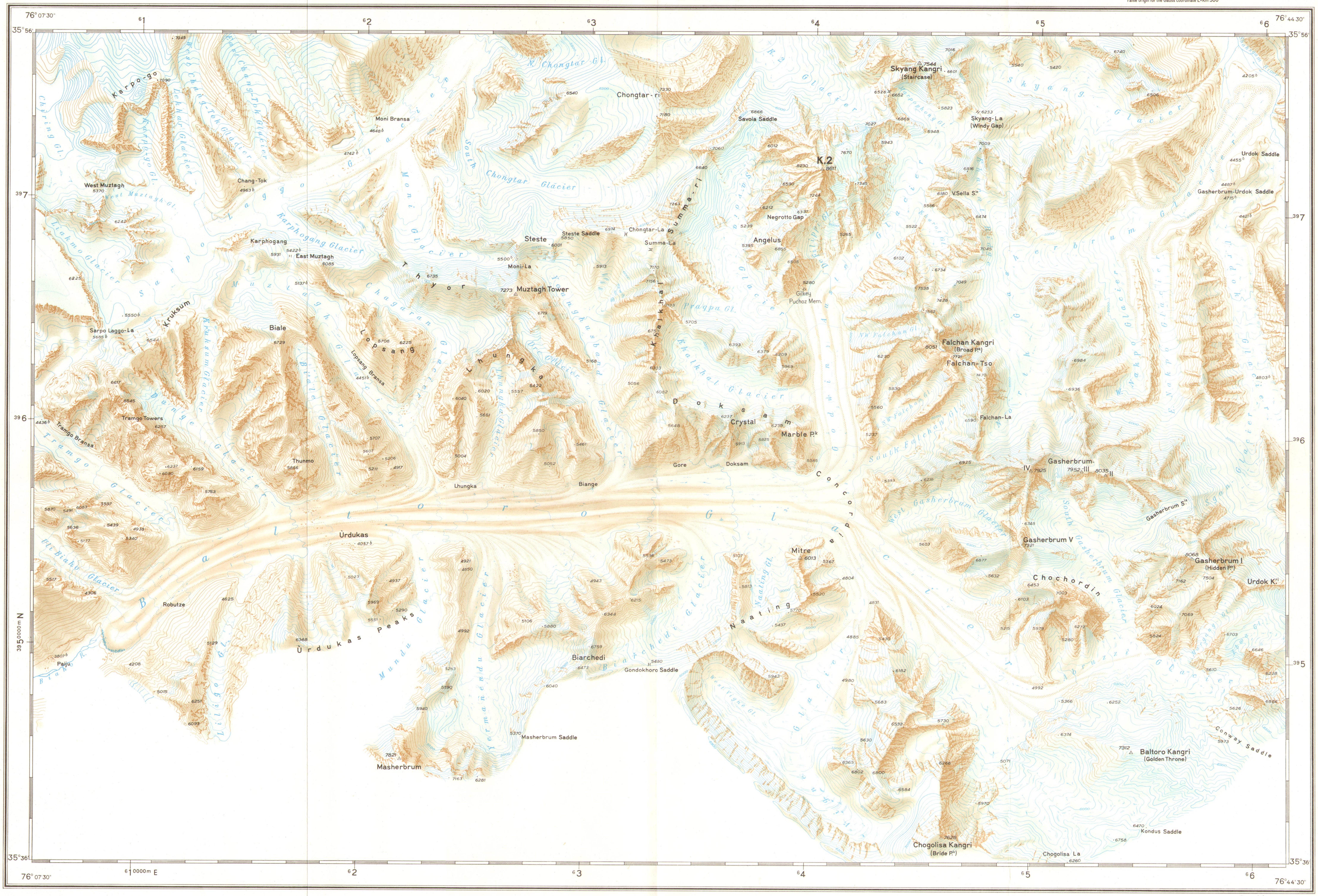


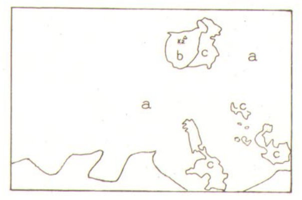
Scale 1 : 50 000

Contour interval: 50 meters

BALTORO GLACIER

International spheroid. Origin meridian 74°57'32," 82 East of Greenwich.
False origin for the Gauss coordinate E+Km 500





a *Map at the scale of 1:75.000 at the Italian Geografic Expedition (1929)*

b *Map at the scale of 1:12.500 of the Italian Expedition to Karakorum (1953-1955)*

c *Ground stereophotogrammetric survey of the Italian Expedition (1954)*

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For the Gasherbrum ridge it has also been utilized a sketch map at the scale of 1:100.000, by F.Maraini (1958)

Scale 1:100.000

Contour interval: 100 meters

Heights in meters

Symbols

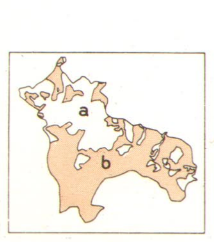
△8611 *Trigonometric points*

.4960 *Spot heights*

.6984b *Barometric Spot heights*

STAK AND TURMIK VALLEYS

Gauss Projection (U.T.M.) with Origin Meridian 74°57'32"82 East of Greenwich
False Easting E=500 Km International Ellipsoid



Copyright

Scale 1:100.000

Contour interval: 100 meters

Heights in meters

Source of the Map

Italian Expedition to Karakorum 1954

a *Terrestrial stereophotogrammetric survey. 1:50.000 (Surveyor: Cap.no Lombardi)*

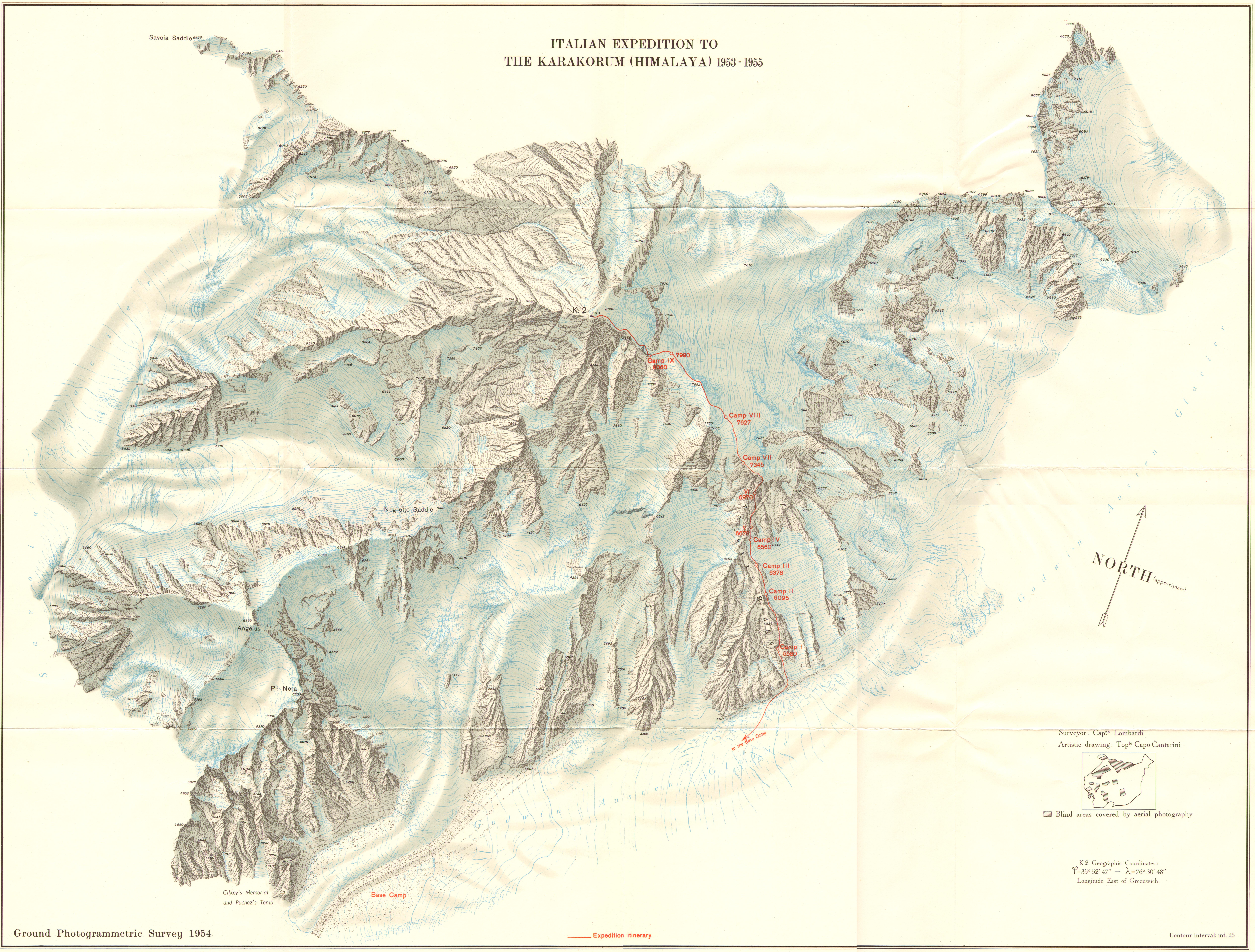
b *Plane-table survey. 1:158.400 (Traced by Badshah Jan S.A. supdt)*

Symbols

△ 5500 *Trigonometric points*

· 5165 *Spot heights*

K 2



ITALIAN MILITARY GEOGRAPHIC INSTITUTE

Scale 1 : 12.500

0 250m. 500m. 750m. 1 2Km.

I. GEOGRAPHICAL FEATURES OF THE KARAKORUM (1)

1. Introduction

Geographical atlases show the Karakorum as a large wrinkle situated north-west of the largest system of mountain ranges, the Himalayas. A 600 km long wrinkle running from north-west to south-east and slightly curved, which contains 4 of the 14 mountains over 8000 m in height including the second highest peak in the world, K^2 (8611 m), which is only 229 m lower than Everest (fig. 2).

I said that the Karakorum is situated north-west of the Himalayas: this means that while the latter range faces the Indian plain, the Karakorum is separated from the Punjab plain by various chains of mountains extending over an area 300 km wide. It is, therefore, easy to understand why the Karakorum climate is different and, on the whole, more dry and severe than that of the Himalayas, since it lies at an average latitude of a least 8 degrees further north.

These brief notes give us an idea of the difficulty pioneers had in reaching the Karakorum range. Up till a few years ago the only way to reach this remote region was along tracks which could be followed partly on trained mountain ponies and partly with porters hired at each stage of the journey.

It was a tiring and uncomfortable journey along rough traks often only held up by stony walls over jutting rocks smoothed by glaciers, and along barely visible paths on slopes prone to landslides, with rickety foot-bridges; or across hanging bridges swinging over gorges through which rushed tumultuous swollen rivers. These were age-old caravan routes winding along valleys, sometimes, narrow and uninhabited, and sometimes open with villages scattered among the green of welcoming oases on morainic terraces spaced out along the rivers, or on wide alluvial fans. Oases created by an ingenious network of running water fed by the glaciers into canals which irrigate small fields of grain (mainly barley), vegetable and fruit, that, together with the products of sheep-farming, are the only source of alimentation for those poor, but not unhappy, populations.

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(1) By Ardito Desio

Fig. 2 - *Orographic sketch map of the Karakorum mountain range.*

Srinagar, the capital, of Kashmir, was once the starting point for three main caravan routes going north: the western route, which reached Gilgit, the chief town of Dardistan, after a 16 day march; the central one, which went to Skardu on the Indus, chief town of Baltistan, in 15 days, and the eastern route, which reached Leh, chief town of Ladak, in 20 days.

The three towns are spaced out along the Indus valley, and along that of its tributary, the Gilgit, over a distance of 350 km and they represent the starting and supply centres from which one enter the three sectors, western, central and eastern, of the Karakorum.

Now the journey is much shorter; with an hour's flight from Islamabad, Pakistan's capital, one can reach the first two villages mentioned; for the third one have to start from Srinagar controlled by the Indians, as the range's eastern sector is under Indian control. In fact, the armistice line garrisoned by the Indian and Pakistan armies and patrolled by United Nations observers, who ensure the ceasefire is kept, runs between east and west Karakorum.

I mentioned the natural difficulties of entering the Karakorum from the south. I won't dwell upon details of the new routes that cross the range, as the two which really climb it cross ice-covered Muztagh passes above 5000 m, while the other much more accessible routes go round the range towards the west (Kunjerab pass, 4594 m) (1) and towards the east (Karakorum pass, 5575 m). The latter is also the one that inappropriately gave its name to the whole range.

The approach to the Karakorum from the north, i.e. from the Sinkiang side, is much longer. At present the nearest starting point which can be reached by air is Kashgar (K'a-shih), about 3450 km from Peking. From Kashgar there is a road suitable for motor vehicles which runs to Yarkand (So-ch'e), Karghalik (Yehch'eng) and the Khunjerab pass (4594 m), where the so-called K.K. Highway entering Pakistan begins.

Another approach from Karghalik is the road to Mazha and the Surukwat bridge (554 km from Kashgar). From here one then have to travel in a camel caravan for about 654 km across the Aghil pass (4870 m) as far as the Skaksgam valley, on the north side of the main crest of the Karakorum.

In a territory as remote as the Karakorum, the difficulty in reaching the area is added to the convergence on its high ridges of four nation's political frontiers (Afghanistan, China, India and Pakistan), which virtually represents insuperable barriers even for those with valid credentials. What is more, a part of those frontiers is either still being fought over, or serves as armistice lines.

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(1) The altitude marked on the milestone 0 at the pass is 15072 feet (4594 m).

The political situation, vastly different from that found by the first travellers who penetrated the Karakorum, underwent radical change at the time of Pakistan's partition from India (1947) and, above all, after the wars that later followed between the two countries (fig. 3). Among those who felt the negative effects most were the scholars of those territories who saw their freedom of movement and, therefore, the material possibily of efficient research, reduced year by year.

However, when we talk of scientific exploration of the earth's surfaces, we have to define our terms. In the early days of exploration, when a territory was really unknown, even vague topographical data gathered by occasional travellers together with information on the climate, inhabitants, fauna, flora, and rocks, represented a real contribution to scientific knowledge of the territory. Nowadays it is difficult to find an extensive area that can really be considered unknown from a geographical point of view.

With so many difficulties, scientific exploration of the Karakorum progressed, but much slower than elsewhere. In general, we can say that scientific exploration progressed at the same speed as the evolution of the roads and the local means of transport and/or with the development of means of communication. Then, today, aerial photographs from high and low altitudes (including those taken by artificial satellites) allow us to make maps without having to cross the territory itself, with the advantage that even the most inaccessible spots can be surveyed in details by the magic eye of sophisticated photogrammetric cameras. We have to admit that a lot of data which up to a few years ago, explorers gathered with great difficulty and dedication are, today, rapidly obtainable through instrumental registration. Pioneers watch in amazement as they see instrumental automatism take over their long, tiring work, carried out in the field with so much zeal and effort and so many risks, and they therefore feel what can almost be defined as a sense of frustration and dejection.

2. The name Karakorum

The name *Karakorum* usually applied to the mountainous range running northwest of the Great Himalayan range, originally referred to a pass located to the east of the Karakorum mountain range. This pass was used by caravan traffic which had developed over the centuries between India and Sinkiang. The inhabitants of the area tended to give local names to places which they saw not as geographical feature like a mountain range, but using names to refer to the places they lived in and, occasionally, to same prominent peak visible from their villages. Geographers

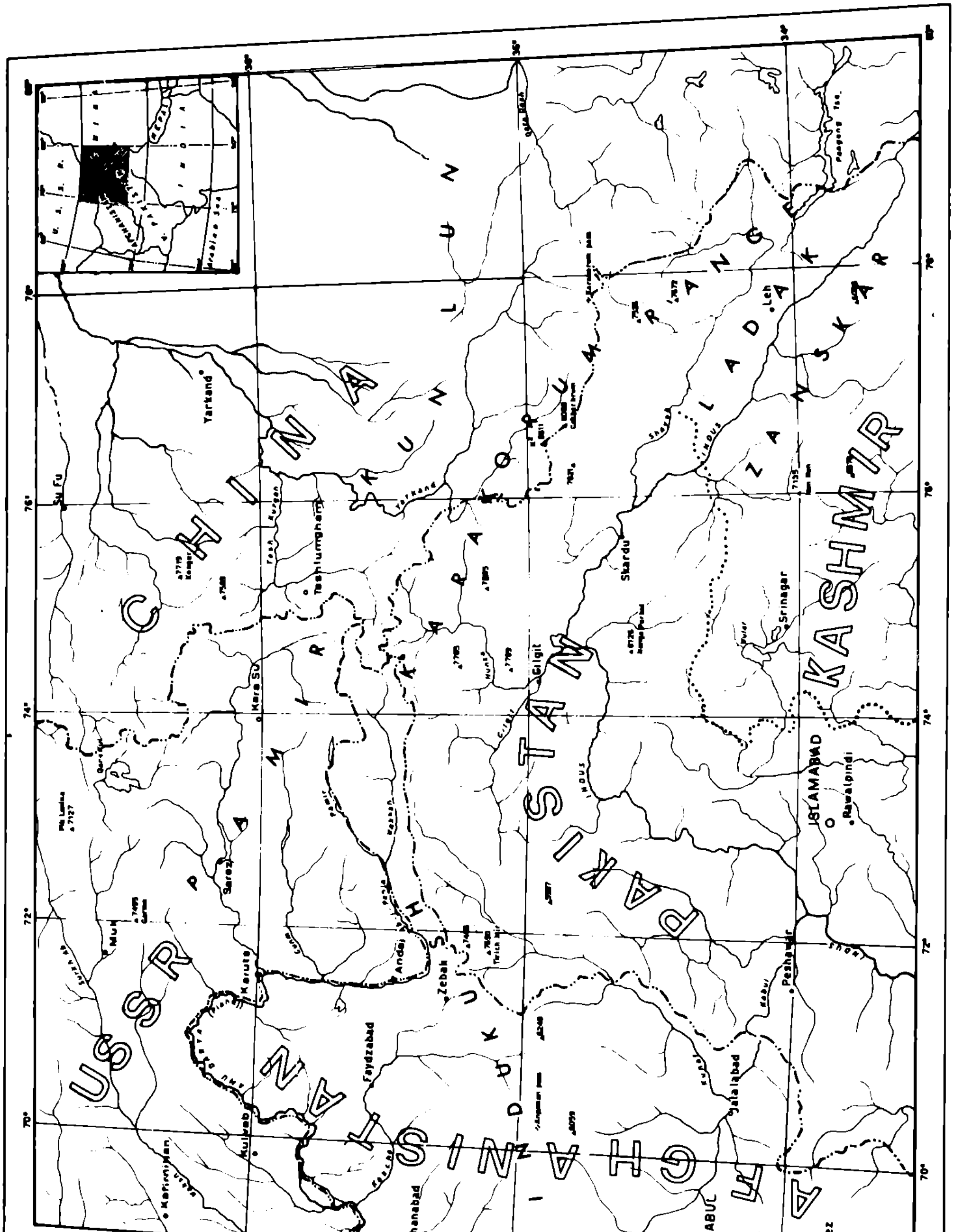

Fig. 3 - *The present political boundaries of the territory explored by the Italian expeditions* (-.-).

invented most of the names of the large geographical features even when they took them from local toponymy.

According to Burrard & Hayden (1) the first European explorer to introduce the toponym «Karakorum mountains» was W. Moorcroft back in 1820. In 1830 and 1844 the geographer A. von Humboldt, followed by the explorer Sven Hedin, gave the name Karakorum to the central range of the Tibet plateau, but the toponym Karakorum gained in popularity later on (1855-1865), particularly when Colonel Montgomery, of the Survey of India, between, 1857 and 1859, gave to the peaks of that mountain range, gradually measured geodetically from a great distance (100-210 km), the initial of the word Karakorum. This is also the origin of the name commonly used for the second highest peak in the world, K^2 (2). This toponym was officially adopted for use on maps in 1876 by the Survey of India. Other names were given to K^2, such as Mt. Vaugh and Mt. Albert (1860), Mt. Montgomery and Mt. Godwin Austen (1866), Mt. Akbar and Mt. Babar (1905-1906), but none of these was generally accepted. The name Mount Godwin Austen, however, was frequently used on maps, but without a specific reason. If a particular name is to be introduced, I think it ought to be Balti name Chogo-ri, which is a generic name for a large (*chogo*) mountain (*ri* or *rhi*), and was also sometimes used by our porters. Many other peaks, marked, with the symbol *K* (K^3, K^4, K^5, ecc.), were subsequently given other names.

As we know, the name Karakorum is composed of two Turki words, *kara,* which means «black», and *korum* which means «fallen rock» or «scree». It is not clear when this improper name was introduced for the pass, though we do know that the name Karakorum had previously been given to an old town of Mongolia, the ruins of which still exist in the upper Orkhon valley. The town was founded by Genghis Khan and it was the chief city of his great empire in the 13th century. Successively (1267) the chief town became Khanbaliq (Peking), while the town Karakorum, which was visited by Marco Polo in 1275, was then destroyed.

Burrad & Hayden venture the hypothesis that the name was extended at that time to the road coming from the capital and going to India, so this became known as «Karakorum road». The hypothesis seems probable if we take into consideration the fact that the landscape and the geological feature of the pass have no relationship with the meaning of the name.

Some clarification is also needed with regard to the final syllable of the name

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(1) Burrard S.G. & Hayden H.H. *A sketch of the Geography and Geology of the Himalayan Mountains and Tibet.* Delhi 1933.

(2) Some recent authors write K2 instead of K^2 but the original symbol is K^2. See Burrard & Hayden (1933).

as some authors write *um,* others *am.* Moorcroft, Humbold and Burrad & Hayden, for instance, use the final *um* as did many others until 1938, when in the «Karakoram Conference Report» of the Royal Geographical Society (1) use of the final syllable *am* was recommended.

I had no opportunity to investigate *in situ* the pronunciation of this name, but Dainelli assured me that in the area of the pass the name was pronounced with the last syllable *um.* This version also tallies with the Turky pronunciation adopted for other names such as Masherbrum, Gasherbrum, etc. For these reasons I have therefore adopted the *um* termination in my reports (2).

The use of the name Karakorum was not unanimously accepted by the geographers, however. Another name, which is also of Turki origin, was proposed for the same mountain range: *Muztagh.* This name refers to two passes (East Muztagh and West Muztagh) which lie far west of the Karakorum pass. It seems that the name Karakorum was in widespread use particularly in Ladak, while Muztagh was used in Baltistan. As a compromise, a further solution was proposed, i.e. the double-barreled name Muztagh-Karakorum. Even this solution failed to please everybody.

Burrad & Hayden (1933) deal more fully with the geographical nomenclature of the Karakorum and the «Karakorum controversy», but I shall not examine the question further here. It is worth noting, however, that the two authors proposed some double names to replace the previous ones which had ill-defined meanings. They are as follows:

	Existing names	*Double names proposed*
The Main Range	Karakorum	Muztagh-Karakorum
The Mountain Region	Karakorum	Karakorum-Himalaya
Outer subsidiary range	Aghil	Aghil-Karakorum
Inner subsidiary range	Kailas	Kailas-Karakorum

Opposition to the adoption of these names came particularly from the Survey officials, political officers and climbers. Among the geographers, Dr. Tom Longstaff was the main opponent of the denomination Karakorum-Himalaya (3).

On the subject of double names, and especially with regard to use of the name Muztagh, in the 1938 conclusions of the R.G.S. «Karakorum Conference»,

(1) «Geogr. Journal», vol. XCI (1928), pp. 123-128.

(2) Also the Encyclopedia Britannica (edition of 1990) uses the termination *um.*

(3) Longstaff T.G. (1930). *Himalayan Nomenclature,* «Georgr. Journ.» vol. 75, n. 1, pp. 44-45, London.

in referring to the name Muztagh, it was stated that it «could be suitably applied to the major divisions of the Great Karakorum as a generic name, similar to a range». This nomenclature was also used in the R.G.S. map of 1939 on a scale of 1:750,000 and later introduced on other geographical maps. It is, therefore, true to say that geographers and mountaineers now commonly use the simple name «Karakorum» or «Karakorum Mountain Range» to refer to the Great Karakorum Range of the Karakorum Conference of the R.G.S. The same use was made in the Scientific Reports of my expeditions on the Karakorum.

As already mentioned, the first geographers to explore this area used the name Karakorum for the mountain range stretching to the west of the Karakorum pass. Yet, they had no knowledge of the extent and features of the orographic entity they referred to with the name. Only later, when little by little the mountainous territory was explored and marked on the topographical maps, and the orographic units were gradually outlined, could the geographers attempt to fix the boundaries and divide it into smaller units.

3. Transcription of local names

Like all regions which are for the most part uninhabited, at the time of our early explorations the area had very few local placenames. The reason for this was obvious. The inhabitants give names only to those places which they are interested in for one reason or another (pastures, passes, stopover places, etc.) either because they have strange shapes, for instance a mountain which is particularly visible, or a place which serves as a landmark, and so forth. Names have, therefore, been given to passes, the main mountains visible from the villages, the valley where the shepherds take their flocks to graze in summer, the glaciers accessible for hunting or which can be crossed, and so on.

In the area we are dealing with, the local people do not normally move of their own free will beyond the highest pastures. In the past people have been known to travel for trading purposes into some of the areas further inland among the mountains on their way to important passes, such as the two Muztagh, but up to just a few years ago only few among the local people knew the existence of these passes.

As a consequence of this, we can see the local placenames become fewer and fewer as we move away from the higher villages along the valleys occupied by the huge glaciers or the mountain slopes. There would be no reason to bemoan the fact if the need did not arise in geographical descriptions of the territory, to indicate and refer to places in just a few words without having to resort to long circumlocutions with the danger of misunderstandings. Let's have a look at the situation and see how the problem has been solved to date.

Firstly we must distinguish between actual toponyms and common names such as river, pass, peak, etc. in the case of the latter, reference can either be made to them using terms in the local language or dialect or, alternatively, the same terms expressed in a widely spoken language. The local language or dialect name is the one the traveller needs if he must make himself understood by the local inhabitants; the terms in a widely spoken language on the other hand are the ones which will be familiar to the reader of reports and topographic maps.

In fact, both criteria have so far been used indiscriminately both in geographical reports and in old and more recent cartography. Consequently, written names include Turkestan-la, Skoro-la and Skyang Kangri, Khunjerab pass, Aghil pass, Karakorum pass, and so forth. It is, however, true to say that the local geographical names in general usage are in fact so few that this does not create problems, and in any case there are special glossaries listing them.

The problem of true toponyms is more complicated, however. We came across two common situations. If there was a local name, and it existed in a language which has only a spoken form (such as Dardi, Baltì, Ladaki, etc.), to transcribe the name it was necessary to refer to a written language. Obviously the choice fell on English since it is the language most widely spoken even among people of modest culture in Pakistan, India and China, the countries in which the Karakorum lies. On the northern side it is a question of keeping the local languages i.e. Chinese and those of Tibet, Sinkiang, etc., but transcribing the name into the European alphabet.

Even using English to transcribe the local names, however, can give widely differing results depending on the precision of the researchers, and the different pronunciation of the various people questioned, which is inevitable, but also because the transcription into English of the local names is fraught with uncertainty as pronunciation in English too varies considerably, particularly in the vowel sounds.

The Royal Geographical Society attempted to remedy this by adopting the method of transcribing the consonants as in English and the vowels as in Italian (1), a criterion which we considered much more practical and adopted ourselves, though official cartography has not always followed suit. On the other hand I believe that once a new toponym has been introduced (and I refer to true toponyms, not appellatives) with a certain spelling, this should not be changed in travel reports,

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(1) Royal Geographical Society: *Alphabets of Foreign Languages.* 2 end ed., London 1933, page XII.

scientific works and local cartography even if transcribed in a language other than English, as it would only lead to greater confusion. It's acceptable to write Savoia glacier and not Savoy glacier, but the line has to be drawn at writing Singy or Singhi glacier instead if Singhié glacier which was the original spelling (Italian) with the accent on the last syllable as it is in fact to be pronounced.

Let's consider too the case of English toponyms used in the Baltoro valley such as Bride Peak, etc. which have been replaced in later cartography with local type names: Chogolisa Kangri, Baltoro Kangri, Gasherbrum I and Skyang Kangri respectively. Oddly enough, Broad Peak has remained unchanged, though we replaced it with Falchan Kangri in 1954, the name suggested to us by Balti porters and which has in fact the same meaning.

With a view to settling many of the inconsistences in transcription of place names, in 1936 the Royal Geographical Society organized the "Karakorum Conference" publishing a report whose recommendations were accepted by the Council of the Society and approved by the Surveyor General of India, thus ensuring acceptance by official cartography.

At the same time, an extensive revision of Karakorum toponyms was being carried out by K. Mason (1), a revision which has been used in subsequent editions of the topographic maps of the Survey of India and in the Royal Geographical Society maps on scale 1:750,000. We too used this nomenclature except for the names already mentioned above, Broad Peak translated as Falchan Kangri and the Singhi glacier corrected to Singhié glacier.

During the Duke of Spoleto's expedition to Karakorum in 1929, I myself carried out some research among the Balti as to the toponyms marked on the Survey of India maps at that time and those used by the different travellers in their reports for the press to discover which was the most correct pronunciation and meaning of the names, in an attempt also to identify which names were familiar to the local people and which were not, and to ascertain which of the familiar names did not appear on the maps mentioned above. The research was only carried out, however, in the Braldo, Dumordo, Panmah, Baltoro and Sarpo Laggo valleys visited on that occasion and the official volume of the expedition (1936) gives the results.

4. New local names

With regard to the new names introduced by us, as far as possible we tried to extend the local names with suitable appellatives, to the various geographical

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(1) Mason K., (1938). *Karakoram nomenclature.* «Geogr. Journ.»: vol. XCI, n. 2 pp. 129-152. London.

subjects. A glacier, for instance, comes down from a saddle which is known locally as Muztagh and so we called it Muztagh glacier; if there were two glaciers rather than one, one on each side, then they were called Northern Muztagh glacier and Southern Muztagh glacier. If a ridge or a peak had a local name, then we used that as the name for the entire ridge of which it is part.

When no toponym exists and a name has to be invented, I feel that it is generally best to use names which are as close as possible to the local nomenclature, ideally suggested by the natives themselves in their own language. My experience has shown that the more highly civilized natives are often quite capable and imaginative enough to suggest new placenames themselves.

Another point worth mentioning with regard to this method of coining new names rather than using names of people, cities or nations, etc. is that there is the added advantage of using names which are easier to pronounce and understand and therefore more likely to be adopted by the local people and to be accepted by the institution responsible for the compilation and publication of topographic maps of the countries involved.

While this solution which we adopted seems to be the best, it is not always easy in these places and on the spur of the moment to deal with the nomenclature problem and once you sit down at your writing desk to give a detailed description of mountains, glaciers, and valleys in the region explored which have no name, then you come up against the obstacles mentioned above. At this point you have to solve the problem as best you can. Generally speaking I again have always thought it preferable to adopt new toponyms in the local languages or dialects, taking them, if no research has been carried out on site, from the dictionaries of local languages. Numbers too, i.e. for the altitudes, can be used to indicate, for instance, peaks on the same ridge. The method is not always applicable, however, as the heights of many peaks or saddles may not be known or the heights may have been assessed with barometric measurements and be approximate. With each new measurement some of the altitude figures could vary and peaks known as a figure would have to change their identity. The system of using altitudes rather than names is not therefore as practical as it might seem at first glance. Then there is the added difficulty of the memory exercise involved in remembering numbers rather than names, difficulties in applying the "number-name" to different geographical subjects varying the appellation, the problems of peaks which are the same height and so on. Despite all these disadvantages, however, we too have used the method in some cases.

Going through the reports by different authors who have collaborated in compiling the volumes of Scientific Reports of my expeditions to the Karakorum so far published, I am aware that the rules indicated above have not always been complied with. This is due to the fact that I did not expound them sufficiently prior to publication of the first volumes and that I did not take enough care in reading the proofs of the volumes compiled by some collaborators. I feel I am to blame for these culpable omissions (1). The cases are, however, few and some of these have been put right by repeating the correct name in the analytical index at the end of the volumes.

5. The boundaries of the Karakorum

5.1 Introduction

The definition of this mountainous area has given rise to controversy among geographers since last century, but this was particularly heated between the two World Wars. No real settlement has ever been reached. Burrad & Hayden, leaders of the Survey of India and of the Geological Survey of India, in their geographical work on the Himalayan mountains (1933) devote a whole chapter (14) to this question, but they leave the question open, entrusting the solution to posterity (fig. 4).

It is not necessary here to quote the different arguments involved in the controversy. Suffice it to say that the official opinions which influenced the geographers after the age of pioneers, were mainly those expounded by the circles of the Royal Geographical Society and the Survey of India. The latter were able to spread their ideas through the cartography, which for many years was virtually the only reliable source of topographic information.

The different opinions can be divided into two classes, one wide and the other more restricted. In the first the Karakorum covers the mountain ranges lying between the Yarkand and Indus rivers (fig. 5) together with some of their major tributaries. According to this interpretation, the Karakorum comprises not only the central part of the mountainous area, but also the peripheral ranges of Aghil and Ladak. In the second more restricted sense, however, one or both of the above peripheral ranges are excluded. K. Mason, for instance, in his first orographic scheme includes one of the two Aghil ranges calling it «Aghil Karakorum», but excludes the Ladak range. Visser (1935) (2) includes the Ladak range, calling it «Ladak Karakorum» and Norin (1946) (3) refers to the «Ladak Range or Ladak Karakorum».

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(1) I am myself culpable not having always repeated the rules. I have applied, for instance, the name of the Duke of Abruzzi to one of the upper tributary of the Baltoro glacier (Abruzzi glacier) and the name of Sir Martin Conwey to a saddle at he head of that glacier (Conwey saddle).

(2) Visser P.C., *Wiss. Ergeb. Niederl. Exped. in der Karakorum* etc. Bd. I, Geographie, Leipzig 1935.

(3) Norin E., *Geol. Expl. in Western Tibet,* Rep. Sc. Expl. in Western Tibet, Rep. Sc. Expl. S. Hedin, Publ. 29, II, Geol. 7 Stokholm 1946.

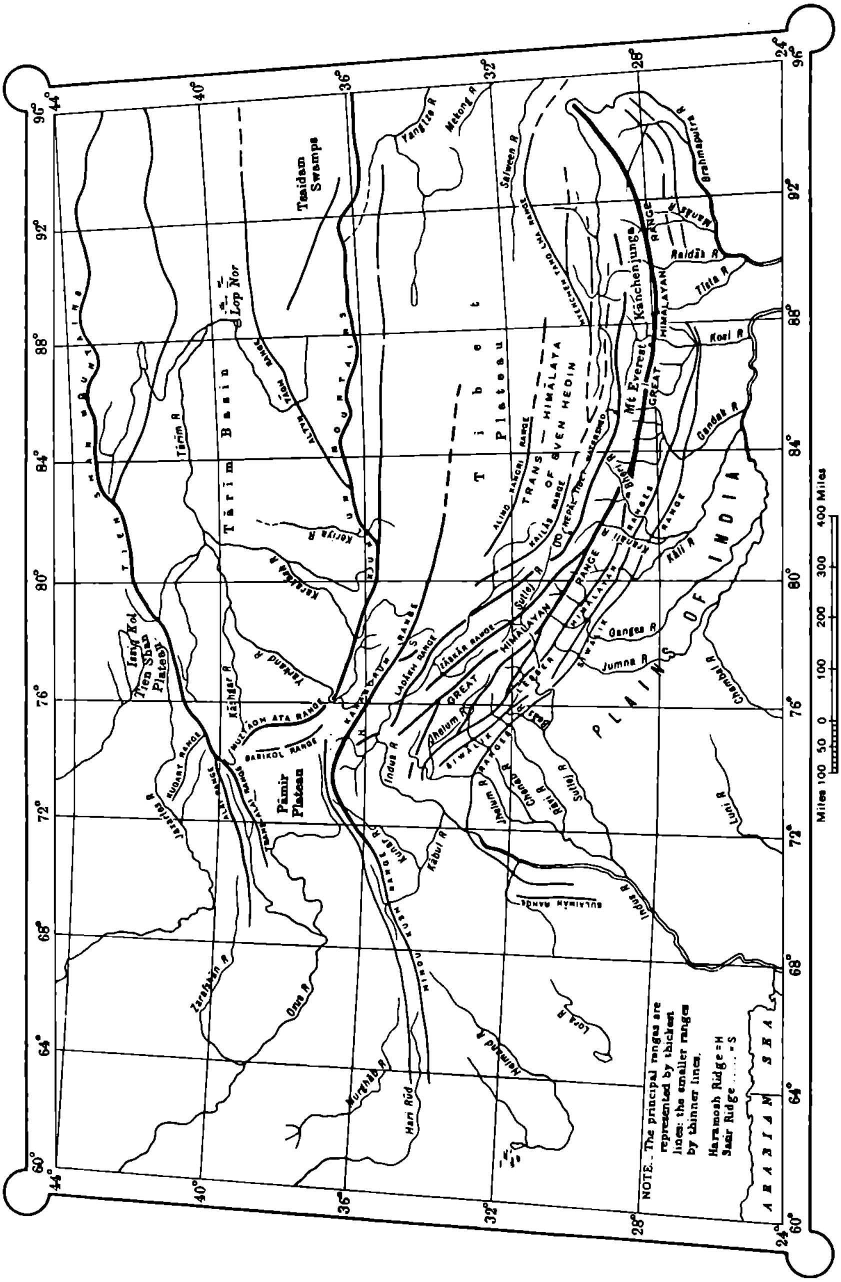

Fig. 4 - *The Karakorum in the Central Asiatic mountain ranges according to Burrard & Hayden (1933).*

The 1938 Karakorum Conference of the R.G.S. excludes both the «Aghil Mountains» and the «Ladak Range» from the «Great Karakoram». nevertheless the name Karakoram alone is often used with a wider meaning particularly on the headings of maps.

The name Karakorum in modern geography and tourism circles has acquired a very wide meaning; it sometimes refers to the mountainous area located between the Yarkand and Indus rivers, yet sometimes refers to the central and higher portion only. Like other geographical names, it has undergone some change over a long period of time and it is usage which in fact confirms its validity.

A certain confusion in the use of the name Karakorum was caused by geologists who applied this name to geological areas which were different from the geographical ones. In 1964, 1965 and 1979 I myself introduced a geotectonic partition of this kind, extending the Karakorum towards the west as far as Chitral and towards the south as far as the Dras line.

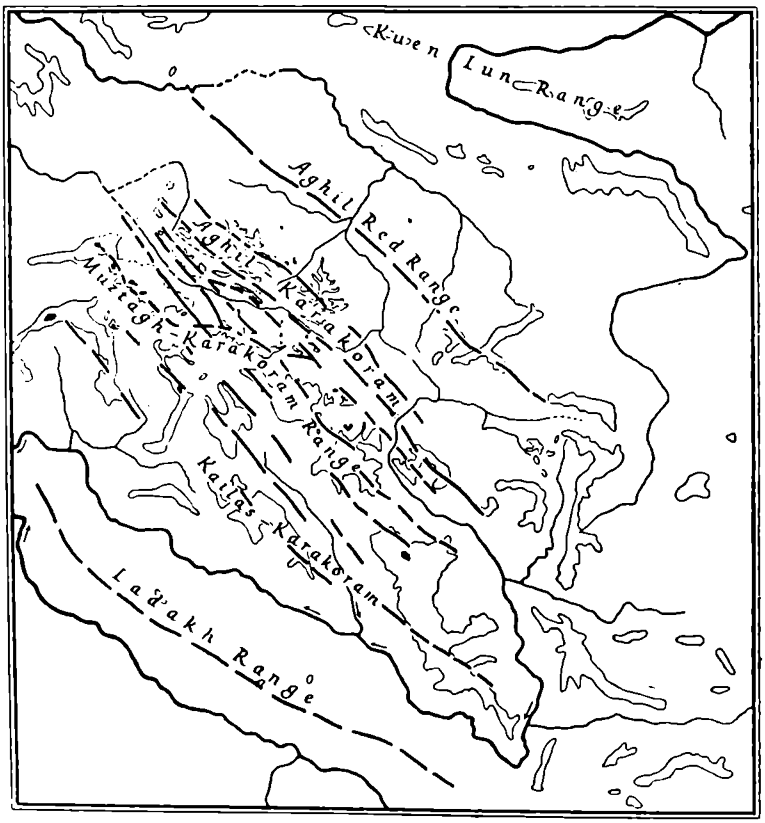

Fig. 5 - *Diagram of proposed range-names in the Karakorum by the Geographical Journal (vol. LXXV, no. 1, p. 30, 1930).*

The geological nomenclature introduced by the Soviet geologists is much more extensive. According to N.A. Beljaevsky (1976) the «Karakorum folded system» comprises not only the orographic Karakorum, but also, to the north, Central Pamir and Southeast Pamir; to the west, most of Badakhshan and Eastern Hindu Kush. In fact, this author divided the Karakorum folded system into two tectonic first order zones i.e.: «North Karakorum megasynclinorium» and «South Karakorum meganticlinorium». The first zone should consist of 6 second order tectonic zones; the second should have one zone, the «Muztagh zone», which should include virtually the whole orographic Karakorum. The name of the «Muztagh tectonic zone» for the central portion of the Karakorum was introduced by me in 1964.

It has so far proved practically impossible to modify geological nomenclature which may influence the geographical partition of that area and introduce new parameters relating to the morphological features of the territory.

Returning to the question of the Karakorum boundaries, I would suggest that the geographical boundaries of a mountain range should be chosen chiefly from the main drainage lines which surround that area.

Going back to the two different meanings of the geographical name Karakorum mentioned in the previous section, I must indicate two boundaries in the Karakorum, one for the restricted meaning (Karakorum str.s.), another for the wider meaning (Karakorum l.s.). The first was called «Great Karakorum» by the Karakorum Conference of the R.G.S. and I will deal later on with this name.

5.2 The boundaries of the Karakorum str.s.

The boundaries of the Karakorum str.s. were defined by the Karakorum Conference with the agreement of the Surveyor General of India. The conclusions were expounded in the report published by the «Geographical Journal» in February 1938.

I quote below the part of the text concerning the boundaries.

«*On the south:* by the Shyok river from its bend at about long. 78° 15' to its junction with the Gilgit river about long. 74° 40'; and by the Gilgit river to the confluence of the Ishkuman river about long. 73° 45'.

On the west: by the Ishkuman and the Karumbar river to the Chilinji pass.

On the north: from the Chilinji pass, down the Chapursan river, over the Kermin pass to Rich, and down the Kilik river to its junction with the Kunjerab; then up the Khunjerab river to the Khunjerab pass, across the head of the Oprang Pamir to the Oprang pass, and down the Oprang river to its junction with the Shaksgam; then up the Shaksgam river to its source at Wood's Pass «G» (for which we propose the name Shaksgam pass); then to the snout of the Rimo – Yarkand river source, and by the left bank of the Rimo glacier to the junction of the Rimo river and the Chip-chap.

On the east: by the upper Shyok from the Rimo – Chip-chap junction to the great bend of the river about long 78° 15'».

The limits mentioned previously are well defined to the north, east and south, while some uncertainty exists to the NW and NE.

Towards the east and south, the Shayok (1), the Indus and the Gilgit rivers mark clear geographical lines, as does the Shaksgam to the north.

There is some uncertainty with regard to the connections between those lines in the NW and NE where they refer to passes and short drainage lines. Again to the NW, between the upper Karambar river (tributary of the Ishkuman) and the upper Chapursan (tributary of the Hunza), there is the Chillinji An (5292 m). From this pass the boundary goes down into the Chapursan river, following it for 42 km. Further on it leaves this river to cross the Kermin pass (4023 m) and reach the Dardy and then the Kilik river.

The boundary follow the lower Dardi river for about 5 km, while upstream the river marks a long drainage line for about 30 km in a WNW direction. However, the difficulty in assuming this part of the river as NW boundary of the Karakorum is the lack of passes at its head, towards the upper Chapursan. So, the long ridge west of the Kermin pass, which is about two thirds longer and much higher than the east section, remains outside the northern boundary of the Karakorum. However, as we shall see later on, this ridge can be included in the Karakorum l.s.

On the boundary of the Karakoum the name Oprang is mentioned; but it is not completely clear what river the name Oprang refers to. Burrard and Hayden (pag. 168) assert that «the Shaksgam river is the upper portion of the Oprang, and the most important tributary of the Yarkand river». But further on (page 256) they write: «The Shaksgam river (also called Oprang) follows a long course north of the Karakorum».

In the map of the Survey of India «China & Kashmir & Jammu», Sheet N. 42 P (Hispar Glacier) scale 1 inch to 4 miles (1:253,440) «Preliminary Edition» of 1928, the name Oprang Jilga is marked along the tributary river of the Shaksgam joining with the main river near Sokh Pulag. At the head of the Oprang valley, «Oprang Pass» is marked, but the name Oprang also appears in the valley descending from the Khunjerab pass, near Ak Jilga.

On shet N. 51D «Raskam Valley» of the same series of maps, dated 1939, the name Oprang refers to the pass only, and the name «Shaksgam or Muztagh river» is extended not only to the upper, but also to the lower course of the river up to the confluence with the Yarkand river.

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(1) My transcription of this name is different from that used on the English maps; but I have respected the rules proposed by the R.G.S. (see pag. 9).

According to F. Younghusband (1), it seems that the Balti name Shaksgam corresponds to the name Oprang used by the Kirghiz people, although these two names may also refer, as I said above, to different portions, or branches, of the same river. According to information I gathered among the Askole's Balti inhabitants, the name Shaksgam derives from two words: *Shaks,* meaning «sandy», and *gam,* meaning «dry». According to Mason (2), it means «box of gravel», or «dry gravel».

The above mentioned report of the R.S.G. refers to the Oprang rivers, one under the name of Oprang Pamir, tributary of the Tash Khurgan to the NW of the Oprang pass, the other to the river SE of the pass, and tributary of the lower Shaksgam river. In the Karakorum map of the R.G.S. the name Oprang is applied only to the first, without the appellative Pamir. The pass and the river beyond the pass, towards NE, do not bear any name.

On this question I must mention the work of R.C.F. Schomberg (3) who explored the Oprang area and supplied a topographic map at the scale 1 inch to 4 miles (1:243,440) (4).

On this map the name Oprang refers to a pass SE of the Khunjerab pass and to a place situated about 17 km downstream of the last pass. The river flowing down towards SE from the Oprang pass is named Oprang as far as the junction with the Shaksgam river.

The area upstream bears the name «Shaksgam or Mutztagh», downstream it is termed only «Muztagh» as far as the confluence with the Yarkand river.

I want to quote here also the «Shimshal» Sheet (NJ 43-15) of the U.S.A. maps of India & Pakistan, 1:250,000, which bears the name Oprang pass in the divide between the drainage basin of Oprang Jilga (to the SE) and an unnamed river to the north along which is marked «Oprang». According to this map, the divide between the two opposite Oprang valleys appears wide and relatively flat, but the whole area around the pass is indicated in a «provisional edition» as an «unsurveyed area».

Apart from the accuracy of the above mentioned maps, I think that the best solution, with regard to the existing local names, is to maintain the name Oprang

(1) Younghusband F.E. (1986). *The Heart of a Continent.* Murray, London.

(2) Mason K. (1928). *Exploration of the Shaksgam Valley and Aghil Range,* 1926. «Rec. Survey of India», vol. 22, Dehra Dun.

(3) Schomberg R.C.F. (1936). *Unknown Karakorum.* M. Hopkinson, London.

(4) This map is a partial reproduction of Sheet 42P «Hispar Glacier» of the Survey of India at the same scale. On this map the name Oprang refers only downstream from the Khunjerab pass.

for the pass and the river flowing SE down from the pass as far as the confluence with the Yarkand river. The name Oprang Pamir can be used to refer to the river below the Khunjerab pass. This solution also avoids the use of the name «Muztagh» for the last section of the main river, since it is a generic name, often employed for ranges, passes, etc.

Let's take a look now at the NE section of the boundary, i.e. on the eastern side of the Shaksgam-la (5465 m). The boundary runs along the rivulet which flows down into the glacial stream of the main Rimo North glacier. From here it runs along the «left bank» of the Rimo glacier to reach the confluence of the glacial stream of the main tongue of the Rimo glacier with the Chip-Chap river (tributary of the Shayok (fig. 6).

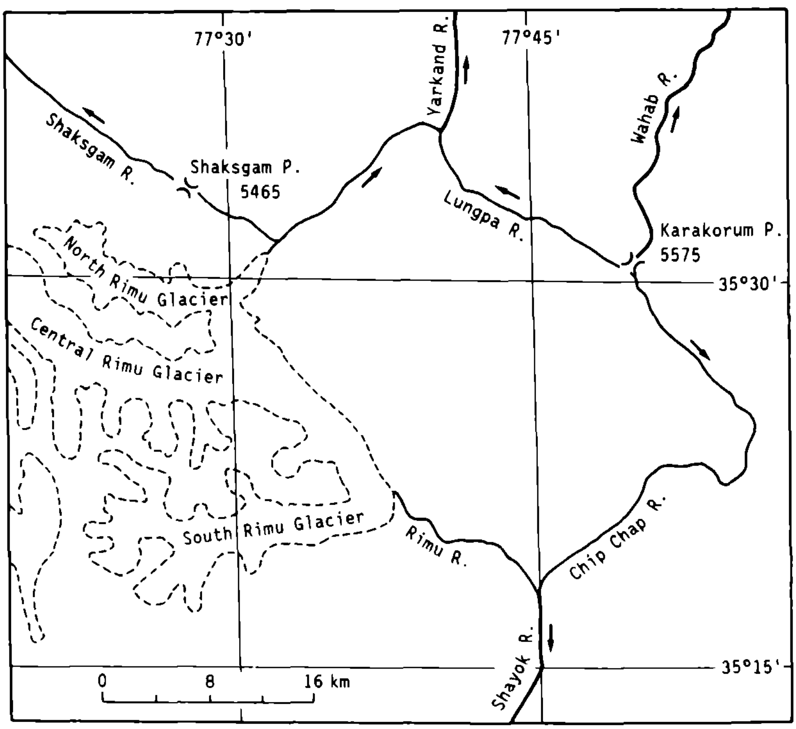

Fig. 6 - *The eastern boundaries of the Karakorum l.s.*

It this case I should like to suggest an alternative solution so that the Karakorum pass, which gives its name to the whole Karakorum range, is not excluded. It would simply mean moving it from the Shaksgam-la to the confluence of the

Yarkand source river (melt-water from the Rimo North glacier) with the Ngonpo rivulet, then upstream to Ngonpo-la and to the Karakorum pass. From here it would follow one of the ravines going down to the Chip-Chap river and farther on to the Shayok river.

5.3 The boundaries of the Karakorum l.s.

I have already said that the Karakorum *lato sensu* covers the whole mountain range included between the Yarkand river to the north, and the Indus river to the south. Practically we have to add the Aghil ridge to the area of the Karakorum str.s. to the north, and the Ladak range to the south. But NW of the Aghil, there are other mountain ridges located north of the Chapursan river, for which I would suggest the name «Dardi mountains» from the name of the main river crossing that area.

The majority opinion holds that these mountains, too, should be enclosed within the Karakorum l.s.

Now we must establish the boundary between the Karakorum to the east, and the Hindu Kush to the west.

The map of the Survey of Pakistan, scale 1 inch to 4 miles, sheet 423L (Baltit), bears the name Hindu Kush just to the west of the watershed of the Chapursan catchment area, which is at the western end of the Dardi Mountains, i.e. of the Karakorum range. In this case the Irshad Uwin pass (4925 m) may be taken as the point at which the two mountain ranges part. But we still have to decide how to deal with the high ridge to the north of the Derdi Mountains, along which runs the watershed between the Indus to the south, and the Ab-i-Panj and the Yarkand river catchment areas to the north (1). I think it should be included within the Karakorum range, with the name «Kilik ridge», rather than in the Hindu Kush. In this case the western boundary of the Karakorum l.s. must be shifted toward the west to the Irshad Uwin and to the Chillinji An (5292 m), where the range reach the Qoz group which, according to Mason's scheme, belongs to the Karakorum. The Karambar river marks the western hydrographic boundary of the Karakorum range as far as the Chillinji village (fig. 7).

This suggestion derives from my previous orographic study which offers one possible solution. The extension of the name Karakorum to the north is suggested

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(1) The division between the two northern hydrographic basins is to the north of the range at the Wahjir Dawan saddle. Below this, to the west, flows the Ab-i-Wakhan river, tributary of the Ab-i-Panj; to the east flows the Qara Chukur river, tributary of the Tash Khurgan, which flows to the Yarkhun.

on the basis of its widespread use among the mountaineers and tourists I have contacted.

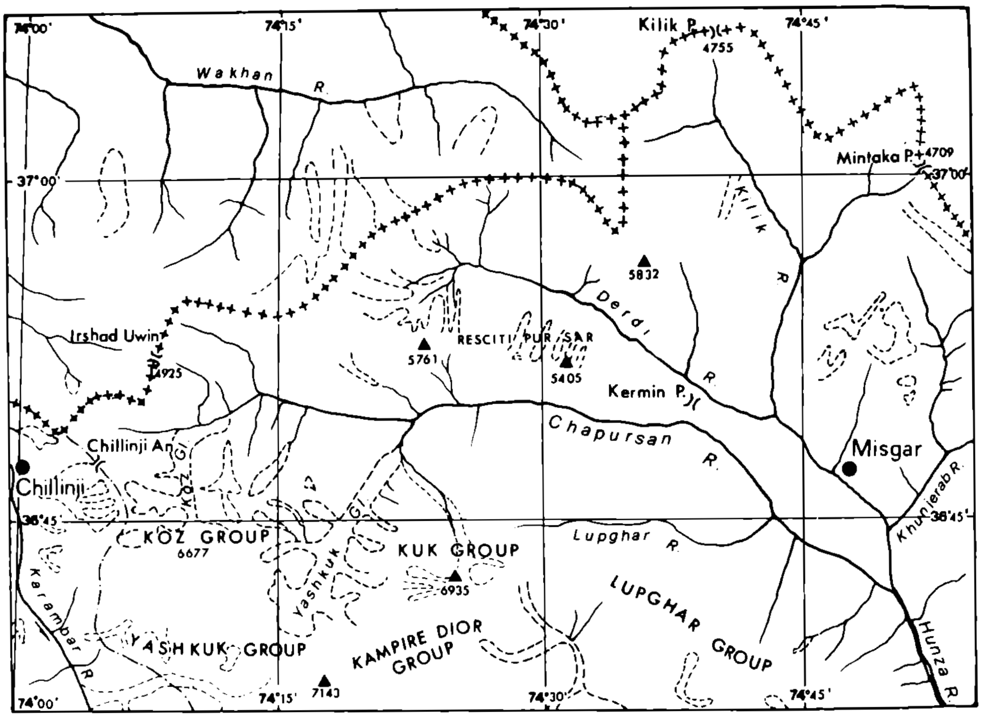

Fig. 7 - *The western boundaries of the Karakorum l.s.* (+ + and - · -)

With regard to the southern limit of the Karakorum 1.s., this might involve the Deosai mountain, which is to the south of the middle Indus and west of the Ladak range. My opinion is that it should be excluded from the area of the Karakorum 1.s. also because the orographic features are somewhat different from the other mountain ranges of the Karakorum.

In conclusion, the Karakorum 1.s. consists of the Karakorum str.s. with the addition of the Aghil range, the Kilik ridge, the Dardi mountains to the north, and Ladak range to the south.

There is another point which should now be considered. This concerns the questions of the generic geographical names for the two interpretation of Karakorum orography. It is difficult to suggest specific names for the two interpretations of the geographical boundaries with the name Karakorum as described above, though for the restricted area the name «Great Karakorum» was introduced.

I do not agree with this nomenclature as the name «Great Karakorum» seems to be more suitable for Karakorum l.s. than for Karakorum str.s. I think it preferable to maintain the name Karakorum as an appellative of the main range, as in the case of Hispar Karakorum, Panmah Karakorum, etc. A similar policy has been applied to the Alps for many years. In fact name «Alps» refers to the whole orographic system from Provence to the Vienna area. In the restricted interpretation they include the classical sections of the Alps: Maritime, Cottian, Graian, Pennine, Lepontine, Norian, Carnic and Julian Alps. Minor partitions were also introduced into these sections, such as Bernese Alps, Orobic Alps and Dolomite Alps. So the term «Alps» becomes an appellative: a similar solution may be suggested for the Karakorum.

In conclusion, I think it is preferable to give the word Karakorum a wider meaning like that of the Alps. Nevertheless in common usage the appellative Karakorum is omitted and substituted by generic names such as range, ridge, etc.

6. Partition of the Karakorum

According to the two geographical conceptions of the Karakorum illustrated in the previous section, we are dealing with two kinds of partition, one for the Karakorum l.s., another for the Karakorum str.s.

The first, which includes all the ranges between the Yarkand and Indus-Gilgit rivers, is made up of three main ranges: Aghil range, Karakorum str.s., and Ladakh range.

The partition of the Karakorum str.s. is more complicated. Firstly, there are two directions to take into consideration: the longitudinal, parallel to the main extension of the ranges, and the trasversal, perpendicular to the main direction.

We are indebted to Mason (1938) (1) for the detailed description of the Karakorum partition, in the appendix of the R.G.S. Karakoram Conference report (fig. 8). We agree on the whole with Mason's orographic nomenclature with the exception of the introduction of the appellative «Muztagh» as a synonym of the main ranges, as has already been stated. Mason's nomenclature, that is the R.G.S. official nomenclature, was introduced on the Karakorum map, scale 1:750,000 of the R.G.S. and on the 1:250,000 maps of the U.S.A. Army Map Service.

According to Mason (1938), the orographic longitudinal sections of the Karakorum str.s. are as follows:

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(1) Mason K. (1938). *Karakoram Nomenclature.* «Geogr Journal», vol. 91 n. 2, pp. 123-152, London.

A) The *Batura Muztagh:* From Koz Sar, south of the Batura glacier, to the gorge of the Hunza river.

B) The *Hispar Muztagh:* From the gorge of the Hunza river, north of the Hispar glacier, to the head basin of the Biafo glacier.

C) The *Panmah Muztagh:* The groups drained by the Panmah glacier and its main tributaries from the head of the Biafo glacier to the West Muztagh pass.

D) The *Baltoro Muztagh:* From the West Muztagh pass, north and east throughout the lenght of the Baltoro glacier, to its head south-east of the Gasherbrum group.

E) The *Siachen Muztagh:* From the above head of the Baltoro glacier along the northern mountains of the Siachen glacier and south of the Skaksgam valley, as far as the pass between the Teram Sher and Rimo glaciers, thence north of the Central Rimo glacier to its snout.

F) The *Rimo Muztagh:* From the pass between the Teram Shehr and Rimo glaciers along the mountain groups between the Siachen and the upper Shyok, as far as the Saser pass.

G) The *Saser Muztagh:* From the Saser pass to the south-eastern extremity of the Great Karakorum in the bend between the upper Shyok and the rivers».

We can see, then, that the names of the mountain ranges refer to the names to the nearby glaciers and/or their valleys, except in the case of the Sasir, which refers to the pass. I shall not give here the list of all the mountain groups, i.e. the minor orographic element, but I should like to recall the list of Mason's mountain alinements outside Karakorum str.s (fig. 8).

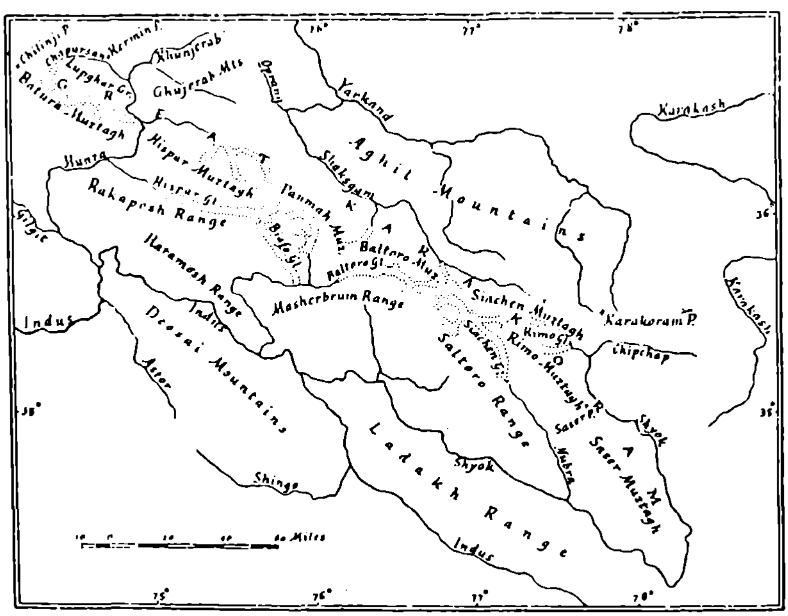

Fig. 8 - *The partition of Karakorum according to the Royal Geographical Society (1938).*

A) North of the «Great Karakoram», in Hunza territory, there are two systems of mountains, one on each side of the Hunza river, which may be called the *Lupghar group* and the *Ghujerab mountains* respectively.
The remainder of any importance all lie to the south of the Great Karakoram, and may be conveniently listed on the following alinements.

B) *The Rakaposhi range,* from the Hunza river west of the peak Rakaposhi, following the snowy crest zone between the Hispar and Chogo Lungma glaciers as far east as long. 75° 30'. Two subsidiary groups at the eastern end may be considered independent of Rakaposhi. These are the *Ganchen group* and the *Meru group.*

C) *The Haramosh range,* from where it joints the Rakaposhi range about long- 74° 50', along the crest zone between the Chogo Lungma glacier, Basha and Shigar rivers on the north and the Indus on the south.

D) *The Masherbrum range,* from the junction of the Braldu and Basha rivers, west of Mango Gusor, along the crest zone south of the Braldu river and Baltoro glacier, as far east as the Kondus glacier and valley. Two independent groups, at present unnamed, extend south from the Masherbrum range.

E) *The Saltoro range,* lies between the Kondus on the west, the Siachen and the Nubra on the east, and the Shyok valley on the south. It is crossed by the Saltoro or Bilafond pass.

Let me add some remarks concerning the Haramosh range. The summit of the Haramosh (7397 m) and the Malubitin (7458 m) are connected by a high crest, somewhat tortuous, but fairly continuous and running approximately north–south, that is perpendicular to the crest of Rakaposhi and to the range running between the Basha – Shigar valleys to the north and the Indus valley to the south. The Haramosh, together with Malubitin, constitutes both an orographic and in particular a geologic unity, independent from the range to the east. I prefer to call it the «Haramosh group» and to assign the name «Turmik range» to the mountain chain running to south of the Basha – Shigar valleys. The Gorophа-la (5465 m), at the head of the Stak valley, may mark separation of the group from the range to the east.

Geologically the Haramosh is the northern outilier of the Nanga Parbat anticline, which represents a well-defined geotectonic unit composed of different and much older rocks than the surrounding ones among which it is included (1). More precisely, the Nanga Parbat massif – one of the highest mountains of the world (8131 m) – with its northern outlier, the Haramosh, represents an orographic and a tectonic individual element 140 km long in a NNE direction, inserted, like a huge wedge, in the ESE oriented Karakorum range (fig. 9).

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(1) Desio A. (1976). *Some Geotectonic Problems of the Kashmir-Himalaya – Karakorum – Hindu Kush and Pamir Area.* «Inter. Coll. on the Geotectonics of the Kashmir Himalaya etc.», Accad. Naz. Lincei, Roma.

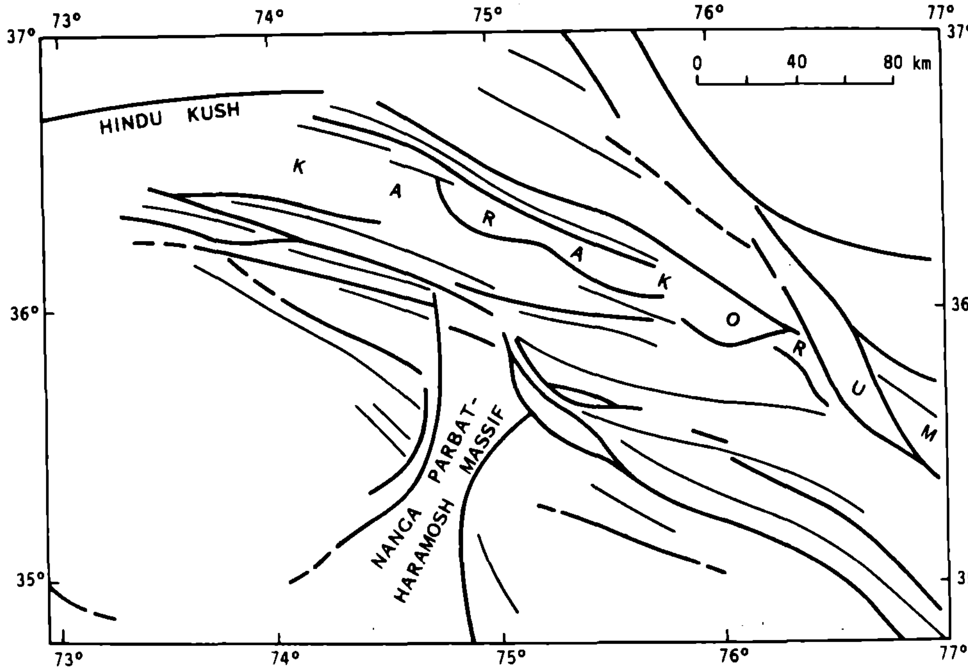

Fig. 9 - *Geotectonic location of the Nanga Parbat – Haramosh Massif.*

7. The main watershed and the highest crest of the Karakorum

Along the high crest of the Karakorum runs the divide between the Indus drainage basin, which discharges its water into the Indian Ocean, the Yarkand and the Amu Darya basins, whose waters flow into the arid basins of the Takla Makan desert and Aral depression. As we can see in the map (fig. 10) the trend of the divide is very irregular and coincides with the line of the highest crest for less than one third (190 km) of the whole lenght of the Karakorum (600 km).

While the divide from the Chillinji pass runs NE describing an arc passing through the Kilik, Mintaka, Parpik, Khunjerab and Shimshal passes, the line of the highest crests describes a short arc in the opposite direction, while further on it turns ENE as far as the Bobisghir peak (6640 m) above the Nobande Sobande glacier. Here the crest-line joins the watershed.

From here to the east, both lines coincide and run along two Muztagh passes (5370 and 5422 m), the K^2 (8611 m), the Falchan Kangri (8047 m), the Gasherbrums (8068 m), the Singhié Kangri (7645 m) and the Teram Kangri (7235 m). From

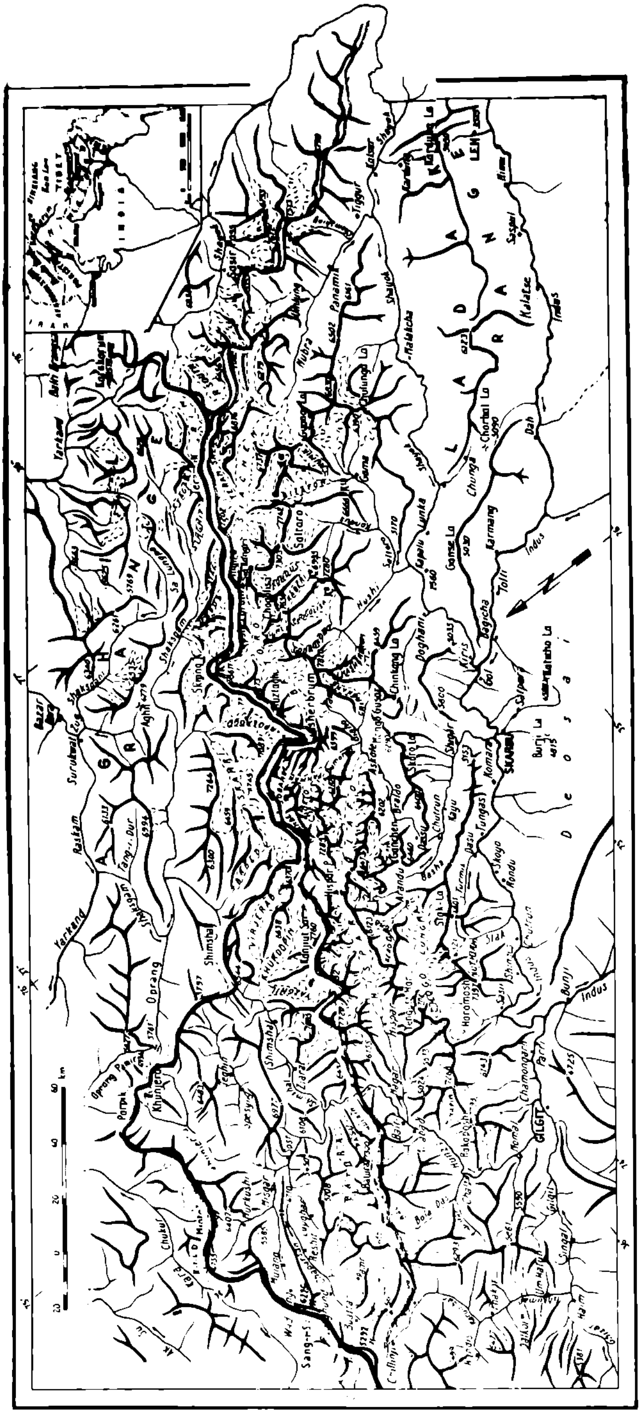

Fig. 10 - *The main watershed (green) and the main ridge (red) of the Karakorum.*

this peak eastwards the two lines are separate and whereas the divide runs NE as far as the Karakorum pass (5575 m), the line of the highest crest follows the Saser range to its end at the bend of the Shayok river.

The maximum distance of the two lines amounts to about 100 km between a peak NNW of Parpik pass (6840 m) and the Pumarikish peak (7492 m), which is in the drainage basin of the Hunza river.

In order to make clear the origin of the partition of the two lines in the western section, I superposed the orographic scheme onto the geological map (1) of the same area. We can see that while the line of the highest ridges for the most part follows the granite outcrops, the other line, which crosses an area of which little is known geologically, cuts the geological structures transversally as far as the Parpik pass (5092 m) and further west it seems to follow them rather irregularly (2). This verification makes us think that the rise of the granite belt must be relatively recent as the age of the axial granites and their instrusion is recent (Neogene) (3).

This situation reflects the complexity of the geomorphological history of that area which, at present, is still obscure on account of the scarcity of studies devoted to this subject.

Let me venture to make, however, some observations on the trend of the drainage lines, which represent the heritage of the primitive valley system, and perhaps I may also suggest some steps in their evolution.

Starting from the assumption that the present morphology depends on the heritage left by the feature of the primitive surface and the passive influence exerted by the geolithological composition, we want to direct our attention to the valley system which represents the main effect of the erosion processes. For the time being we shall not take into consideration the possible deformations of the surface produced by orogenic movements.

According to the above assumption, we may follow two directions in the interpretation of the present valley system; on the one hand the geolithological composition, on the other, the different climatic events which alternate in our country.

If we start from the recent geological history, we may suppose that the primitive valley system, that is the drainage lines, was perpendicular to the

(1) Desio A. (1964). *Geological Tentative Map of the Western Karakorum.* Institute of Geology University of Milan.

(2) The detail of this area is geologically virtually unknown.

(3) Searle M.P., Tirrul R. (1991). *Structural and thermal evolution of the Karakoram crust.* "Journ. Geol. Soc.", *148*, pp. 65-82, London.

general slope of that area. The tectonic structure suggests that from the origin a series of mountain ranges line up from west to east, describing an arc with its convexity towards the north. The «consequent» system of rivers in the southern slope of the range was oriented partly in directions converging towards the centre of the arc, partly parallel to them in the syncline or fault valleys.

There are numerous geomorphologic and paleogeographic problems which serve to justify this situation. In view of present day geomorphologic knowledge of the region, I shall do no more than make a few comments on the question.

It must first be noted that the area forming the greatest distance between the two lines is that of the largest transverse valley in the whole of the Karakorum range, the Hunza valley. Elsewhere there are longitudinal valleys which are also parallel to the tectonic structures. But moving further to the west, in the area of Hindu Kush, the reverse applies, i.e. the main valleys include prevalenty transverse valleys, as in the case of the Ishkuman and Yasin valleys for instance.

The other main valleys in the range, such as Shayok and Shigar, have relatively short transverse stretches where they join the longitudinal segments.

On the other hand the transverse valleys too have longitudinal stretches of varying lenghts particularly where the valleys of the tributaries are to be found.

The same situation applies to the north of the main watershed in the lower part of the Shaksgam valley downstream from the Oprang confluence up to the confluence with the Yarkand river and in the lower part of this river valley.

The present Indus valley is a more complex example. In the upper course there is a longitudinal stretch which runs ESE-WNW as far as the junction of the Gilgit river, which represent a continuation of the same drainage line. Downstream there are alternating longitudinal and transverse stretches with the latter prevailing. These irregularities can in part be attributed to the the distribution of the rock outcrops giving differing resistance to erosion.

At this point we might put the question of whether these transverse valleys could not perhaps be «consequent» and the other valleys «subsequent» and in that case the transverse valleys would have come into existence before the others.

It's a difficult question to answer. It is, however, worth noting that while the first intersect the geological structure more or less at right-angles, the second tend to run alongside. We can add, too, that the second ones are generally located on the outcrops of the more erodable rocks, or along fault lines, which means long lines with a lower resistance to erosion.

It would seem, however, that the theory of the earlier dating of the transverse valleys than the longitudinal ones could have an element of truth. But then this poses the question of why in the Karakorum range there are so few transverse valleys if they are really consequent, since they are located on the initial topographic surface whereas the reverse is true in the Hindu Kush.

Our knowledge of recent geological history in the area is insufficient for us to give an answer without resorting to flights of fancy instead of facts. One striking element is that long stretches of the granite masses, which follow the orographic axis of the Karakorum range and which are relatively recent (Neogene) (1), have been laid bare by erosion. And again the general rise of the whole range must be a relatively recent event (and is probably still in progress) exerting a considerable influence on the morphological evolution of the whole region.

This all suggests that erosive action on our territory as a whole was so intense as to destroy a considerable part of the initial topographic surface leaving traces only in the few transverse valleys and in the short stretches of this type in the longitudinal valleys, the older children of the processes of erosion, so to speak.

It should also be borne in mind in examining such a large area as the Karakorum, that elevation was probably not uniformly spread over the area and this could have caused a certain disorder in the pre-existent hydrography and consenquently in the evolution of the valleys and orographic system. Another factor contributing to the partial cancellation of the initial topografic surface could be a reduction in the central area of Karakorum due to the crushing effect of the collision between the Indian and Eurasian plates, as I tried to explain in one of my reports (Desio 1965).

If we look at a larger area, we can recognise the prevalence of longitudinal valleys over transverse valleys, which would seem to confirm the influence which tectonics and orogeny have had on the hydrographic system, i.e. as the folding developed, the tectonic origin of the valleys took shape. The general folding created huge arched structures with their convexity facing northwards and the main valleys of tectonic origin had to follow it.

The problem of the origin of the transverse valleys still remains, hovewer, and they appear almost anomalous in the regional orographic system as a whole. Besides those already mentioned, the main transverse valleys include the Indus valley between the confluence of the Astor and Jalkot, where it transversally intersects the massif of Nanga Parbat - Haramosh and further downstream below the confluence of the Kabul river.

8. Orographic relations between Karakorum, Himalaya and Hindu Kush

At this point the question arises as to the relationship, orographically speaking, between the Karakorum and the Himalaya. The question could be re-phrased to

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(1) See pag. 26.

ask where in fact the Himalaya finish to the north-west. Opinions differ here too, though Mason's nomenclature (1929), where Karakorum is included in the Great Himalayan range under the name Karakorum-Himalaya, is unaceptable since the two ranges are independent both from an orographic point of view and from a geological point of view, as will be shown later. According to Burrard and Hayden (1933) the Punjab Himalaya finishes on Nanga Parbat, so this high ridge with an altitude of 8126 m would therefore represent the most westerly point of the Himalaya.

The main ridge of the Himalaya runs NW, i.e. towards the Nun Kun massif (7135 m), and beyond this there are no mountains high enough to be considered a continuation of this ridge. The same authors of «The Great Himalayan Range» state that at the Sutlej river a secondary branch separates to form the Pir Panjal range which Dainelli takes to be the western end of the Himalaya. The Zanskar range forms yet another off-shoot which is in fact a terminal branch of the Himalaya.

There is, however, no direct connection between Nun Kun and Nanga Parbat. In fact Nanga Parbat lies along a somewhat irregular orographic axis, but can be considered as lying basically SSW-NNE and therefore perpendicular, or almost perpendicular, to that of the Karakorum (see page 24 fig. 9).

From this information it would see feasible to conclude that from an orographic point of view there is an appreciable distinction between the Himalaya and the Karakorum, which should therefore be considered as two separate mountain ranges.

With regard to the orographic relations between the Karakorum and Hindu Kush ranges, on page 20 fig. 7. I have marked what I consider to be the western limit of the Karakorum.

9. Summary of the scientific activity of Italians in exploration of the Karakorum before the Second World War

We can begin by leaving aside the age of pioneering when very little really scientific work was done, and in doing so we do not whish to belittle the efforts of those men who opened the roads to geographical exploration. The names of the travellers who penetrated some of the Karakorum valleys for the first time are prestigious. Take for example – among the Italians – Father Ippolito Desideri da Pistoia in the first half of the 18th century, Marquis Osvaldo Roero di Cortanze between 1853 and 1875, the two brothers, Dukes Lante Grazioli della Rovere in 1878. Their published reports, even though they contained some detailed information on the countries they crossed and, above all, about the eastern and most accessible part of the Karakorum, do not amount to anything more than journalistic accounts nowadays. Incidentally, Marco Polo passed north of the Karakorum range without touching or even seeing it.

In the meantime, the geodetic and topographic operations of the Survey of India started in our region establishing the regional cartography within rational base lines, an indispensable element for any true progress in territorial research.

In the second half of the 19th century the heart of the Karakorum range was penetrated, particularly by English travellers, and one of them even crossed the central part which is the highest. In 1987, Francis Younghusband reached India from China across the Eastern Mustagh pass (5422 m) which was completely covered with glaciers. We'll talk about this again soon, as this way was covered later by an Italian expedition exploring the range's northern slope. But before, it is to mention that in the summer 1890 an Italian, Roberto Lerco from Gressoney, travelled up the tracks of Kashmir reaching the Baltoro glacier. Here he attempted

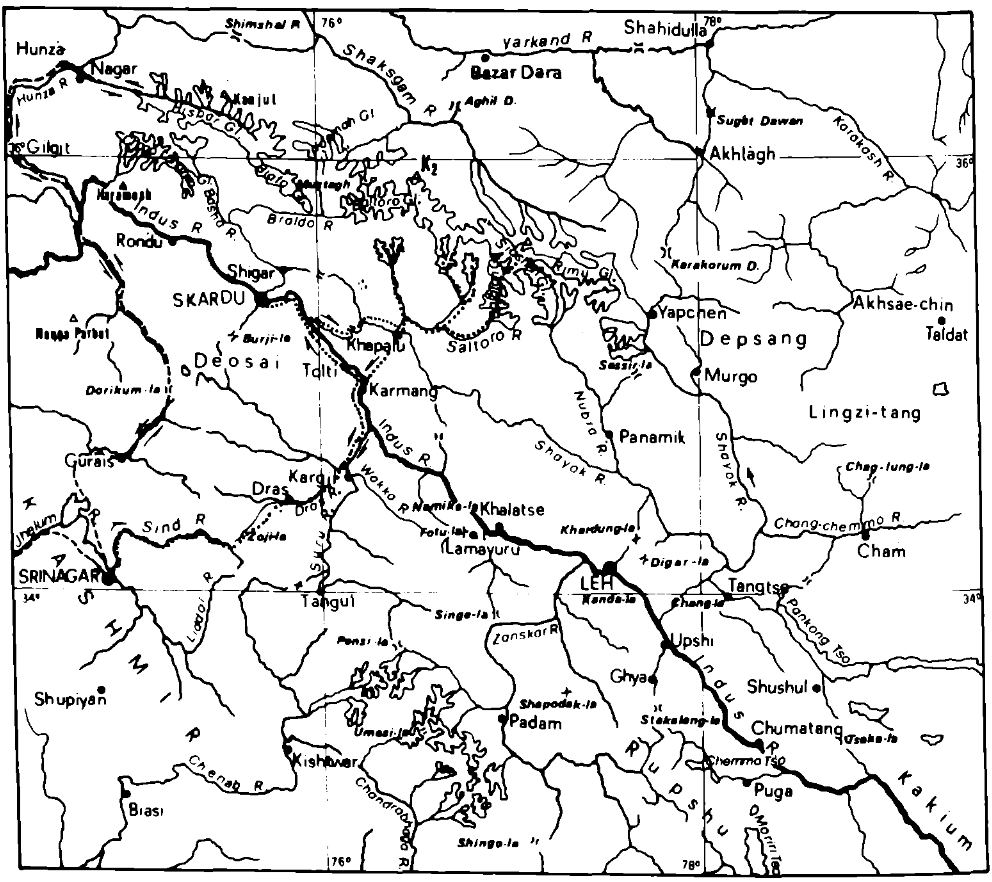

Fig. 11 - *Routes travelled by Cesare Calciati during the expeditions of the years 1908 (-) and 1911 (...).*

to climb the K[2] along the SE spur (Abruzzi spur) reaching the height of 6500 m where he was stopped by a wall considered insuperable.

There is no need to go back over the whole history of geographical explorations in the Karakorum. Among the most famous names, next to that of the Englishman H.H. Godwin Austen (who was the first after Lerco to see K[2] from fairly close to) we must not forget the German Schlagintweit brothers, the Englishman Martin Conway and the American Workmans, who continued their intense exploration activities almost up to the First World War and who had Italian collaborators not only among the guides (M. Zurbriggen, G. Petigax and C. Savoie), but also as topographers. In particular I refer to Dr. Cesare Calciati who was part of the Workman expeditions in 1908 and 1911 (fig. 11), carrying out topographic surveys of the Hispar glacier and of some minor glaciers of the Shayok basin

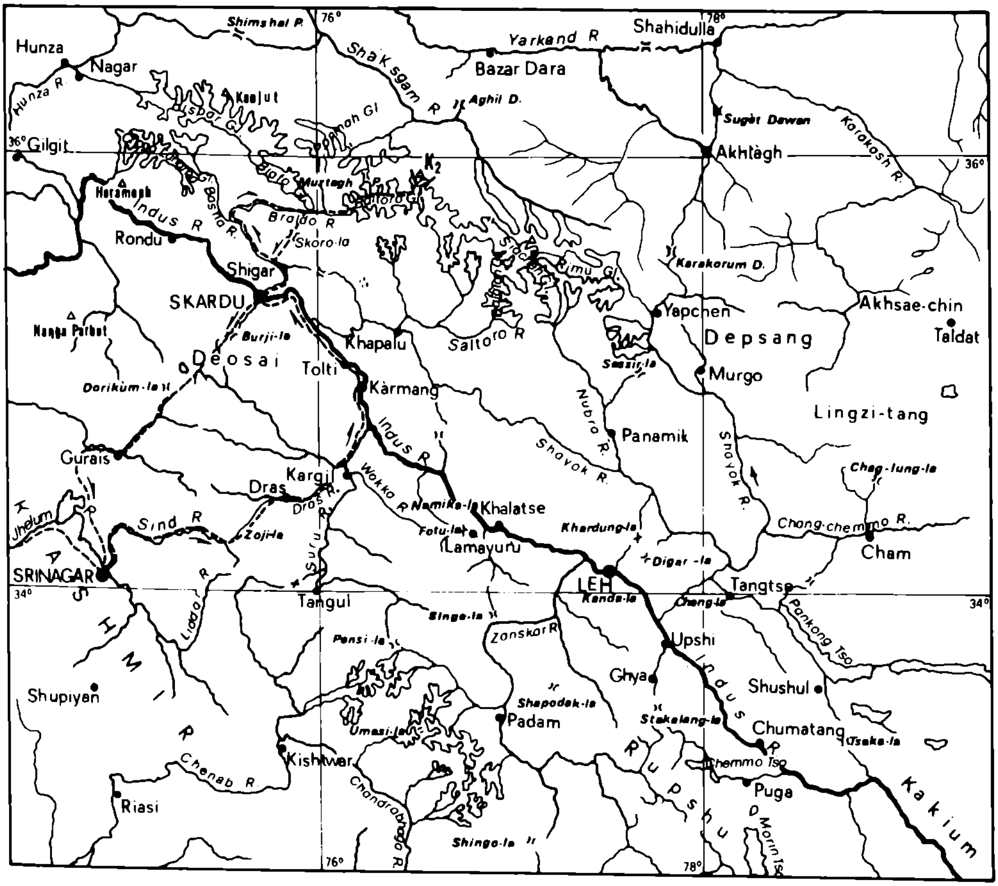

Fig. 12 - *Routes travelled by the Duke of Abruzzi expedition 1909 in the Karakorum* (- -).

(Masherbrum, Gondokhoro and Kabery). Calciati also collected numerous rock samples and some specimens of the flora which led to publications by specialists.

During this time (1909), an Italian expedition led by Duke of Abruzzi (fig. 12) was heading towards the highest and most inaccessible part of the range which rises in the high basin of the Baltoro glacier, with the predominant aim of climbing K², an attempt on which had already been made 19 years earlier by Lerco and 7 by a multinational expedition (Eckenstein-Pfannl-Guillarmod). As on his previous expeditions the Duke was accompanied by a topographer, in this case Federico Negrotto Cambiaso, who used photogrammetric methods for high mountain surveys for the first time, employing the Paganini camera, invented and constructed in Italy.

The expedition doctor, Filippo De Filippi, took care of the naturalistic collections which were then entrusted to experts for study (Vittorio Novarese

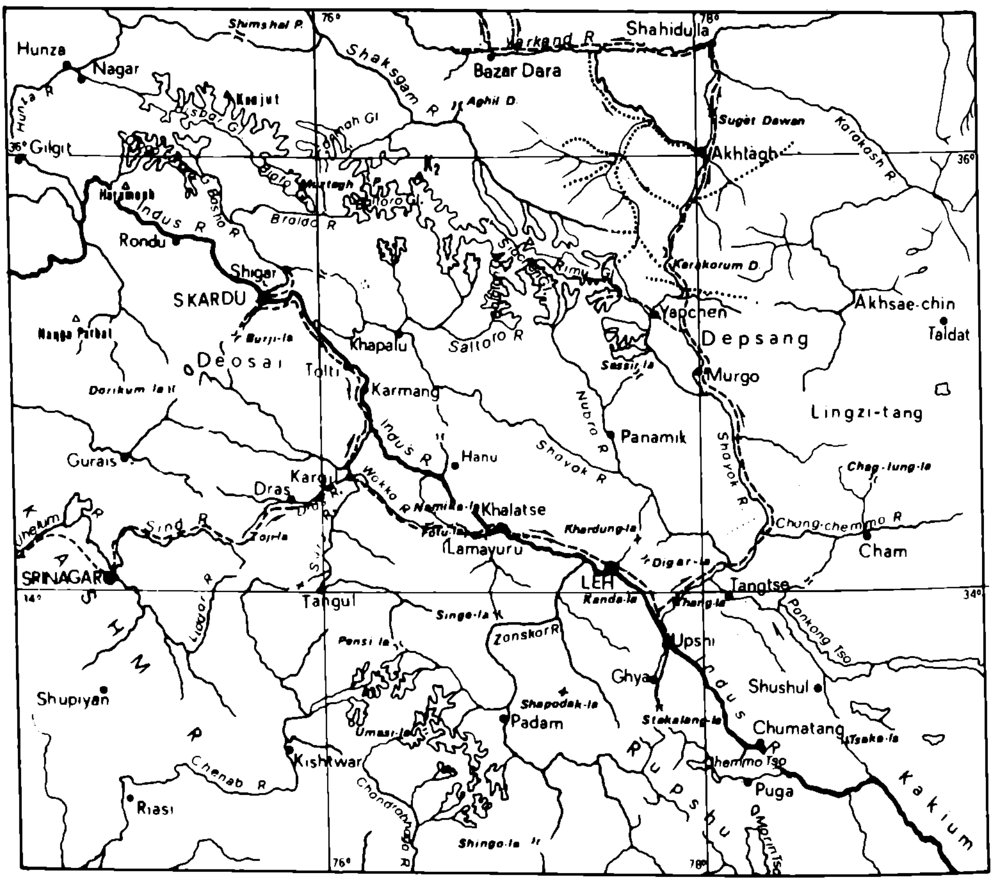

Fig. 13a - *Routes travelled by the Filippo De Filippi expedition 1912-1913 (– –) except the Dainelli, Marinelli routes. (···) Routes of the geodetic-topographic group.*

for the rocks and Romualdo Pirotta and Fabrizio Cortesi for the plants).

Among the Italians who accompanied the expedition we must also mention the incomparable photographer, Vittorio Sella with his assistant Erminio Botta and the seven guides and porters from Aosta valley (Giuseppe and Lorenzo Petigax, Alessio, Enrico and Emilio Brocherel, Alberto Savoie and Ernesto Bareux).

Mario Piacenza's expedition to Nun Kun in 1913 was also of a mixed mountaineering and scientific nature. Of the scientific investigations was charged C. Calciati mentioned above. However, I will only mention it fleetingly as that mountain system is not part of the Karakorum, but of the Western Himalaya.

Before the First World War, the only truly Italian scientific expedition to visit the Eastern Karakorum and its bordering areas, was that organized and led in 1913-1914 by Filippo De Filippi (fig. 13a, b), who had often accompanied the Duke

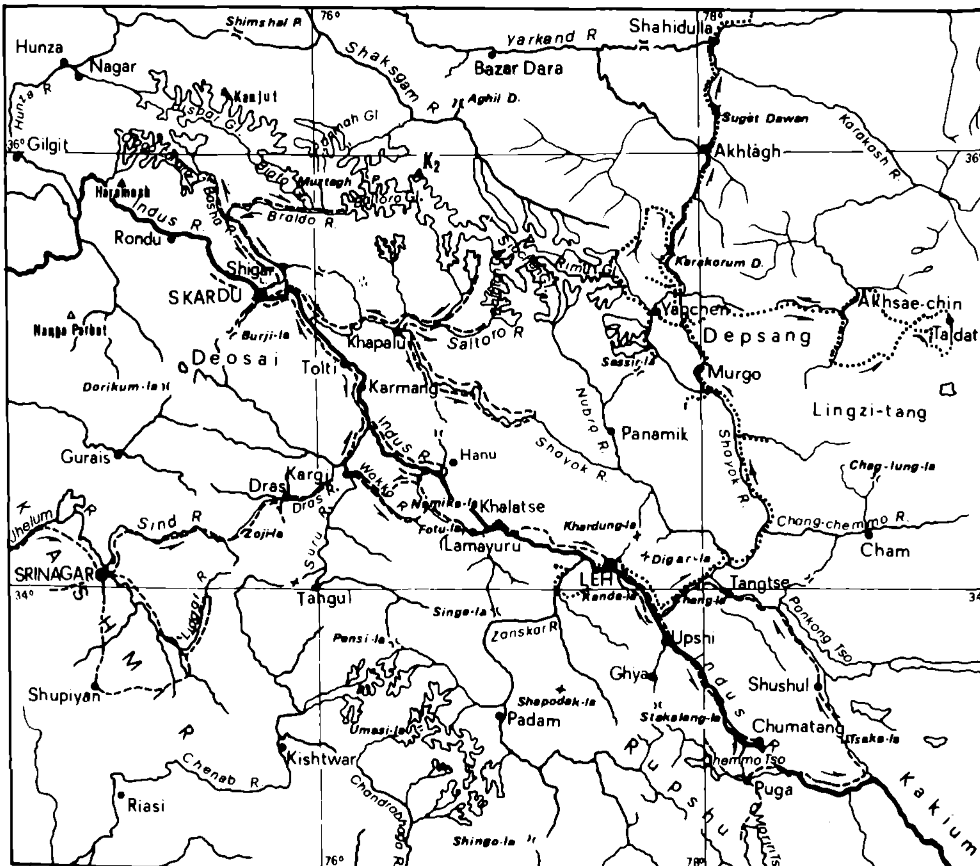

Fig. 13b - *Routes travelled by Dainelli (- -) and with Marinelli (...) during the De Filippi expedition 1912-1913.*

of Abruzzi on his expeditions. I must therefore devote a little more time to this expedition than to the others.

The De Filippi expedition had ten membres besides its leader (who was also its doctor) of which six left for India with most of the baggage at the end of summer 1913 to winter at Skardu. The others joined them in April the following year. Their names can already tell us something about the expedition: prof. Alberto Alessio, geodesist an geophysicist; prof. Giorgio Abetti, geophysicist and Alessio's assistant; marquis Nello Ginori Venturi, meteorologist; prof. Giotto Dainelli, geographer an geologist; prof. Olinto Marinelli, geographer; major Henry Wood and John Alfred Spranger, topographers; lieutenant Cesare Antilli, photographer and Giuseppe Petigax, the alpine guide.

It is not easy to summarize briefly here all the research done by the De Filippi expedition during the year and a half stay in Asia, research that has been illustrated in 15 volumes published in the following twenty years.

This monumental work, in Italian language, includes three volumes on geodesy and geophysics, three on geology, three on petrographic and paleontologic descriptions, one on the history of expeditions to this region, one on physical geographic description, two volumes on anthropogeography and ethnography, one on the plant gathered above 4500 m and on the fish in the Indus while the last volume is an index. Numerous collaborators helped in the study of the naturalistic materials collected by the expedition.

Among the results of the geodetic-geophysical research, particularly interesting is the connection made for the first time between the Survey of India's network of gravimetric stations on the pre-Himalayan plain and the Russian Army Geographic Service's network of stations north of the Karakorum, in Pamirs and in Ferghana. Among other things, this enabled us to establish the deviations of the vertical and the regional gravimetric anomalies and to establish that the values of gravity are generally in excess in the mountain ranges of the Himalaya and the Karakorum and in default in the plains that extend at their feet, besides showing us the greater thickness of earth's crust under such ranges. To be brief I shall leave aside the results of the magnetometric and meteorological research even though they are interesting.

The geological research carried out by Dainelli enabled him to reconstruct the stratigraphic sequence of the Eastern Karakorum with greater precision and detail than was previously possible, and he was able to extend this knowledge to unknown areas towards the east of the Karakorum. The paleogeographic and the regional tectonic reconstruction are also illustrated and extended to Central Karakorum.

Even if the volumes published by the De Filippi expedition didn't receive the acclaim they merited, above all due to the language they were written in and the exuberant prolongation of some texts, and if a part of the results, perhaps illustrated with an excessive use of logistic details and of attestations and therefore difficult to interpret, was surpassed by subsequent research, they still represent a milestone in the history of the geophysic, geologic, etnographic and anthropo-geographic knowledge of the Karakorum.

After the end to the First World War, in Italy, the political and even the economic moment was not favourable to the launching of a new scientific expedition in the heart of Asia. Almost a decade, therefore, went by before the idea could be realized and the chance came with the celebration of the tenth anniversary of the Italian victory of Vittorio Veneto in the First World War.

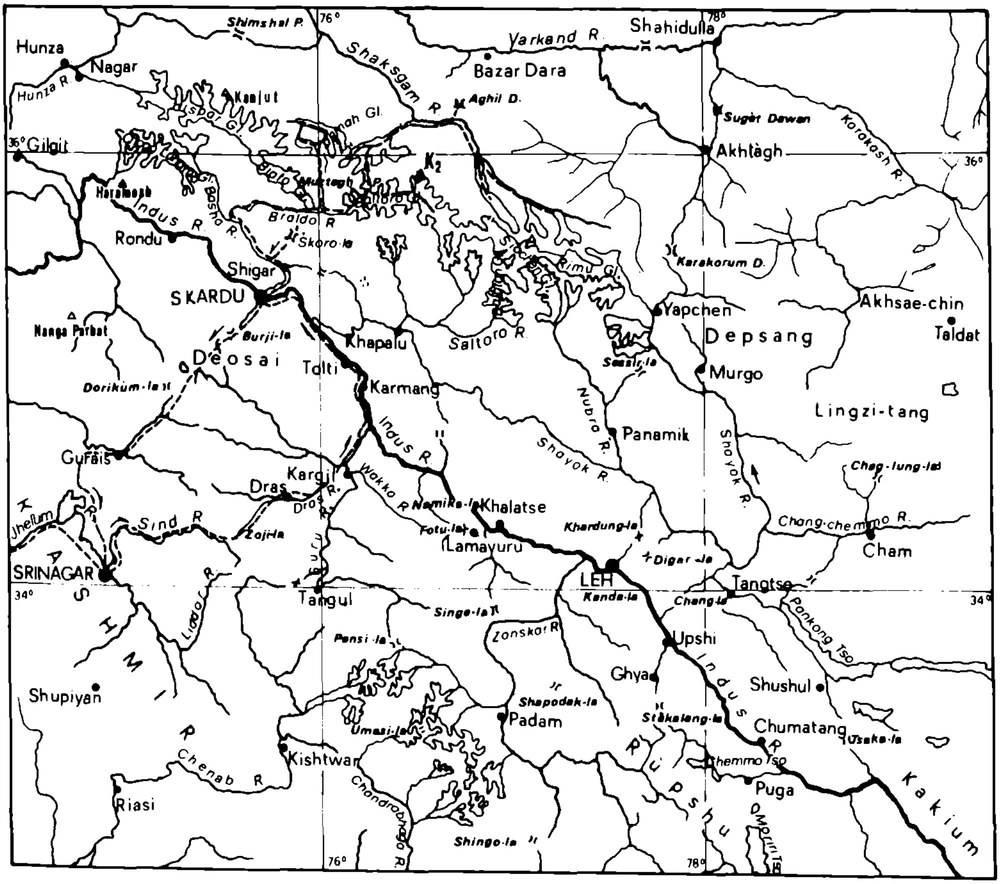

Fig. 14a - *Routes travelled by the Duke of Spoleto expedition 1929 in the Karakorum* (- -).

The idea originated in Milan with a small group of climbing friends, but, then, their real goal was a sporting one, that is, to climb K². I won't go into the various events that preceded the start of the expedition complicated by the future leader's personal problems. I will only say that while they were setting the bases, and a preliminary journey was being prepared for spring 1928, the newspapers announced that the tenth anniversary of the victory would be celebrated by the flight of the airship «Italia», commanded by Umberto Nobile, to the North Pole. So, our project passed into second place and was almost cancelled.

During that time, the Duke of Spoleto, the Duke of Abruzzi's nephew, was called by the Italian Geographical Society, who had assumed the scientific sponsorship of the enterprise, to command the expedition; but after the dramatic end of the Nobile expedition, and with orders from above, he had to modify the programme by cancelling the climbing part and considerably reducing his personnel. Modified in this way, the expedition assumed a geographic-naturalistic tendency and took place in the Baltoro glacier region and in the surrounding areas (fig. 14a, b).

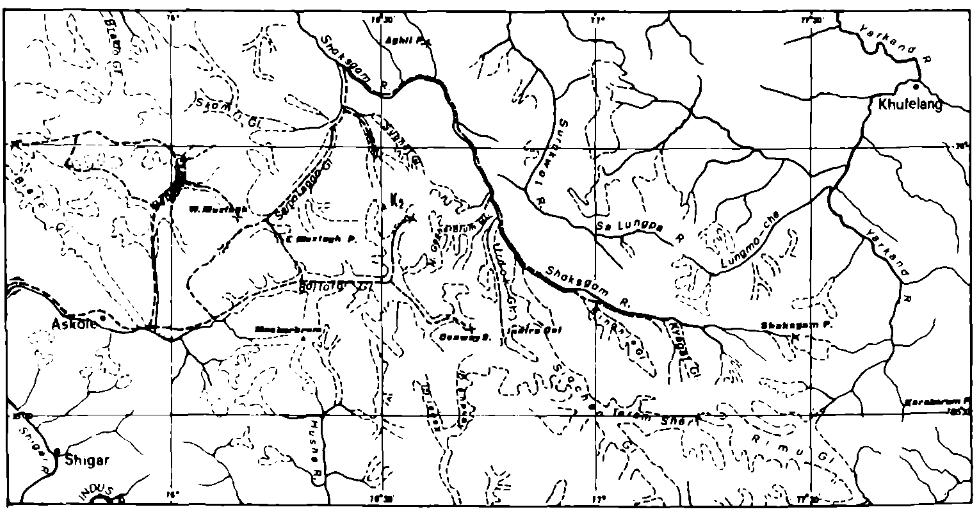

Fig. 14 b - *Routes travelled by A. Desio during the Duke of Spoleto expedition 1929* (--).

Among those called to take part in the expedition were, commander Mario Cugia, to help the Duke in taking geophysical measurements and making topographical surveys; dr. Lodovico di Caporiacco, a naturalist, to collect specimens of the flora and fauna; myself as geographer and geologist; dr. Gino Allegri, assigned also to take anthropologic measurements; three mountaineers who had been with the previous team (Umberto Balestreri, Giuseppe Chiardola and Vittorio Ponti); a photographer-cineoperator, Massimo Terzano; a radiotelegraphist Angelo Anfossi and two alpines guides from Courmayeur, Evaristo Croux amd Leon Bron.

The expedition left Italy in April 1929 and worked for five months, especially in the Baltoro glacier area. A small group crossed the Eastern Mustagh pass, which I have already mentioned, and explored the upper Shaksgam valley, with the glaciers that bar it and which had stopped Mason's English expedition in 1926. The team also climbed the Urdok glacier looking for a way to re-enter the upper Baltoro across the Conway saddle and the Abruzzi glacier which had been previously explored by the expedition, but because of bad weather they had to give up. Then, it split up into two groups to allow two members, Balestreri and Desio and few porters with just enough food to survive, to explore the still unknown part of the Shaksgam valley, while the other group went back to the base-camp.

The scientific work of the 1929 Italian expedition was especially recognized and appreciated in England, while in Italy official scientific circles almost ignored it, mentioning it as if it had been a tourist trip.

Apart from a few brief preliminary accounts, the of the expedition scientific report didn't appear till 1936, because of economic difficulties. That year, a large volume was printed summarizing the geographical and geological results fairly extensively, and in brief appendixes, the data regarding the geodetic, geophysical and anthropological measurements and the zoological and botanical collections. Unfortunately, only very few copies were printed, because, as the last copies were being printed, the publishing firm closed down and nobody heard anything more about all the unfinished copies.

With all that, the expedition's scientific contribution is sufficiently well documented. Apart from the discovery of the Staghar and Singhiè glaciers (so named by the expedition), which barred the Shaksgam valley, the geologist-geographer (Desio), who was part of the exploratory group, did the topographic survey (with the plane table «Monticolo») to a scale of 1:50,000 (1), of the upper Shaksgam valley and its main confluents, the Sarpo Laggo valley, which up to then had no map representation, as well as the whole Panmah glacier basin on its southern slope, while the expedition's topographers took care of the photogrammetric survey of the Baltoro basin.

For the first time, relatively detailed geological surveys were done of all the above-mentioned areas and were illustrated on single maps in the expedition's

(1) The map was published on the scale 1:75,000.

official volume accompanied by the illustration of the stratigraphy and of the tectonics. The discovery of fossils of the Paleozoic and Mesozoic eras, not only in the sedimentary zone situated on the range's northern slope, but also in metamorphic rocks on its southern slope, and the petrographic study of numerous rock samples, allowed to set that whole territory's geology on secure bases for the first time. This study also helped to correct several interpretational errors made by earlier and later authors. The publication of other volumes dedicated to individual scientific fields was planned, but the economic difficulties, that – as I said before – had already greatly hindered and delayed publication of the official volume, stopped these

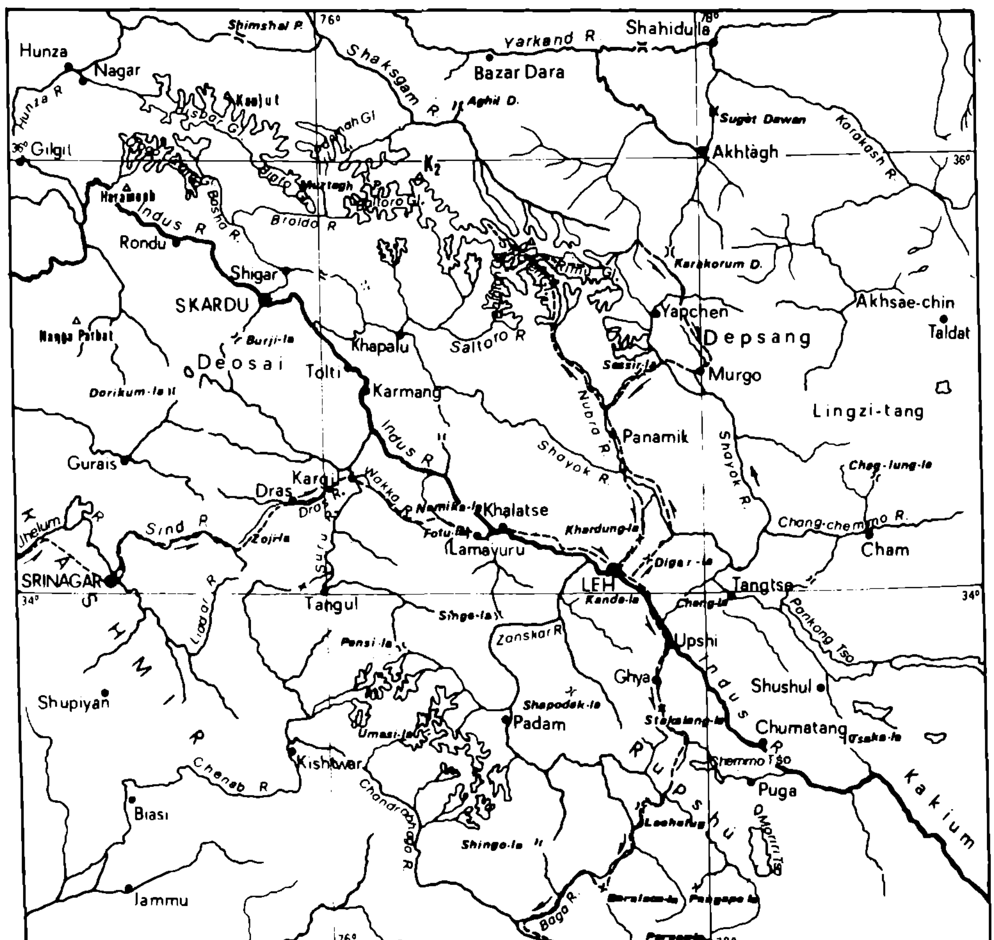

Fig. 15 - *Routes travelled by the G. Dainelli expedition 1930 in the Karakorum* (- -).

works altogether. However, in their place, we still have about fifty notes and reports of varied size contents, published in the following years and, a part, even recently (1).

The following year (1930), a member of the De Filippi expedition, Giotto Dainelli, visited the Siachen glacier again and crossed into Rimu (fig. 15) with a small expedition (which I had been invited to take part in) and which included, as well as its leader, two topographic officers from the Italian Military Geographical Institute, captain Alessandro Latini and lieutenant Enrico Cecioni, and a secretary, E. Kalau von Hofe. Unfortunately, because of a disagreement that arose between the expedition leader and the topographers, the map of the Siachen basin, plotted all over again with a "Santoni phototheodolite", was never published. The geological data were included in the De Filippi expedition's volumes.

In the decade preceding the Second World War no other Italian expedition visited the Karakorum. With the support of the Italian Alpine Club, I was well ahead with plans for a mountaineering – scientific expedition to K^2, but the sudden start of hostilities put an end to this enterprise.

After the Second World War, the Italian scientific – exploratory activity in the Karakorum range began again, rather late because of the country's well-known political and economic difficulties.

10. A brief history of Desio's expeditions to the Karakorum and Eastern Hindu Kush

I began a first attempt to get a new expedition to the Karakorum in 1952 with the financial help of the Italian National Olympic Committee. It was not a scientific expedition, but a sporting one (the ascent of K^2), for which it was easier to awaken public opinion in order to raise the necessary funds.

Even if the goal was a mountaineering one, I had, nevertheless, arranged for a group of scientists to take part in the expedition with a well-defined programme to carry out in almost complete logistic autonomy from the climbing group. The difficult negotiation with the Pakistan Government continued the whole of the following year during an attempt to climb K^2 by an American expedition, led by dr. Charles Houston.

In summer 1953, I went on a reconnaissance of the Karakorum financed by the Italian National Research Council, visiting, at the Pakistan Government's invitation,

(1) In 1980 I published a volume on the «Geology of the Upper Shaksgam Valley, North-East Karakorum, Xinjiang (Sinkiang)», containing the results of the geologic investigations of the 1929 expedition, still valid.

the Stak valley, where the Kuthia glacier, in the last three months, had advanced 12 km, invading the main valley and threatening the higher villages (fig. 16).

From there, with a companion (Riccardo Cassin) I crossed into the adjoining Turmik valley to do a geological survey and collect rock samples, and then event on into the Basha and Braldo valleys towards the Baltoro glacier and the foot of K^2, in order to study the possible ways of climbing it. I carried out geological surveys and perfected the ones begun in 1929 along this itinerary, using the maps plotted at that time. This journey helped me, among other things, to get permission for the K^2 expedition; permission that was being contended by four other countries.

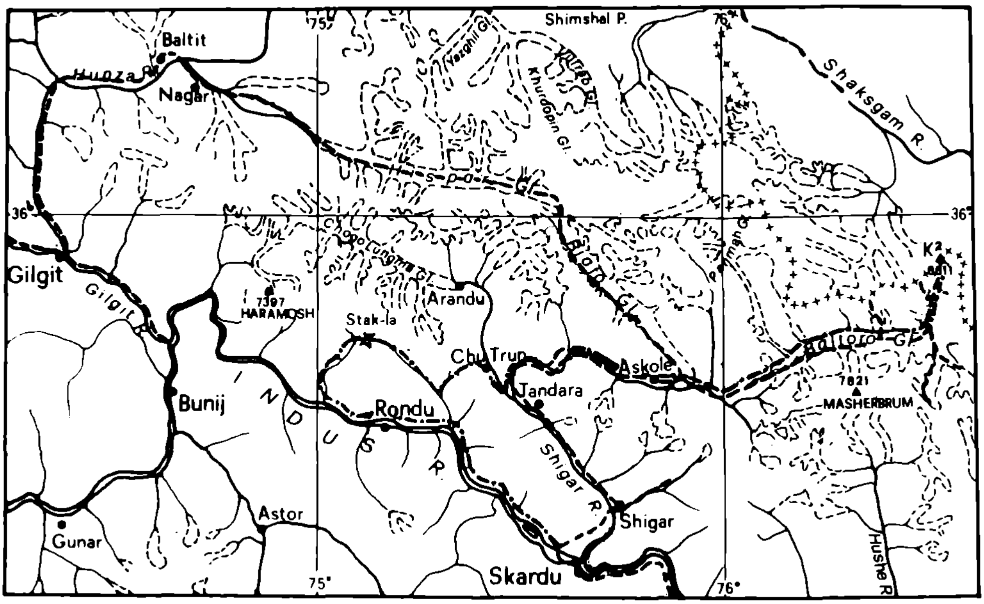

Fig. 16 - *Routes travelled by the A. Desio expeditions 1953 (-.-) and 1954 (--) in the Karakorum.*

1954 was, of course, the year the scientific-mountaineering expedition to the Karakorum climbed K^2. I won't devote much time to that undertaking, with which many people are familiar, but I would like to mention the scientific research combined with it, especially as I was severely criticized, both in Italy and abroad, for such a combination, which would have caused – according to many critics – the failure of both undertakings. I was, then, at my thirteenth scientific-exploratory expedition and I felt pretty sure of what I was doing.

First, I have to mention the colleagues who collaborated in the research with me. Prof. Paolo Graziosi, from Florence University, was in charge of anthropological research on the local populations and pre-historic surveys in the inhabited zone of the North-Western Karakorum. Prof. Antonio Marussi, from Trieste University, took the geophysical measurements and prof. Bruno Zanettin, from Padua University, did the geopetrographic investigation. Captain Francesco Lombardi of the Italian Military Geographic Institute was assigned to topographic surveys with a Pakistani assistant, Bashad Jan. I myself, besides the considerable responsibility of the leadership, took charge of the geological survey and the metereological observations with one of the mountain climbers; the anthropological research on the Hunza and Balti porters, which had been entrusted to the expedition doctor, was not carried out.

I can't go into much detail with regard to the scientific results, which would require an excessively long presentation: even more so as the 1954 expedition was followed by five other, purely scientific, but easier and shorter trips, which were meant to complete and extend the research done during the 1929, 1953 and 1954 expeditions.

It embarrasses me somewhat to talk about these last expeditions, as I was both organiser and leader. But, at the time of the Second World War, I directed and organized all the Italian scientific expeditions that explored the Karakorum range, and, of the foreign ones, only a few did scientific surveys as well.

I will say, though, that in 1955 I went back to the Karakorum with two Italian collaborators, prof. Paolo Graziosi and prof. Antonio Marussi, and was accompanied by dr. M.N. Khan, director of the Pakistan Geological Survey. The expedition went as far as Gilgit from the Chitral territory along different routes, carrying out anthropologic and ethnographic research among the Kafirs, taking gravimetric and magnetometric measurements and doing geological research and studies in the whole of that vast territory which includes the western extremity of the Karakorum and a part of the Eastern Hindu Kush (fig. 17).

In the next expedition in 1961 I again had as collaborators prof. Marussi for the geophysical part and drs. Ercole Martina and Giorgio Pasquarè for the geological part. It was supposed to take place on the northern slope of the Karakorum and the Eastern Hindu Kush – namely in Wakhan, the corridor that separates Pakistan from Russian Pamirs and that belongs to Afghanistan – but as, at the last minute, we were unable to get permission to enter Wakhan, it took place mainly in Badakhshan and in some surrounding areas (fig. 18). I would like to add that it was a provident drawback, as Badakhshan proved to be the key-zone in interpreting the structural relationship between Pamirs and Hindu Kush, and explaining the stratigraphy and tectonics of an area characterized, among other things, by an exceptional seismicity.

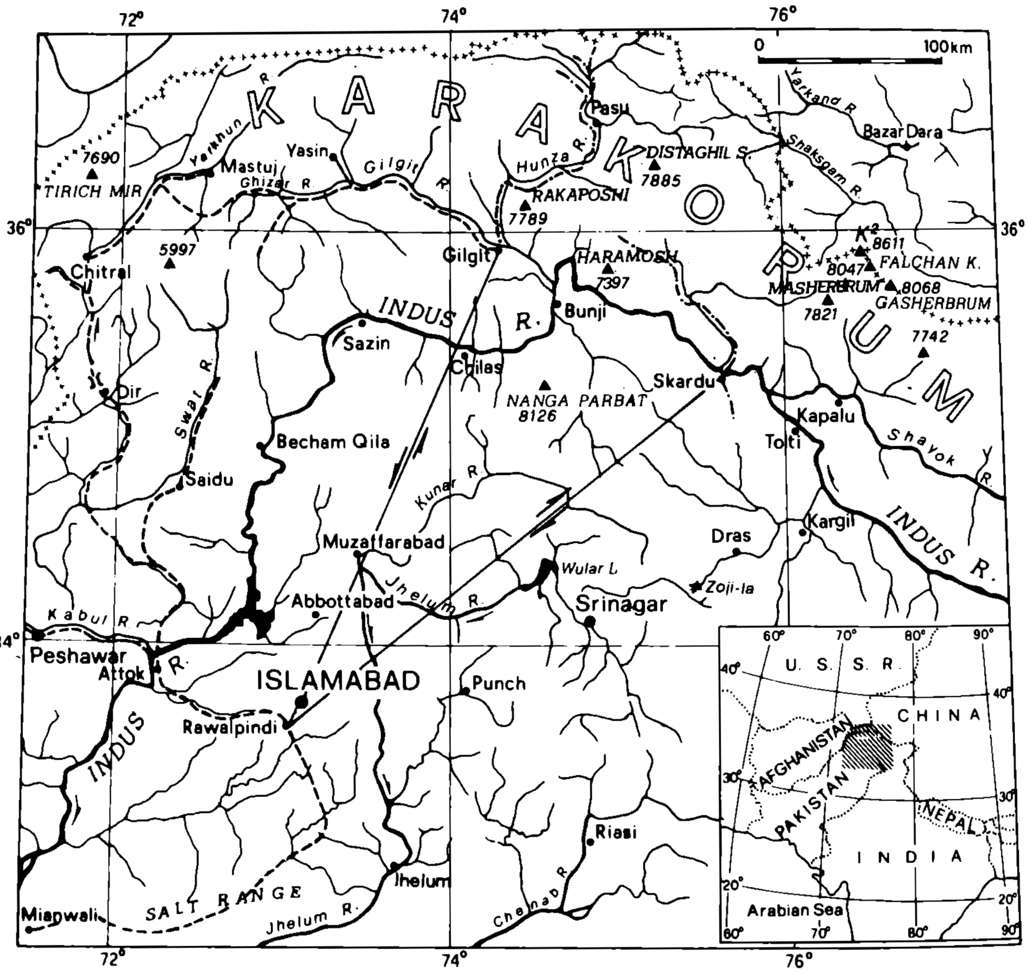

Fig. 17 - *Routes travelled by the A. Desio expeditions 1955 (-) and 1962 (--) in NW Pakistan.*

The followings year, 1962, with two geological assistants, E. Martina and G. Galimberti, and thanks to a special permit from the Pakistan President, and the help of the Mir of Hunza, I was able to ascend the whole Hunza valley again, as I had only partly covered it in 1954, and reach the Chinese border, finding the solution to still unsolved geological problems regarding the structure of Central Karakorum. In the same summer I reach the Chogo Lungma and Martina the Hoh Lumba glaciers.

The 1971 expedition took place along the new road being built along the

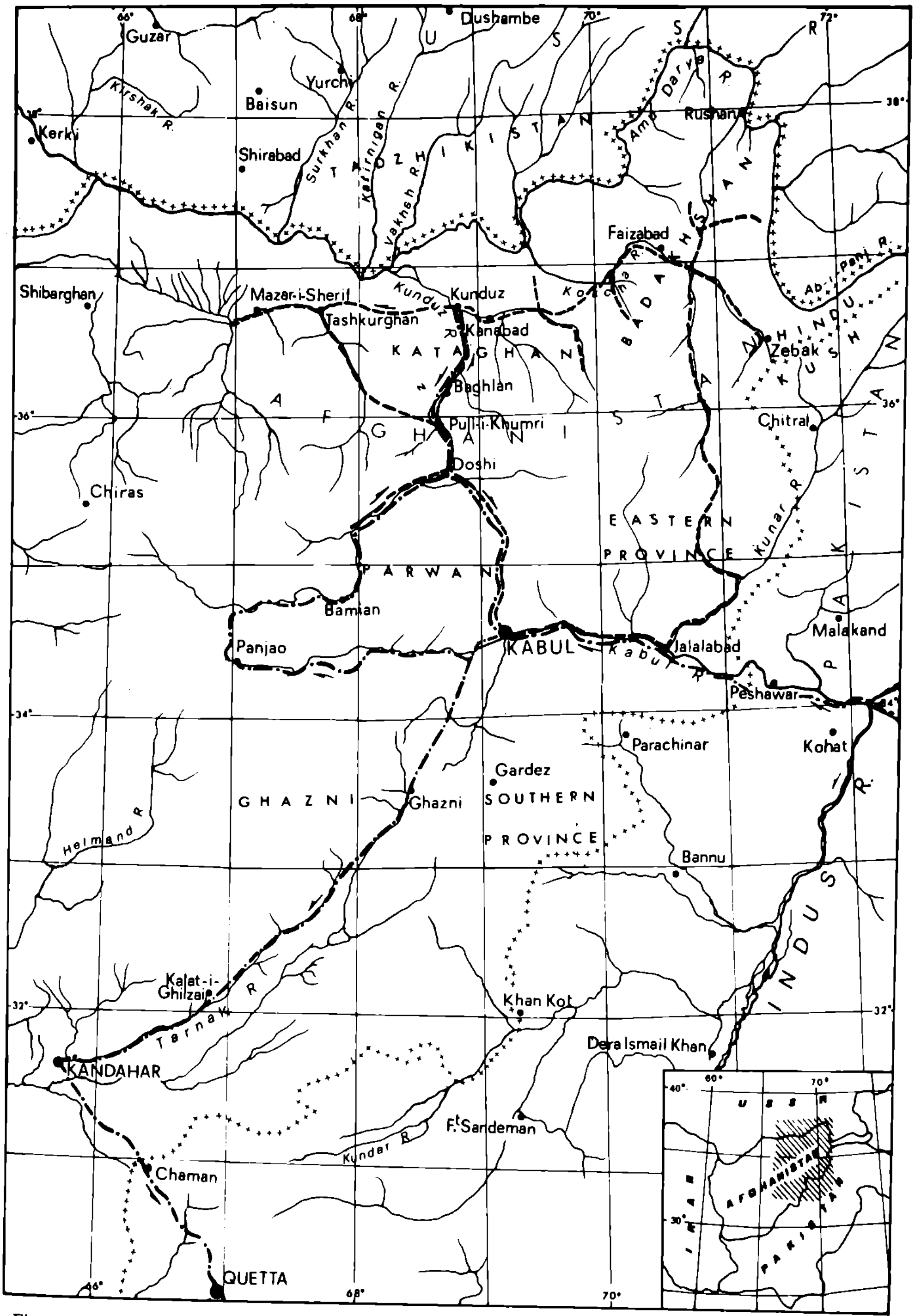

Fig. 18 - *Routes followed by A. Desio expeditions in Afghanistan in the years 1955 (--) and 1962 (-.-).*

middle Indus valley (fig. 19), and which was almost completely unknown geologically, and I was accompanied by an assistant geologist, dr. Giuseppe Orombelli. On that occasion, I was able to establish for the first time, where the huge ice-tongue of the great glacier that occupied the Indus valley in the Quaternary came to a stop (the position was in fact different from those assumed by previous authors). I was also able to help in solving some other geological problems that were still under discussion.

That year I wanted to see the Kuthia glacier again, but various kinds of difficulties prevented me from doing this. It was only two years later that I managed

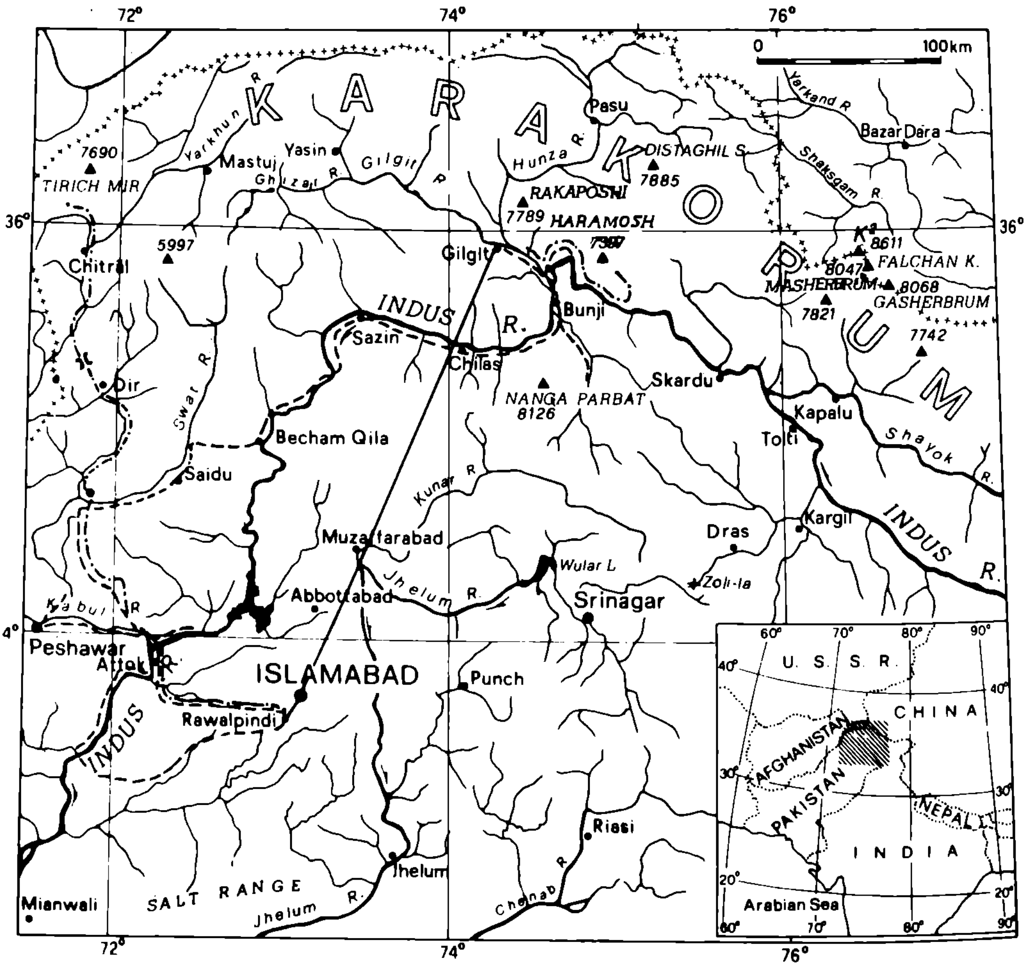

Fig. 19 - *Routes followed by A. Desio expeditions 1971 (--) and 1973 (-·-) in Pakistan.*

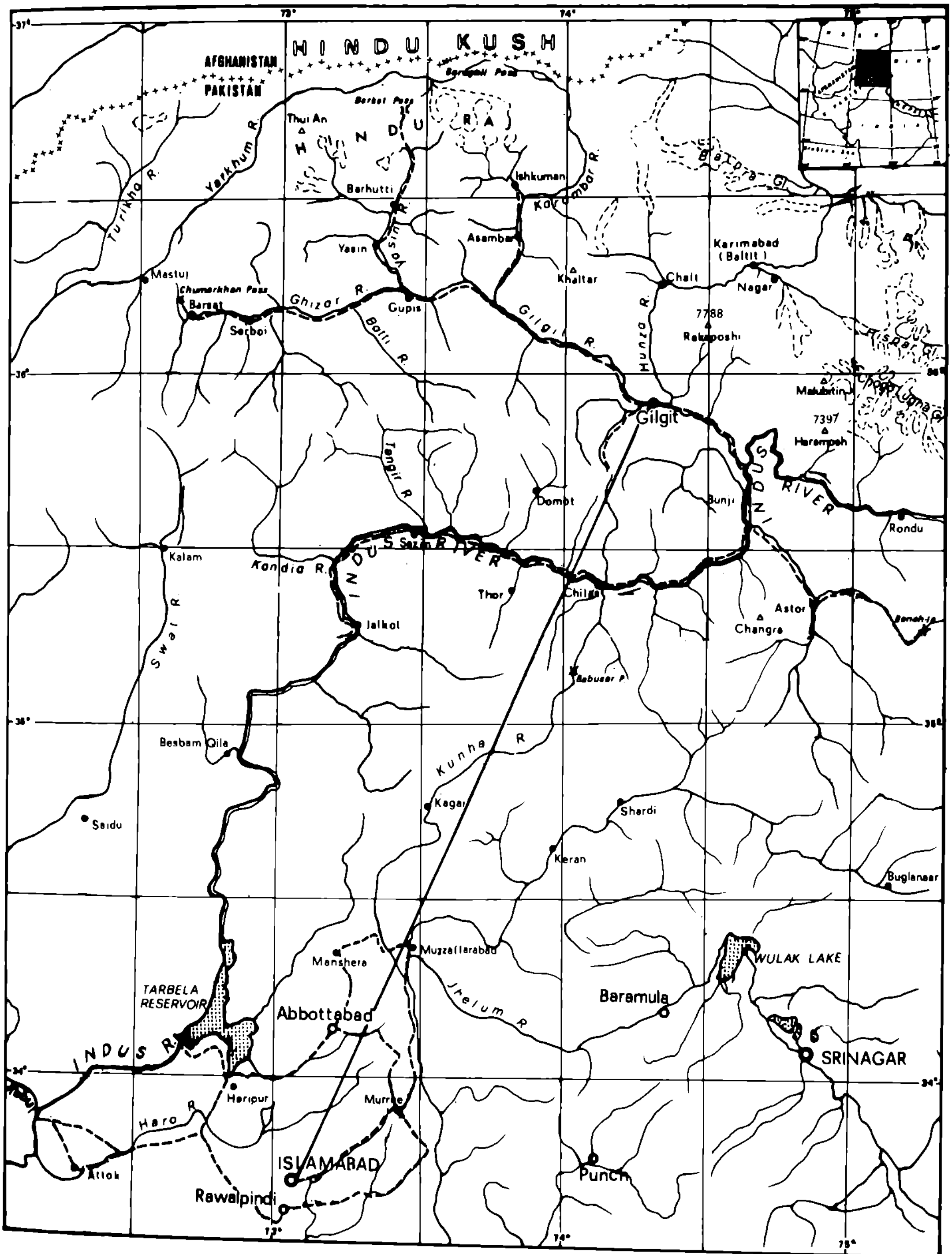

Fig. 20 - *Routes followed by A. Desio Expedition 1975 in Pakistan* (- -).

to make a trip to that remote valley with a Hunza student and complete other research on the ancient glaciers of the Indus basin. In the same year I visited also the Astor valley.

The last expedition was that of 1975, which was organized and directed by my collegue Marussi for the geophysical (geoseismic) side, and by myself for the geological side (fig. 20). My expedition was composed of 8 members which worked in the Yasin, Ishkuman and Ghisar valleys, and in the Gilgit and Astor surroundings along the way to Rawalpindi (1). It was financed, as were my previous expeditions, by the Italian National Research Council.

I must remind that the geological and geophysical researches were intended to complete the study of the structural connection between the Indian and the Eurasian plates with the intervening orogeny of the Kashmir Himalayas, of the Karakorum and of Pamirs. The research was carried out using not only surface geological and geophysical surveys, but also a deep seismic sounding between the Punjab plain and northern Pamirs. This was to be done in collaboration with a Pakistan team, and a Russian team for the area north of the Karakorum.

The documentation of the scientific results of my eight expeditions to the Karakorum and Hindu Kush is illustrated in eight volumes – part of a collection that would include at least ten volumes – published between 1964 and 1980. There were another two still to be published, one of which is the present, and the other is being prepared. The content of the eight volumes published before this one, is mentioned in the Preface (pag. IX). I have said that so far nine volumes have been published, but, to these, are to be added more than a hundred reports, mainly of geological content, mostly in Italian and English and some in other languages (see bibliography at the end of this section).

11. Topographic maps surveyed by Italian expeditions in the Karakorum

The basis of most of our topographic knowledge of the Karakorum consists of the topographic maps surveyed and published over a considerable number of years by the Survey of India. Explorers of different nations, though prevalently English, published original maps of some areas. Some of these are Italian and will be mentioned here, also on account of the fact that their work was often forgotten in the geographical reports.

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(1) The members of expedition, besides myself, were: B. Bigioggero and A. Ferrario of the Institute of Mineralogy University of Milano, G. Orombelli and F. Forcella of the Institute of Geology University of Milano, R. Casnedi of the Institute of Geology University of Pavia; S.A. Jafry and M. Zaidi of the Geological Survey of Pakistan.

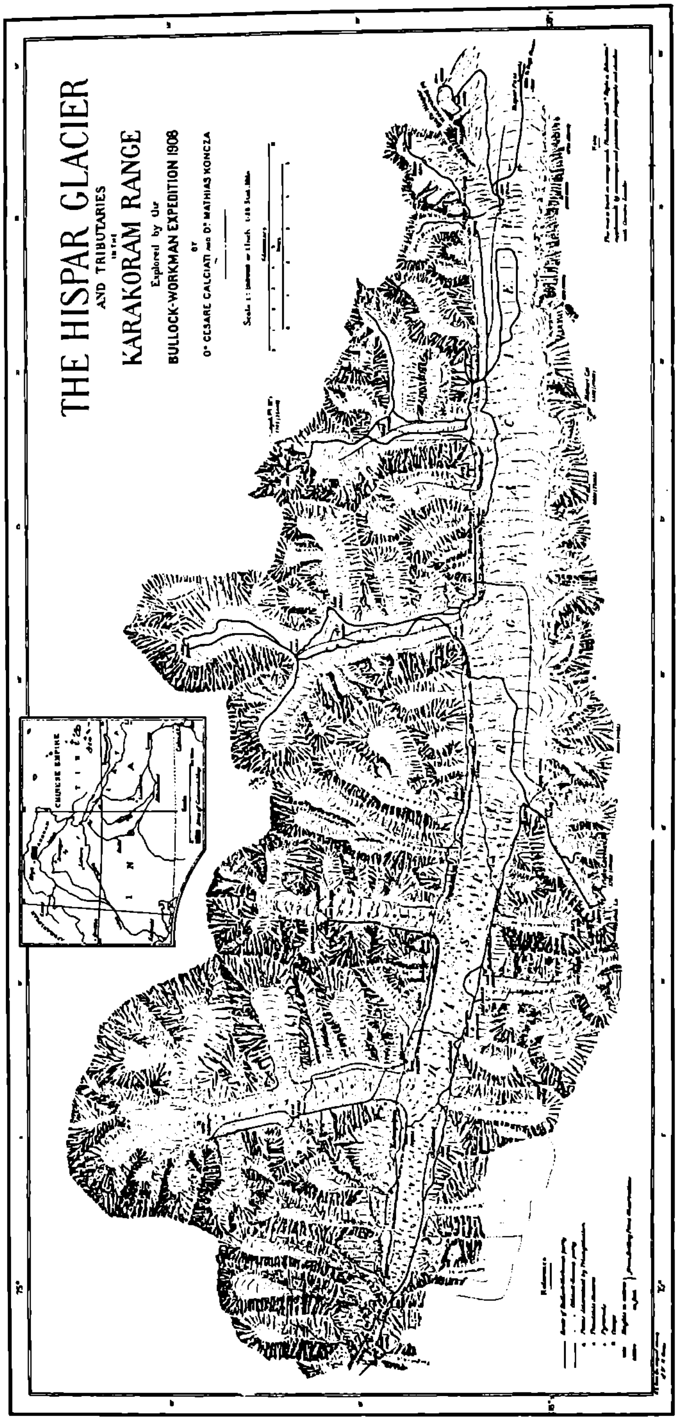

Fig. 21 - *The map of Hispar glacier surveyed by C. Calciati and M. Koncza.* (Reduced scale).

I think that the first of these is dr. Cesare Calciati, who participated as surveyor, together with dr. Mathias Koncza, in the 1908 expedition of F. Bullock and W. Hunter Workman to the Hispar glacier in the central Karakorum. The map surveyed by the two topographers is enclosed at the end of book published by the explorers in 1910 under the title «The Call of the Snowy Hispar».

The map, scale 1:100,000, was based on a triangulation carried out with a theodolite by Koncza, while Calciati worked with a «Gulier's régle à éclimètre», an instrument adopted at that time by the French Army Topographical Service.

The map was supplemented – so it states on the map – by stereoscopic and panoramic photographs and sketches with «Camera Lucida». In fig. 21 the map is reproduced in black and white (the original is drawn in two colours) on a reduced scale.

Calciati and Koncza's map was preceded by a similar map surveyed in 1989 by W. Martin Conway at the scale of 1:126,720 (1 inch = 2 miles) enclosed in an appendix to the Conway book: «Climbing and Explorations in the Karakorum - Himalayas», devoted to the «Maps and Scientific Reports's», published in 1894 (T. Fisher Unwin).

The main difference between the two maps summarized by Calciati and Koncza is as follows:

«The map (Conway's) gives a fairly good idea of the country in the immediate vicinity of this itinerary. But obviously, it was impossible for him to state cartographically the parts he had not seen. In consequence his representation of the tributaires of that immense glacier is devoid of all objective reality».

I omit unnecessary details, which are amply disclosed in the above mentioned report by the two authors.

During the 1908 exploratory trip made by Bullock and Workman, Calciati was in charge of exploring and surveying the Masherbrum, Gondokhoro and Kondus valleys. He travelled independently of the expedition leaders, but he was deeply hindered and delayed in his work by the frequent uncertainties in the orders received from his chiefs. Nevertheless he was able to carry out the exploration and survey of the Masherbrum and Gondokhro glaciers (fig. 22) and the upper Kondus valleys with the Kabery glacier (fig. 23). Later on he reached the Siachen glacier measuring the height of the Teram Kangri (7559 m) to which Tom G. Longstaff had previously attributed an excessive altitude.

On account of some commitment in Italy he was obliged to give up work on the new task offered to him by Bullock and Workman of surveying the Siachen glacier. His place was taken by C.C. Peterkin who also measured the height of Teram Kangri as 7470 m (B.W. 1917).

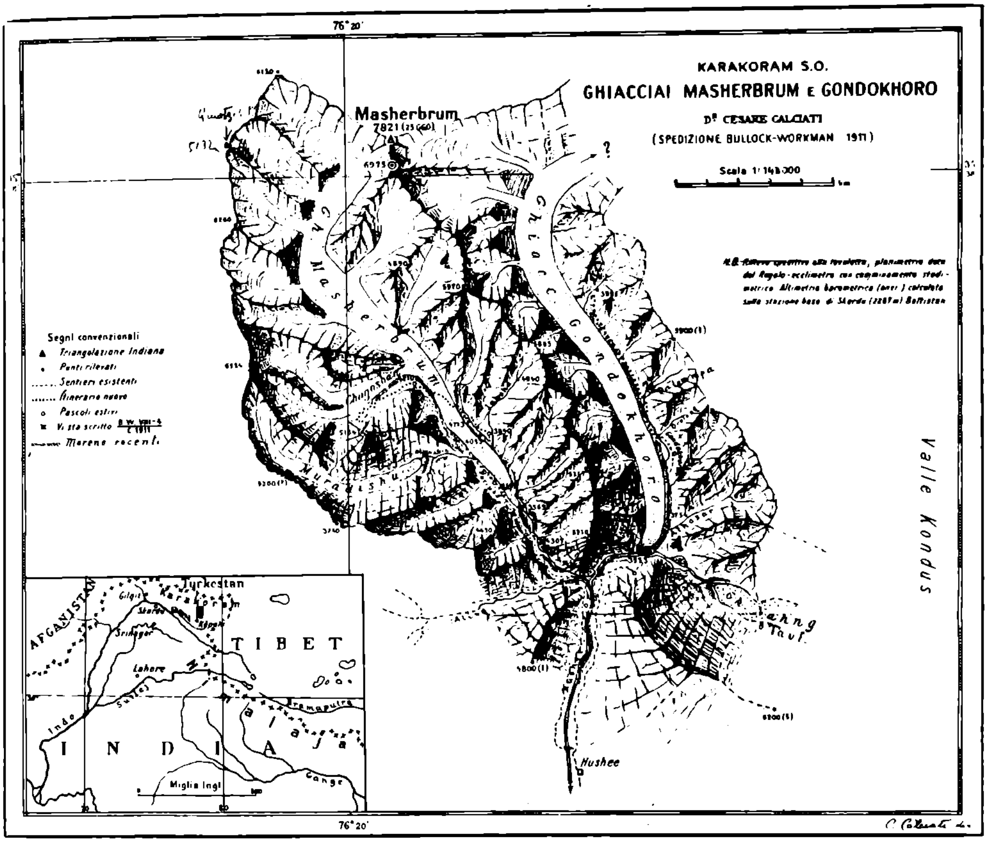

Fig. 22 - *The map of Masherbrum and Gondokhoro glaciers surveyed by C. Calciati.* (Reduced scale).

The two maps published in 1914 were surveyed using the «régle à éclimètre» for triangulation, and with barometers and two hypsometric thermometers for the altitude, with reference to the Skardu Station.

Chronologically speaking, the next map published in 1912 by Italians was a map of the Baltoro glacier, surveyed by the Duke of Abruzzi expedition of 1909 at the scale of 1:100,000 (fig. 24). It was one of the first examples of maps surveyed with the photogrammetric system and is therefore of much better quality than those published previously.

Another map was surveyed by the W. Martin Conway expedition, (scale 1:126,720) which was, in fact, a good map at the time of publication (1894). Compared with the first one it is, however, incomplete and only approximate in many places, particularly along the watershed; there are also mistakes in the orography and in the local names.

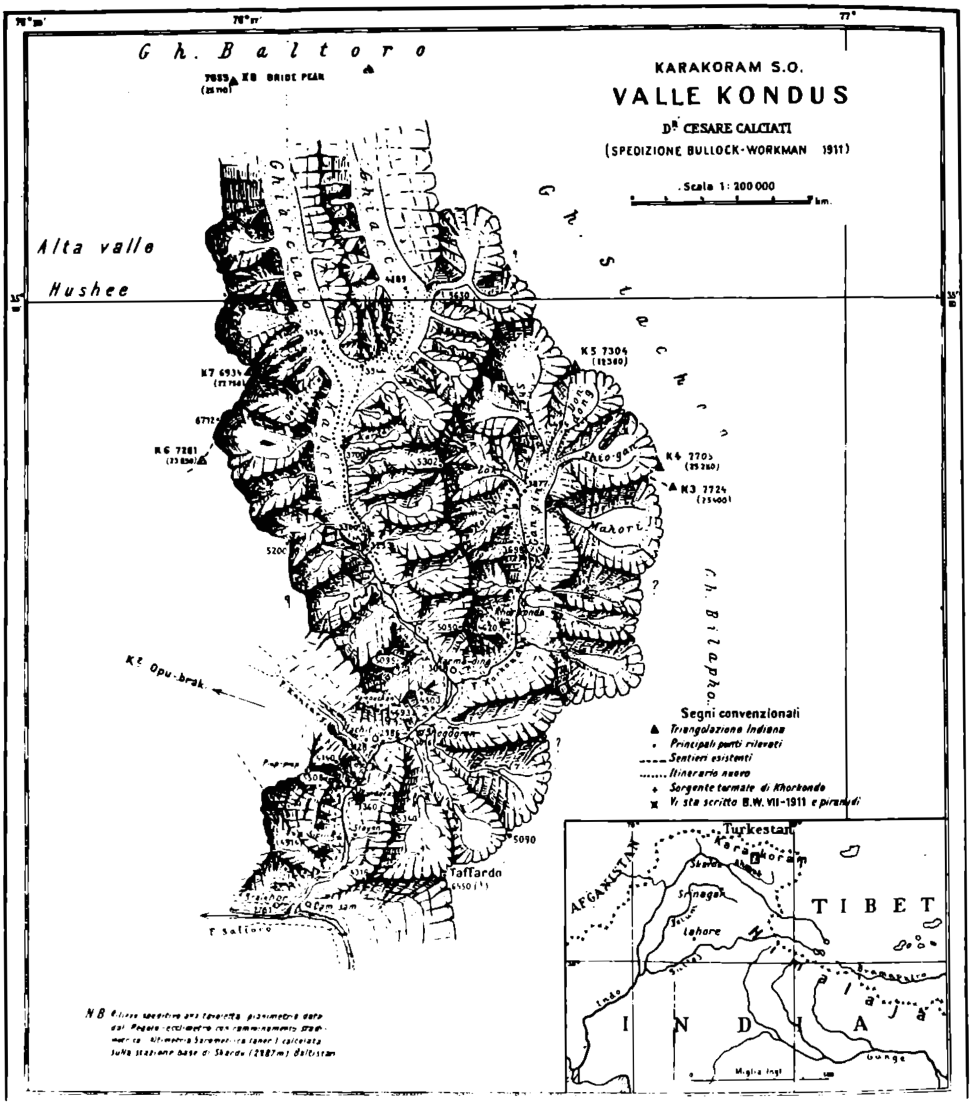

Fig. 23 - *The map of the Kondus valley surveyed by C. Calciati.* (Reduced scale).

The last topographic map published by Italians in the Karakorum area before the First World War is that of the Rimo glacier, in the eastern part of the mountain range. This map was surveyed by the geodesists A. Alessio and G. Abetti and the topographer J. Pershad from the De Filippi expedition in 1912-1913, scale 1:100,000. The area is represented in two colours outside the Rimo glacier and extends to-

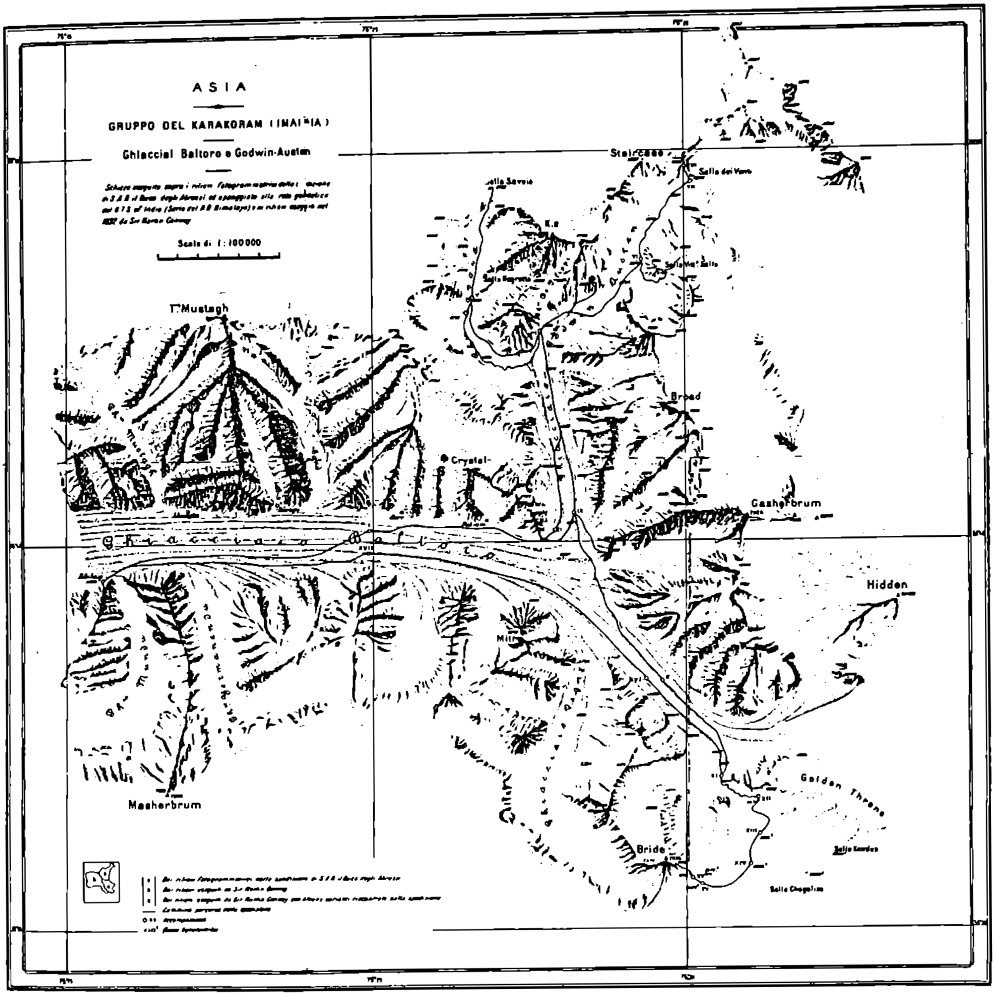

Fig. 24 - *The map of the Baltoro valley surveyed by the 1909 expedition of the Duke of Abruzzi. (Reduced scale).*

wards the east as far as the Karakorum pass and the Depsang plateau. The area outside the Karakorum is also reproduced on a separate sheet.

The area was surveyed using the photogrammetric system and this map can be considered the best map of the area. The map was printed by the Italian Military Geographic Institute in 1920 (fig. 25).

This brings us to the period between the two world wars. The only Italian expedition to venture into the Karakorum at that time was the expedition led by

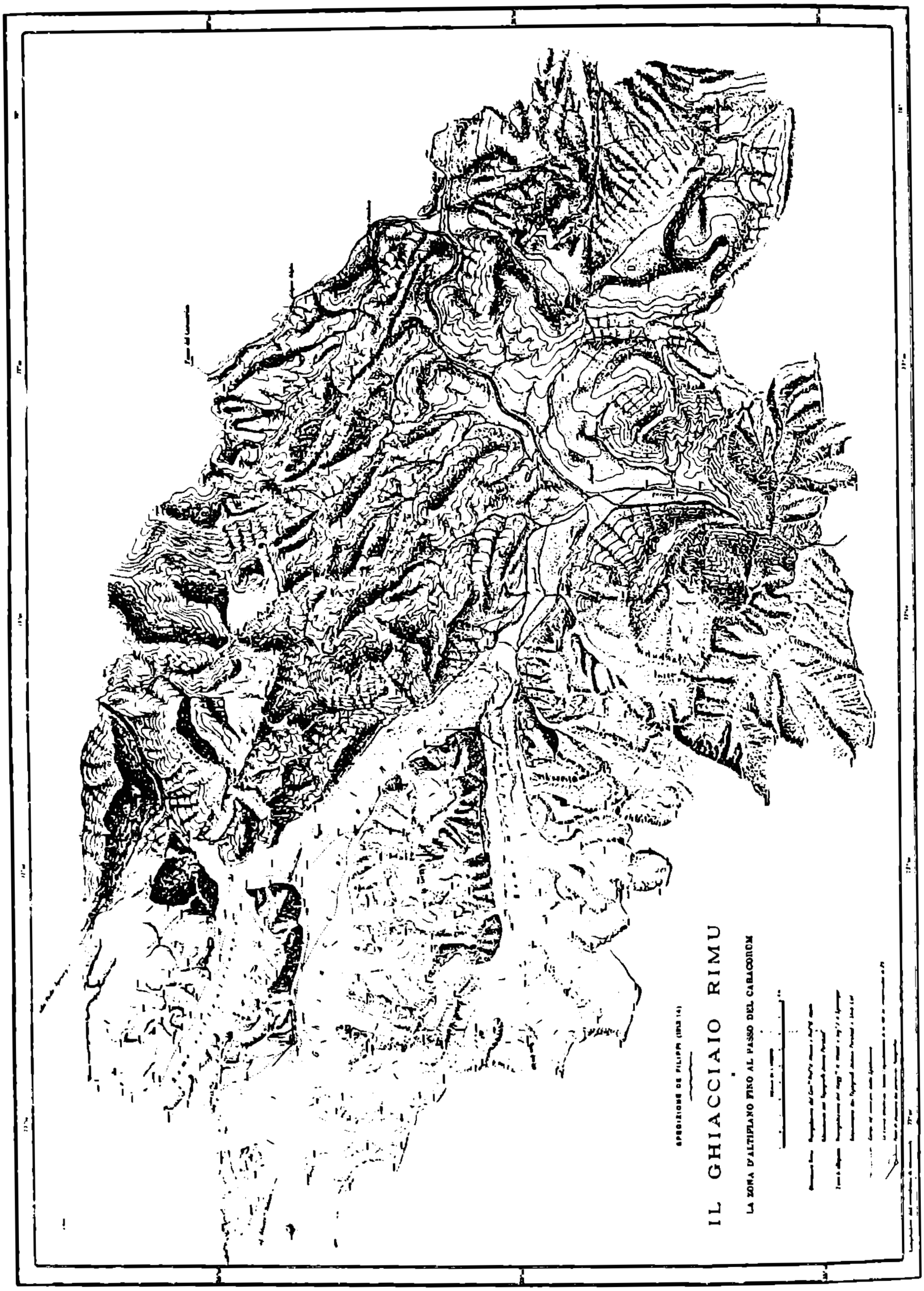

Fig. 25 - *Map of Rimo glacier surveyed by the F. De Filippi expedition 1912-1913.* (Reduced scale).

the Duke of Spoleto in the summer of 1929. The Duke himself took charge of the topographic surveys assisted by a Navy Officer, Mario Cugia, who carried out topographic surveys on the Baltoro glacier and on the south, east and west slopes of K^2 on the scale 1:75,000 by photogrammetry. The map of this area, which completes and perfects the Duke of Abruzzi's 1909 map, is included as one of 3 sheets enclosed in the official report of the expedition (1936) and it gives the major surrounding areas surveyed by myself using the Plane Table "Monticolo" and the aneroid barometer and the ebullition hypsometer for the altitudes.

My surveys, carried out on the scale 1:50,000, include the Dumordo valley and Panmah glacier on the south side of the range, and the Sarpo Laggo glacier on the north side. I extended the survey on the same scale to the central area of Shaksgam valley from the confluence with the Sarpo Laggo valley up to the Kyagar glacier, which had been reached on the upstream side by Kenneth Mason's expedition in 1926. Besides the Shaksgam valley, my survey covered the valleys of the lateral glaciers, i.e. North Gasherbrum, Urdok, Staghar and Singhiè. At that time this area, was for the most part unexplored and so these were the first topographic maps ever to be surveyed here.

The data and topographic drawings made to the scale 1:50,000 were then processed at the Italian Military Geographic Institute by Captain G. Petrini and printed in three colours, scale 1:75,000 (figg. 25, 26, 27, 28). The map of K^2 (fig. 29) was surveyed and printed at the scale 1:25,000.

The for sheets which form the topographic maps include a couple of notes which I believe should be given here for purposes of clarity.

a) Baltoro Basin. From the photogrammetric measurements (Lance-Corporal Wild) by the Duke of Spoleto, completed with topographic data by the Duke of Abruzzi (1909), topographic sketches and (see b) topographic views.

b) From Desio's surveys completed with photogrammetric data from Mason's expedition (1926) and stereoscopic views.

The above-mentioned maps appeared together with expedition's official report, in 1936. Special chapters in the volume are devoted to astronomic indications of position, measurements of the earth's magnetism and methods used in compiling the topographic maps (G. Petrini).

At the end of 1928 the complete official report appeared of the 1926 Mason expedition together with a topographic map, scale 1:253.440, on which the Shaksgam valley appears, mapped from a distance from a hill on the east side of the Kyagar glacier valley.

When the Duke of Spoleto's expedition set out in early spring 1929, Mason's

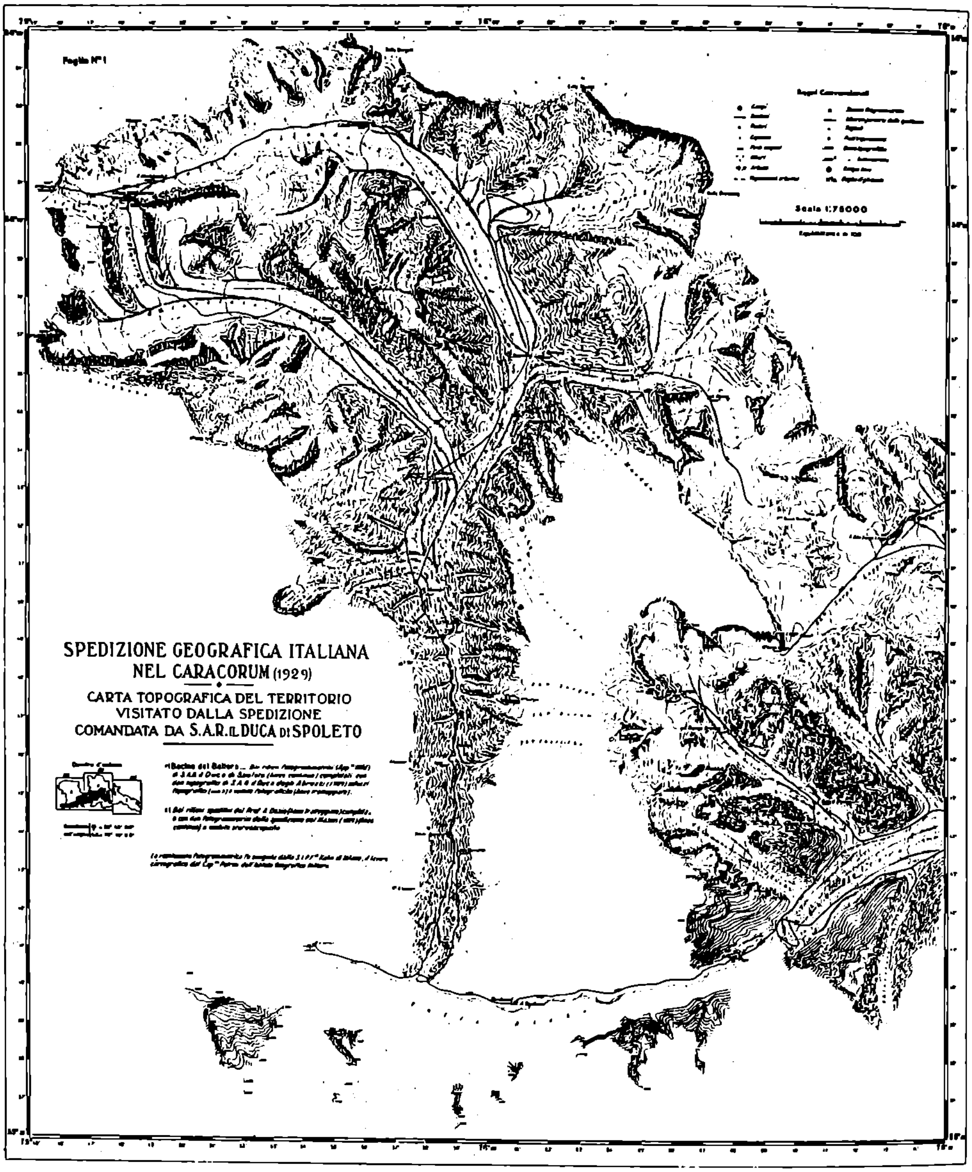

Fig. 26 - *Map of the Panmah-Baltoro area surveyed by the expedition of the Duke of Spoleto, 1929. Sheet 1.* (Reduced scale).

Fig. 27 - *Map of the Baltoro-Shaksgam area surveyed by the expedition of the Duke of Spoleto, 1929. Sheet 2.* (Reduced scale).

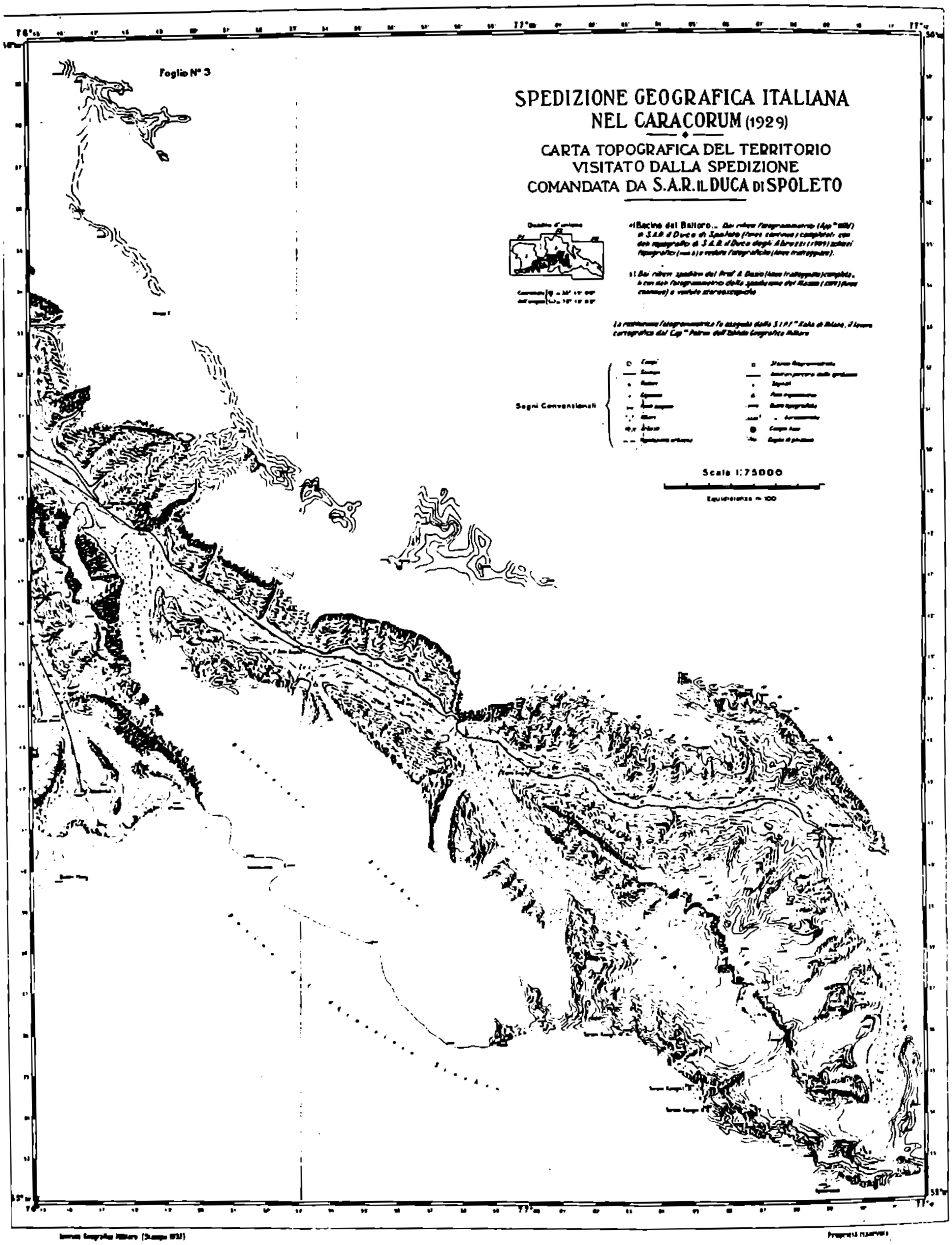

Fig. 28 - *Map of the Eastern Shaksgam valley surveyed by the expedition of the Duke of Spoleto, 1929. Sheet 3.* (Reduced scale).

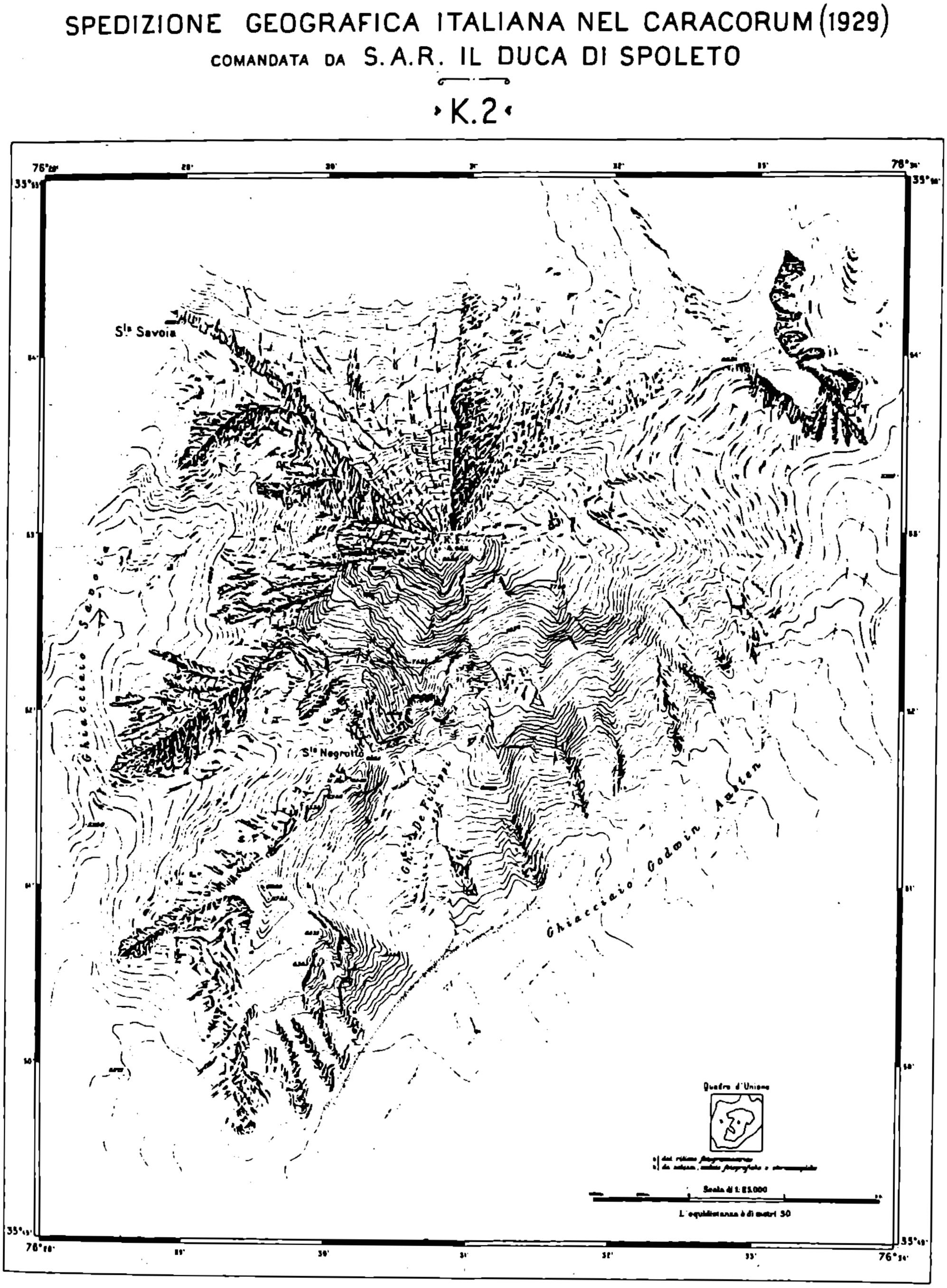

Fig. 29 - *Map of K² surveyed by the expedition of the Duke of Spoleto, 1929.* (Reduced scale).

pubblication had not yet reached Italy, so the expedition had no knowledge of the monograph and topografic maps mentioned above. However, the topographic map scale 1:75,000 of the Shaksgam valley is still today the most detailled map available despite the fact that the topography is not perfect. It is worth noting that the majority of the place-names, and in particular those referring to the large glaciers located upstream from Urdok (Staghar and Singhiè) were introduced by me together with others which do not appear on this map, but were introduced in the topographic base of the geological map of the central Shaksgam valley included in the geological monograph which was not published until 1980.

May I add at this point, to conclude the account, that the explorations made by the Duke of Spoleto's 1929 expedition and the cartographic results achieved were subsequently neglected or totally ignored by virtually all the geographic reports published on the area.

In 1930 there was an expedition led by G. Dainelli to the Siachen glacier which included two topographers from the Italian Military Geographic Institute captains Latini and Cecioni. They carried out photogrammetric survey of the whole glacier, but the leader of the expedition took possesion of the negatives and they were never used for cartography purposes, except for the area of "Italia Pass", a pass between the Teram Sher and the Rimo glaciers at the scale 1:100,000 (fig. 30).

So we come to the Second World War which put an end to all ideas of organizing expeditions to the Karakorum.

It wasn't until 1953 that climbing activities in the Karakorum started again with Charles Houston's expedition to K^2 though no scientific programme was involved here. The next year came the expedition organized and led by myself and one of the assignments the expedition was to carry out in the area of the Baltoro glacier was to take topografic surveys. The task was assigned to the Italian Military Geographic Institute who appointed Captain Francesco Lombardi to the geodetic and topographic work planned by the expedition, assisted by the topographer Bashad Jan of the Survey of Pakistan.

A special report from Lombardi illustrates the operations carried out by the topographic team and here I need only mention in brief the tasks assigned to the topographers. The work involved photogrammetric surveys in the Stak area with special reference to the valleys of the Kuthia and Gorophа glaciers, on a scale of 1:50,000. Sketch maps of the lower Stak valley and the Askore valley (scale 1:150,000) and a photogrammetric survey of the Turmik valley (scale 1:100,000), a photogrammetric survey of K^2 (scale 1:12,500) and of various tributaries of the Baltoro not surveyed in 1929 (scale 1:75,000). Work also included measurement of the flow rate of the glaciers by photogrammetric method and the establishment of astro-

Fig. 30 - *Map of "Italia Pass" by the G. Dainelli expedition 1930.* (Reduced scale).

nomic stations at Skardu, at two places in Stak valley, at Sasli (Haramosh) and at Gilgit with a view to facilitating the preparation of geodetic and topographic surveys.

If the programme was not carried out in full, principally because of adverse weather conditions, the results of the geodetic and topographic operations were nevertheless notable and the topographic maps enclosed in this book amply demonstrate this.

Here is the list:

1) Map of the *Kuthia and Gorophа valleys* and to the east the *Lecho valley* as far as the Stak-la on a scale of 1:50,000.

2) Map of the *Stak and Turmik valleys,* scale 1:100,000.

3) Map of the *Baltoro Glacier Valley,* scale 1:100,000.

4) Map of K^2, scale 1:12,500.

I can add that even today there are no more precise and detailed topographic maps available than those mentioned above.

To complete the picture with regard to the cartography produced by my different expeditions, I should mention the topographic bases of the different geological maps and the geological maps themselves which are all original. They are as follows:

1) Geological Tentative map of the *Western Karakorum,* scale 1:500,000 by Ardito Desio (1964);

2) Geological Map of the *Baltoro basin* by Ardito Desio with the collaboration of Bruno Zanettin, scale 1:100,000 (1967);

3) Geological Map of K^2, scale 1:25,000 (1968) by Ardito Desio;

4) Geological Map of *Central Badakhshan (Afghanistan)* by Ardito Desio, Ercole Martina and Giorgio Pasquaré, scale 1:150,000 (1975);

5) Tentative Geological Map of the *Shaksgam Valley,* by Ardito Desio, scale 1:250,000 (1980).

12. Geographic and Naturalistic Literature of Italian expeditions to the Karakorum and Eastern Hindu Kush (1)

ABETTI G., ALESSIO A. (1929) - *Geofisica, Gravità e Magnetismo.* «Relaz. Scient. Spedizione De Filippi, etc.», I, *2,* pp. 1-222, Zanichelli, Bologna.

ABETTI, ALESSIO, VENTURI GINORI & WOOD (1929) - *Astronomia geodetica, geodesia e topografia.* «Relaz. Scient. Spedizione De Filippi, etc.», I, *1,* pp. 1-418, Zanichelli, Bologna.

ALESSANDRI, VENTURI GINORI (1931) - *Meteorologia, Geofisica, Aerologia e Pireliometria.* «Relaz. Scient. Spedizione De Filippi, etc.», I, *3,* pp. 1-570, Zanichelli, Bologna.

ALOISI P. (1933) - *Le rocce.* «Relaz. Scient. Spedizione De Filippi, etc.», II, *7,* Zanichelli, Bologna.

ARCANGELI A. (1934) - *Isopodi terrestri raccolti nel Karakorum dalla spedizione di S.A.R. il Duca di Spoleto.* «Ann. Reg. Ist. Sup. Agrario di Milano». *1,* pp. 1-23, Parma.

* BALDI P. (1976) - *Magnetism of Karakorum and Surrounding Regions.* «Acc. Naz. Lincei: Geotectonics of the Kashmir Himalaya-Karakorum-Hindu Kush-Pamir Orogenic Belts, 1974, pp. 139-142, Roma.

BALIANI A. (1934) - *Materiali zoologici raccolti dalla spedizione italiana nel Karakoram (1929 VII). Coleoptera, Carabidae: Amara,* «Atti Museo Civico. St. Nat. Trieste», *12,* pp. 101-106, Trieste.

* BARNARD P.D.W. (1967) - *Two new plants from the Upper Triassic of North East Afghanistan.* «Riv. Ital. Paleont. e Stratigr.», *73,* pp. 723-728, Milano.

* BARNARD P.D.W. (1970) - *The Upper Triassic Plants from the Kalawch River, Badakhshan (North-East Afghanistan).* «Desio's Exped. to the Karakorum (K^2) and Hindu Kush. Scient. Reports», IV, *2,* pp. 3-22, Brill, Leiden.

BARTOLE R. (1978) - *Structural lineaments of the Central Asia Orogenic Syntaxis from Randsat imageries.* "Rend. Accad. Naz. Lincei", ser. VIII, *64,* pp. 485-489, Roma.

BEAUX (DE) O. (1935) - *Spedizione Italiana al Karakorum comandata da S.A.R. il Duca di Spoleto (1929). Mammiferi.* «Atti Soc. Ligustica Sc. Lett. Genova», *14,* pp. 61-84, Genova.

* BERIZZI QUARTO DI PALO A. (1970) - *Upper Cretaceous Molluscs and Brachiopods from Badakhshan.* «Desio's Italian Expeditions to the Karakorum (K^2) and Hindu Kush, Scient. Reports», IV, *2,* pp. 77-118, Brill, Leiden.

* BERIZZI QUARTO DI PALO A. (1970) - *Paleogene Pelecypods from Kataghan and Badakhshan.* «Desio's Exped. to the Karakorum (K^2) and Hindu Kush. Scient. Reports», IV, *2,* pp. 161-240, Brill, Leiden.

BERNHAUER M. (1934) - *Materiali zoologici raccolti dalla spedizione italiana al Karakorum (1929 VII). Beschreibung einiger neuen Staphiliniden-Arten.* «Atti Museo Civ. St. Nat. Trieste», *12,* pp. 86-88, Trieste.

BIASUTTI R. (1916) - *Balti e Ladachi.* «Riv. di Antropol.», *20,* Mem. 4, pp. 3-9, Roma.

BIASUTTI E. (1933) - *Osservazioni antropologiche eseguite da G. Dainelli su Cashmiri, Ladachi e Nubresi (1930).* «Relaz. Spedizione De Filippi etc.», II, *11,* pp. 191-251, Zanichelli, Bologna.

BIASUTTI R. (1936) - *I caratteri antropologici dei Balti.* Appendix to: «La Spedizione Geografica Italiana al Karakorum, 1929», pp. XLIV-XLVI. Arti Grafiche Bertarelli, Milano.

(1) The works concerning Desio's expeditions are marked by *. In the list are also included the Italian collaborators of foreing expeditions. This bibliographic review ends at 1989 included.

Biasutti R. (1964) – *I tipi somatici nelle popolazioni dell'Alto Indo.* «Relaz. Scient. Spediz. Ital. De Filippi etc.». II, *9*, pp. 181-299, Bologna.

Calciati C. (1910) – *Les fronts des glaciers de Yengutsa et d'Hispar,* «La Géographie», *22*, pp. 241-246, Paris.

Calciati C. (1914) – *Esplorazione delle valli Kondus e Hushee nel Caracorum sud-orientale,* «Boll. Soc. Geogr. Ital.», *51* (9), pp. 995-1014: (10), pp. 1076-1093, Roma.

Calciati C. (1923) – *Il più grande ghiacciaio della terra. Il Siacen nel Caracorum.* «Emporium», *58*, pp. 105-115, Milano.

Calciati C. (1928) – *Il Karakorum secondo le ultime esplorazioni con speciale riguardo al contributo degli italiani.* Istituto Geografico Militare, Firenze.

Calciati C. (1928-1929) – *Nel Caracorum. L'assalto alle più alte vette del mondo.* «Le Vie d'Italia», 1928: pp. 976-987; 1929 pp. 57-64, Milano.

Calciati C. (1930) – *Al Caracorum. Diario di due esplorazioni.* Bemporad, Firenze.

Calciati C., Koncza M. (1910) – *The basin of the Hispar Glacier,* In: «Workman W. H., The Call of the Snowy Hispar», Appendix I, pp. 245-282. Constable London.

Calciati C., Koncza M. (1910) – *L'expedition Bullok-Workman 1908 dans l'Himalaya,* «Bull. Soc. Fribourg. Sc. Nat.,», *17*, Fribourg.

* Callegari E., Zanettin B. (1960) – *Chimismo di rocce vulcaniche e plutaniche del Karakorum centro-meridionale,* «Mem. Ist. Geol. Min. Univ. Padova», *21*, 38 pp., Padova.

Caporali A., Marzari F., Palmieri F. (1990) – *Attività geodetica in Karakorum nell'ambito del progetto Ev-K²- CNR 1988.* "Boll. Geodesia e Sc. Affini", *49*, pp. 237-260, Trieste.

Caporiacco (di) L. (1933) – *Pesci raccolti durante la spedizione italiana al Karakoram (1929),* «Monitore Zool. Ital.», *44*, pp. 339-344, Firenze.

Caporiacco (di) L. (1934) – *Aracnidi dell'Himalaya e del Karakorum raccolti dalla Missione Italiana al Karakorum (1929),* «Mem. Soc. Entomol. Ital.», *13*, pp. 113-263, Genova.

Caporiacco (di) L. (1936) – *Notizie preliminari sui risultati zoologici della spedizione.* Appendix to: «La spedizione Geografica Italiana al Karakorum 1929», pp. XLVII-LI. Arti Grafiche Bertarelli, Milano.

Casati P., Spadea P. etc. (1980) – *Studi geologici, idrologici e floristico-vegetazionali nel bacino del Ghiacciaio Biafo e nella valle del F. Braldu (Karakorum occid., Pakistan).* "Natura", *71*, pp. 121-164, Milano.

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II. METEOROLOGICAL OBSERVATIONS OF ARDITO DESIO'S 1954 EXPEDITION (1)

1. Introduction

1.1 The aim of this work.

The 1954 Desio's Italian expedition to the Karakorum had two clear aims in mind: it was both a scientific and a mountaineering expedition. Its purpose was to gather information, data and material for a better geographical knowledge of the western Karakorum, and at the same time to climb the second highest peak in the world, the hitherto unviolated K^2.

The meteorological observations contained in the original journal of Prof. Desio were part of the geophysical observations included in the plan of scientific research.

The aim of this work is to subject the original data to critical examination, to enlarge upon them and to analyse them so that they may be included in a full and systematic study of the static and dynamic meteoric conditions of the base camp area. This analysis of meteorological conditions applies to the period of the expedition's stay at the base camp, from May 26th to August 5th inclusive.

One of the first problem was to transform the altimetric data into values of atmospheric pressure, taking into account the meteoric conditions at the time which are very different from those of the altimeter. It was also necessary to apply specific procedures for the analysis of the data regarding temperature, relative and absolute humidity, the speed and direction of both cloud and wind, precipitation, ablation and atmospheric state, because, at that altitude, the usual procedures don't give satisfactory results.

The trends of these meteoric factors, presented in the form of charts and

(1) By Francesca Petrucco.

diagrams, have been compared with each other in order to give a more general picture of the problem. Significant details and results have been drawn from such comparisons and analyses. The temperature rises steadily from mid-June onwards, while in the same period the pressure rises and falls at period of 5-6 days.

The ever present wind keeps at an average speed of 10 kmh in the base camp area, and are predominantly south-south-westerly while cloud direction is mainly south-west.

As far as regards the weather, it will be seen that totally clear days are few in number. Usually, after snow and cold wind during the day-time, an improvement was noted in the evening and the clouds parted allowing the stars to be seen.

Other strictly scientific results spring from the relations pointed out between the various meteoric factors which were examined.

1.2 Previous knowledge

The information taken during the De Filippi expedition (1913-1914) by the scholars Alessandri and Venturi Ginori concern Skardu (Baltistan), Leh (Ladak) and the Depsang plateau.

The expedition stayed at Skardu – 35°17′50″ N; 75°38′32″ E; 2233 m – in the months of November, December and January. Temperatures were noted in December of -12°C, with minimums of -17°C, the lowest temperatures being in January (-20°C), then the temperature began to go up. The monthly average temperature were: November +1°.32, December -2°.89, January -3°.36. The sky was generally obscured by a light white haze, and the air was clear while there was snow in the valleys. The nights were clear and in general there was little wind.

The observations at Leh (34°10′ N, 77°35′ E, 3,500 m) refer to the months of April, May and June and then, although fewer observations were made, to the months of July and August. Only sleet fell in the first months, the sky was generally overcast and «the atmosphere was turbid». At Leh the climate is normally dry and barren, the average annual precipitation not being above 100 mm, while dew and frost were unknown. The heat in summer is intense. The average annual temperature is +14°.1; in January it is -8°.8 and in July it is +16°.2. During the day it varies between 16° and -22°, and there is little difference in the other seasons. The biggest annual change in temperature is 35°.2, with a maximum amplitude of 43°.1.

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(1) Alessandri C., Venturi-Ginori N. (1931) - *Meteorologia, Aerologia e Pirheliometria.* «Relazioni Scientifiche della Spedizione Italiana De Filippi», serie I, vol. 3°, Geodesia e Geofisica, Zanichelli, Bologna.

The sky during the period of the expedition's stay was almost always overcast. It was windy during the day, but calm at night, and there were squalls during the afternoon.

The Depsang plateau is situated on the border between the glacial zone of the Karakorum, which is essentially alpine and morphologically young, and the dry zone of the closed plateau of Tibet, which is morphologically old (Lingzi-tang and Akhsae Cin). The extreme eastern border essentially belongs to the latter-mentioned and forms a part of it. (Alessandri & Venturi Ginori, 1931).

Situated north of the Karakorum, the plateau is completely sheltered from the wet southern winds, the only ones which can bring precipitation to that region. The Depsang plateau, which is oval in shape, borders on the South with the Murgo valley, on the West with the Shayok valley which separates it from the mountain chain of the Karakorum pass, and to the East it joins up with the Tibetan plateau; it has a very high altitude (5,300-5,500 m), a surface area of about 1,000 km^2, and is the highest plain in the world.

The observations made by Alessandri and Ginori refer to the months of June, July and August. In June the number of calm days is equal to the number of days of bad weather, while in July-August the latter are much more numerous. The weather is extremely variable: there is good weather in the morning followed by a deterioration of conditions in the afternoon, and then calm of sunset.

The sun is scorching with temperatures, however, rarely above +5°C. The nights are very cold, and temperatures of -10°C are often recorded.

Clear days are very rare, and when so the sky is covered with a whitish haze because of the high vapours and perhaps also because of the dust on the dry plateaus which is gathered by the wind and lifted up to a great height. Among cloud types stratocumulus and cirrus are the most common; precipitations are frequent but not plentiful, consisting of showers, sleet and drizzle. As at Leh there is a characteristic absence of electric storms (thunder and lightning) unlike those recorded by Dainelli on the western Tibetan Plateau.

One may also note here a windy period during the day: during the night it is completely calm. In the morning there is a light east wind which then turns west, growing in strength until it becomes violent in the afternoon, and finally calms down at sunset.

As will be seen, the above mentioned meteoric conditions present analogies with those noted at the base camp of Desio's expedition.

From the observations made by Alessandri and Ginori at Leh we have the following average monthly day-time temperatures:

April 6°.06; May 8°.96; June 13°.87; July 16°.89; August 15°.93 while for the average monthly pressures we have: April 664.8 mb; May 664.7 mb; June 664.8 mb; July 662.0 mb; August 661.5 mb.

On the Depsang plateau the average pressure for July was 532.2 mb, the values in the three decades being: 532.0 mb (1) - 533.0 mb (II) - 531.6 (III).

In June and July the monthly average temperatures during the day were -0°.31 and +3°.15 while in the ten day periods they were: in June -4°.25 (I), -0°.91 (II), +4°.22 (III) in July +1°.26 (I), +5°.09 (II), +3°.10 (III).

1.3 Summary of the Karakorum climatic conditions.

The climate of the Karakorum, given its inland position and the shelter offered by the Kashmir Himalaya, is continental and, on the whole, severe. This is a result of the considerable altitude of the region which is not only due to the fact that its peaks are high, but also to the great height of its valleys and mountain passes, many of which are above 3,500 m.

Precipitation in the valleys is scanty, which receive more on the ridges, and where it always falls in the form of snow. The snow limit is, on average, very high (about 5,000 m) and gets higher as one proceeds from the great valleys of the Indus and the Shayok; it also rises to the south-east, towards the Tibetan plateau.

While the climate of neighbouring Pakistan is dry (average annual precipitation is from 127 mm in the south-west to more than 600 mm in the north-east) and hot (average annual summer temperature is 33°-50°C, winter 5°C) it isn't like that of the Karakorum because of fundamental factors such as the considerable height of the whole range and the fact that not hot air masses from the south have difficulty in penetrating to the region because they are obstructed by the Kashmir Himalaya mountain range. The maximum rainfall is, however, in summer; the high continental temperatures contribute towards keeping the snow limit high.

Changes in temperature during the day and the year are as a result very considerable. In summer, changes in temperature ranging from -10°C to +25°C can be recorded in the same day. In winter the cold is intense with minimum temperature as low as -40°C. Average temperatures are round about -15°C.

The climate improves the nearer one gets to the Indus and Tsangpo valleys. Sudden violent storms are frequent with intense cold, snow and hail.

By reporting the monthly values and the average annual temperature, pressure and precipitation at various points throughout the Karakorum, we can gain a clear picture of the continental nature of the climate which prevails in that region.

Tab. 1

COORDINATES AND ALTITUDE

Locality	Latitude N	Longitude E	Alt. m
LAHORE	31° 34'	74° 21'	214
JAIPUR	26° 55'	75° 52'	436
ALLAHABAD	25° 28'	81° 54'	94
LEH	34° 10'	77° 42'	3500

PRESSURE (mb)

Locality	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	ANNUAL AVERAGE
LAHORE	857.4	855.6	852.3	851.5	843.8	839.4	838.8	841.2	845.8	851.6	856.1	858.0	848.9
JAIPUR	832.4	830.7	828.2	824.9	821.4	817.4	816.5	818.6	822.9	828.2	831.6	833.1	825.5
ALLAHABAD	871.3	868.0	865.7	861.4	857.7	853.5	853.2	855.2	859.4	865.3	869.7	871.9	862.8
LEH	663.0	661.8	663.7	664.9	665.0	663.9	662.6	663.4	665.7	667.3	667.1	665.3	664.5

TEMPERATURE (°C)

Locality	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	ANNUAL AVERAGE
LAHORE	12.8	14.7	20.5	26.7	31.8	34.3	32.6	31.4	29.9	25.3	18.8	13.7	24.4
JAIPUR	16.3	18.2	23.9	24.9	33.2	33.6	30.1	28.7	28.7	26.5	21.3	17.2	25.6
ALLAHABAD	16.3	18.7	24.9	30.7	33.9	33.7	30.2	29.1	29.1	26.3	20.8	16.5	25.8
LEH	-6.9	-5.9	0.3	6.1	10.2	14.5	17.6	17.3	13.3	7.0	1.2	-4.2	6.1

PRECIPITATION (mm)

Locality	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	ANNUAL AVERAGE
LAHORE	23	26	24	14	18	43	155	128	57	10	3	11	512
JAIPUR	10	7	9	5	15	66	210	185	81	8	3	8	607
ALLAHABAD	19	14	10	4	8	119	305	279	161	59	7	5	990
LEH	9	8	7	6	6	5	12	13	7	4	1	4	83

2. Meteorological investigations

2.1 The meteorological observatory

The meteorological observatory consisted of a ply-wood box, with a layer of cadorite 4 cm thick on the inside which separated it from the ground on which it was placed, that is an icy ridge about two metres off the ground. This ridge was part of a series of reliefs formed by the Godwin Austen glacier which stretched into the valley below it.

The cadorite was widely used by the expedition for the transport and maintenance of all the most easily perishable materials such as special foods, cine-photographic materials etc. In fact it ensures for quite a long time a difference of 20° between the contents and the environment. The dimensions of the box (40x40x80 cm) were those a normal container which the porters had brought up with the expedition.

The instruments used were the usual maximum and minimum thermometers, and a thermometer at 1/10 degree. The only psychrometer broke after the first observations, while it was only possible to read the *altitudes* on the Thommen barometer. *Wind velocity* was measured with a portable windmill.

Observations were made daily at 8.00, 15.00 and 20.00 hours.

The *temperature* reported in the tables under the heading «sh» is that measured in the shade. It was only possible to have maximum and minimum temperatures for a few days because the maximum and minimum thermometer broke on June 3, which meant that normal thermometers had to be used. The measurements, however, are always in °C.

- As will be said further on, *pressure* in millibars (mb) was calculated on the bases of the altitudes found in the diary.
- *Snow precipitations* are under consideration, measured in centimetres (cm), but it is always necessary to bear in mind the continual ablation, owing to the notable change in temperature and the continual wind.
- *Cloud-cover* was measured on a scale of 1-10.0 signifies completely clear sky: 1 that a tenth part of the sky is covered by clouds and the rest is clear etc.: 10 signifies that the sky is completely overcast.
- *Atmospheric state* indicates if there was fog (f), rain (r), snow (sn), cloud (cl), or if the atmosphere was clear (c).
- *Cloud type* and direction are also noted:
  cirrus (cr) = fine white clouds in the form of feathers and plumes, and very high;
  cumulus (cu) = low clouds, shaped like big round flakes;

stratus (s) = clouds lying horizontally in the atmosphere.
Compound forms: strato-cumulus (s cu), cirro-cumulus (cr cu), cirro-stratus (cr s).

By direction is meant the direction the clouds are coming from, observed clouds vertically, and referred to the cardinal points.

- The measurements of *wind speed* (if only with a portable wind-mill) was according to the following scale: o (-) calm; I wind hardly noticeable and which makes some suspended light objects move; 2 wind a bit stronger, which moves the sides of the tents and whistles faintly; 3 very strong and stormy wind which can move heavier objects; 4 hurricane. The *direction* always refers to the direction the wind is coming from, with reference to the cardinal points.
- In those few cases in which the *relative humidity* has been obtained, it is shown in %, while water vapour pressure is in mb.

2.2 The data collected by Desio's expedition.

The original data collected by Desio's expedition are reported on the following pages. Moreover some values, marked with a dot, are not original, but have been obtained by logical extrapolation and put in the table for the sake of continuity.

Abbreviations and symbols of the tables

n	night
m	morning
aft	afternoon
d.t.	day-time
c	clear
cm	calm
r	rain
dz	drizzle
f	fog
sl	sleet
sn	snow, snowing
cl	cloud
wd	wind
temp	temperature
cr	cirrus
cu	cumulus
s	stratus
v.p.	water vapour pressure
R.H.	relative humidity
M/m	maximum/minimum
d/w	dry bulb/wet bulb
sh	shade
D.A./F.C.	the surmane and name of the person who made the observations: Desio Ardito, Floreanini Cirillo
CONF.	Confluence
GLAC.	Glacier
YOUNHUSB.	Younghusband
BROAD P.	Broad Peak (Falchan Kangri)

Tab. 2 ORIGINAL METEOROLOGICAL DATA TAKEN DURING THE EXPEDITION

LOCALITY	ALT.	V Month		PRESS.	TEMPERATURE °C			RH	PREC.	CLOUDS			WIND		ATMOS. STATE	GENERAL OBSERVATIONS
	m	d.	time	mb	sh	M/m	d/w	v. p.	cm	type	dir.	0-10	speed	dir.		
SHIGAR	2308	3	5.30	739.0	10.5					n s	W	10	-	-	nh	*D.A.* n. dz
DASSO	2350	4	6.30	731.0	11.5					s cu	SE	10	-	-	nu	
CHAKPO	2786	4	13.15	714.0	13.0					cu	SW	10	2	SW	nu	m r, then c
»	»	4	20.00	714.0	10.5					-	-	0	-	-	sr	
»	»	5	5.45	714.8	8.0					s cu	SW	7	-	-		
CHUTRUN		5	13.00	675.0	17.0					s	SE	10	1	NW		38°C Thermal sulfur spring
ASKOLE	3032	6	8.00	672.0	8.0	/1.0 10.0/				cu	ENE	5	1	W		*F.C.* n.r
»	»	6	15.00	671.0	10.0	/1.0				s		7	2	W		
»	»	7	7.00	673.0	4.0	28.0/ /4.0				s	SW	9	1	NW		
CONFL. DUMORDO	3200	7	17.00	670.0	8.0					n cu	SW	8	1	W		changeable weather
»	»	8	6.00	675.0	5.0	/0.0				s cu	N	7	1	W		n dz sn below 4.000 m
PAJU	3450	8	18.00	651.0	11.0					cu	SE	3	1	SW		max. temp. during march
»	»	9	6.30	651.0	6.0					s cu	WNW	8	1	ENE		
LILIGO	3850	9	17.00	620.0	2.0					s	-	10	-	-	nv	
»	»	10	6.00	618.5	0.0	/-2.0				s		10	-	-		
URDUKAS	4057	10	17.30	597.5	2.0	13.0/ /-7.5			5	s	W	10	1	W	nv	light sn from 07.00 to 13.00 hours
»	»	11	7.00	598.0	-1.0					s	-	10	-	-	nv	
»	»	11	18.00	597.0	3.0	/-6.0 16.0/				n	WSW	10	1	SE		
»	»	12	8.00	597.0	3.0	/-6.5				s	-	10	-	-	nv	
»	»	12	19.00	610.0	-1.0	17.0/				cu	SW	5	-	-		
»	»	13	8.00	610.0	-1.0					s cu	S	6	1	W		
»	»	13	18.00	620.0	11.0					cu	SSE	3	-	-		
»	»	14	8.00	625.0	-1.0					-	-	0	1	W	sr	
»	»	14	19.00	630.0	2.0					-	-	0	1	W	sr	
»	»	15	8.00	625.5	1.0					-	-	0	1	N	sr	
»	»	15	19.00	615.5	0.0					cu	SSE	1	-	-		
»	»	16	8.00	630.0	1.0					-	-	0	1	W	sr	
»	»	16	18.00	635.0	6.0					cu	S	1	1	W		
»	»	17	5.00	615.5	-3.0					s cu	SE	1	1	NW		

Tab. 2 continued (1)

LOCALITY	ALT.	V Month		PRESS.	TEMPERATURE °C			RH	PREC.	CLOUDS			WIND		ATMOS. STATE	GENERAL OBSERVATIONS
	m	d.	time	mb	sh	M/m	d/w	v. p.	cm	type	dir.	0-10	speed	dir.		
BIANGE GL.	4230	17	19.00	585.0	1.0				4	s	-	10	-	-	nv	In from 15.30 hours
" "	"	18	8.00	585.5	0.0					s	-	10	-	-	nv	little snow
YOUNGHUSB. GL.	4370	19	7.00	575.0	-5.0					cu	W	4	2	E		line sn between; 20.00 and 22.00 hours
CONCORDIA	4530	19	19.00	564.0	-5.0	/-12.5 10.0/			3	cu	W	2	1	N		
"	"	20	9.00	563.5	0.0	-5/-8				s	-	8	1	SE		
"	"	20	18.30	562.0	-8.0					s	-	10	1	SSE	nv	fine snow between 16.00 and 18.00 h.
"	"	21	14.00	561.5	-5.0	/-12.0 12.0/				s	-	10	1	S	nv	Heavy sn in whole 24 hours - 38 cm
"	"	21	19.00	560.5	-7.0	/-10.0				s	-	10	1	S	nv	
"	"	22	8.00	561.0	-3.0	8.0/ /-20.0				s	-	9	1	SE	nv	Heavy sn
"	"	22	19.00	561.0	-8.0				1	s	-	10	1	SE	nv	
"	"	23	8.00	560.7	-1.0					s	N	10	-	-	nv	Heavy sn from 19.00 yesterday until 8.00 hours today
"	"	23	14.00	561.0	3.0	/-13.0 9.0/				s cu	NNW	6	-	-		
"	"	23	21.00	562.0	-14.0	/-20.0			3	cu	W	1	1	N		
"	"	24	8.00	563.0	-9.0	6.0/ /-14.0				ci cu	W	1	1	NE		
"	"	24	14.00	562.5	3.0	30.0/			4	cu	W	2	1	W		
"	"	24	21.00	564.0	-12.0	/-15.0				-	-	0	1	N	sr	
"	"	25	7.00	565.0	2.0	5.0/ /-14.0			3	-	-	0	1	E	sr	
BASE CAMP	4890	25	20.00	532.0	-16.0	17.0/				-	-	0	-	-	sr	The barometer not registering any more - calculate the pressure according to difference in height of the altimeter
"	4880	26	8.00	532.8	-3.0				12	-	-	0	-	-	sr	
"	4890	26	15.00	532.2	1.0					cu	W	1	1	SE		
"	4860	26	20.00	534.1	-9.0					s cu	W	5	2	S		
"	4870	27	10.00	533.5	1.0					cu	NW	2	1	S		
"	4875	27	15.00	533.2	-1.0					cu	NW	2	1	S		
"	4880	27	21.00	532.8	-10.0					cu	NW	1	1	SW		
"	4870	28	7.00	533.5	-7.0					-	-	0	1	NE	sr	
"	4860	28	20.00	534.1	-5.0					cu	SW	2	1	SE		
"	4830	29	8.00	536.1	-1.0					-	-	0	1	E	sr	
"	"	29	15.00	536.1	17.0					-	-	0	-	-	sr	
"	"	29	21.00	536.1	-4.0					-	-	0	-	-	sr	

Tab. 2 continued (2)

LOCALITY	ALT.	V / VI Month		PRESS.	TEMPERATURE °C			RH	PREC.	CLOUDS			WIND		ATMOS. STATE	GENERAL OBSERVATIONS
	m	d.	time	mb	sh	M/m	d/w	v. p.	cm	type	dir.	0-10	speed	dir.		
BASE CAMP	4825	30	8.00	536.4	-2.5	/-8.0				-	-	0	1	S	sr	(1)* The mercury in the maximum thermometer became separated and it was not possible to join it up again
•	4835	30	15.00	535.8	17.0					-	-	0	-	-	sr	
•	4855	30	22.00	534.5	-7.0	/-14.0				-	-	0	-	-	sr	
•	4860	31	8.00	534.1	3.0	13.0/				cu	W	1	-	-		
•	4865	31	15.00	533.8	10.0					s cu	N	4	1	S		
•	4875	1	7.00	533.2	-4.0					-	-	0	-	-	sr	
•	4885	1	15.00	532.5	5.0					s cu	N	3	1	SW		Storm in East
•	4880	1	21.00	532.8	-4.0	(1)*				s	-	1	-	-		overcast in West
•	4860	2	8.00	534.1	0.0	/-11.0				-	-	0	-	-	sr	
•	4885	2	15.00	532.5	4.0	12.0/				s cu	NNW	1	1	SW		
•	4865	2	21.00	533.8	-3.0					s	-	1	-	-		
•		3	8.00		0.5					-	-	0	-	-	sr	D.A.
•		3	15.00		2.0					-	-	0	-	-	sr	Small cloud on K[2]
•		3	21.00		-5.0					-	-	0	1	NNE	sr	
•	4930	4	8.00	534.7	3.3	/-9.0				c cu	WSW	1	1	NNE		
•	4955	4	15.00	533.0	2.5					c cu	NW	4	2	NW		
•	4952	4	20.30	533.2	-1.5	/-10.0				-	-	10	-	-	nv-nb	sn from 19.00 h.
•	4980	5	8.00	531.4	1.5					cu	W	8	2	W	nv	n 2.5 cm sn
•	4976	5	15.00	531.7	-1.5					cu	W	8	3	W		w d; very strong in m and sn in oft
•	4968	5	20.00	532.2	-3.0					s		9	1	SE		
•	4952	6	8.15	533.2	-2.0					s cu	W	8	1	W		n 8 cm sn
•	4962	6	15.15	532.6	0.0					s cu	W	7	1	W		m repeatedly sn
•	4940	6	21.00	534.0	-5.0					s cu		6	-	-	nu	
•	4925	7	8.00	535.0	-4.0					s	W	8	1	W	nu	
•	4938	7	15.00	534.2	3.0					cu	W	4	1	NE		
•	4920	7	21.00	535.3	-4.0					cr cu	NE	7	-	-		
•	4962	8	8.00	532.6	1.0					cr	SW	2	1	N		Ablation from 6/VI cm 3.5 sn
•	4950	8	15.00	533.4	1.8		8.0/3.0	40/4.3		cr cu	NW	4	1	S		same snow-flakes 1/2 hour ago
•	4912	8	21.00	535.9	-5.0					cu	-	1	2	N		

Tab. 2 continued (3)

LOCALITY	ALT.	VI Month		PRESS.	TEMPERATURE °C			RH	PREC.	CLOUDS			WIND		ATMOS. STATE	GENERAL OBSERVATIONS
	m	d.	time	mb	sh	M/m	d/w	v. p.	cm	type	dir.	0-10	speed	dir.		
BASE CAMP	4926	9	8.00	534.9	0.5					cr cu	SW	1	-	-		Ablation from 8/VI cm 2.5 sn
•	4933	9	15.00	534.5	5.5		11.0/4.0	26/3.5		cr cu	SW	3	2	SSW		light sn shawer
•	4920	9	20.30	535.3	-4.0	/-7.0		58/5.0		-	-	0	1	N	sr	
•	4915	10	8.00	535.7	0.8		5.0/2.0			s cu	NW	8	-	-	nv	
•	4935	10	15.30	534.4	0.5			63/7.8	2	-	-	10	-	-	nu	2 cm sn since m
•	4930	10	20.30	534.7	-5.0		10.2/7.0	42/4.5	1	s cu	-	4	-	-	nu-nv	aft 1 cm - from 30/V ablation 45 cm of ice
•	4925	11	8.00	535.0	-3.0	/-1.0				cr	SW	4	1	N		
•	4960	11	14.45	532.7	7.0		(2)* 8.0/3.2			cu	SW	5	1	SW		
•	4930	11	21.00	534.7	-3.0					cr	N	2	1	N		Ablation from yesterday 2 cm sn
•	4940	12	8.00	534.0	1.5					cr	W	2	-	-		
•	4960	12	14.00	532.7	3.0					s cu	SW	8	2	S		short sn shower
•	4940	12	21.00	534.0	-4.0	/-5.0 (3)*			1.5	cr	S	10	1	S	nu-nv	(2)* difference between temp. in the shade and temperature in the dry: the first is obtained by rotating the thermometer in the air and the second in a perforated cadorite cage
•	4960	13	8.00	532.7	-1.5					cu	SW	3	1	S		
•	4975	13	16.00	531.7	-2.5					s	S	10	2	SW	nh	(3)* the maximum and minimum thermometer not working properly
•	4960	13	20.30	532.7	-6.0					s	-	5	-	-		
•	4962	14	8.00	532.6	-1.5					s	SE	5	2	S		Little snow n
•	4978	14	15.30	531.5	-3.5					s	SW	9	2	S	nh	
•	4972	14	20.45	531.9	-5.0					s	SW	8	2	S	nb	aft sl
•	4975	15	8.00	531.7	-4.0		4.3/0.8		6	s	W	10	1	S	nh	n 6 cm sn and w d
•	4962	15	15.15	532.6	-3.0				3	s cu	WNW	7	1-2	S	nv	Another 3 cm sn m
•	4940	15	21.00	534.0	-9.0		5.0/2.5			s cu	SW	5	-	-		Aft little sn, 9 cm sn altogether
•	4920	16	8.00	535.3	-3.0					s cu	NW	3	1	S		
•	4935	16	15.00	534.4	-2.0					s cu	SW	6	2	S		
•	4915	16	21.00	536.0	-6.0					s cu	W	5	1	S		
•	4905	17	8.00	536.3	-1.0					cr cu	W	3	1	S		
•	4910	17	15.00	536.0	0.5			50/4.1		s cu	W	5	1	SW		
•	4890	17	20.30	537.3	-6.0			38/3.3		cr	W	1	1	N		
•	4880	18	8.30	538.0	2.0					cr s	W	3	1	SSW		Ablation since yesterday m 1 cm sn
•	4888	18	15.00	537.4	1.0					s cu	W	9	1	SSW	nh	

Tab. 2 continued (4)

LOCALITY	ALT.	VI Month		PRESS.	TEMPERATURE °C			RH	PREC.	CLOUDS			WIND		ATMOS. STATE	GENERAL OBSERVATIONS
	m	d.	time	mb	sh	M/m	d/w	v. p.	cm	type	dir.	0-10	speed	dir.		
BASE CAMP	4888	18	21.00	537.4	-3.5					-	-	1	1	S		Aft sl 2 times
.	4880	19	8.00	538.0	1.0					cr cu	SW	2	1	S		
.	4885	19	15.00	537.6	1.5					s cu	-	10	2	S	nb	Sl 2 times
.	4878	19	21.00	538.1	-2.0					s cu	-	7	-	-		
.	4888	20	9.00	537.4	2.0					s cu	SW	7	2	SW		At 07.00 h. temp. -2°C
.		20	15.00		2.0					s cu	SW	5	-	-		
.	4890	20	21.00	537.3	-3.0					s	SW	10	1	SW	nv-nb	Begins sn 19.30 h
.	4890	21	8.00	537.3	-1.8				2.0	s	SW	10	1	SW	nv-nb	2 cm sn on the ground
.	4887	21	16.00	537.5	2.0					s cu	SW	5	1	SW		Sn with strong wd for part of m
.	4900	21	21.00	536.7	-3.0					s cu	SW	5	1	S		
.	4935	22	8.00	534.4	-2.0				3.0	s	SW	10	3	S	nv-nb	At 07.00 h, -3°. Squalt
.	4940	22	15.30	534.0	0.0					s	SW	10	2	S	nv-nb	Uninterrupted sn
.	4945	22	21.00	530.4	-4.0				10.0	s	SW	10	1	S	nv-nb	During day 10 cm sn - In total 13 cm
.	4960	23	8.00	532.7	-2.0					s	SW	10	2	S	nv-nb	From beginning has snowed 23 cm
.		23	15.30		0.5					s	SW	10	2	S	nv-nb	
.	4940	23	21.00	534.0	-7.0					-	-	0	-	-	sr	Stopped snowing at 18.00 h
.	4940	24	8.00	534.0	1.0				14.0	cu	S	8	1	SW	nv	27 cm on the ground this morning
.	4950	24	15.00	533.4	3.0					cu	SW	4	2	S		stopped snowing at 13.00 h
.	4915	24	21.00	535.7	-7.0					-	-	0	-	-	sr	In also at 15.00 h
.	4915	25	8.00	535.7	-0.5				1.5	s	SW	10	2	S	nv-nb	N 1.5 cm sn; 07.00 h temp. -3°
.	4932	25	15.00	534.6	0.5					s	SW	10	2	SW	nv-nb	
.	4910	25	20.30	536.0	-4.0				2.0	s	-	10	1	S	nh-nb	Aft. sn continues
.	4910	26	8.00	536.0	1.0					cr s	SW	5	2	SSW		Yesterday another 2 cm of sn
.	4920	26	15.00	535.3	4.0					s cu	SW	5	2	SSW		
.	4888	26	21.00	537.4	-4.0					-	-	0	-	-	sr	
.		27	6.30		-8.0					s cu	SW	4	-	-		
.	4878	27	15.30	538.1	4.0		/1.0	56/4.5		s cu	SW	5	1	S		Last 2 days ablation 6 cm sn
.	4887	27	20.30	537.5	-4.0					-	-	1	-	-		
.	4892	28	8.00	537.2	-1.0					cr	SW	1	-	-		

Tab. 2 continued (5)

LOCALITY	ALT.	VI / VII Month		PRESS.	TEMPERATURE °C			RH	PREC.	CLOUDS			WIND		ATMOS. STATE	GENERAL OBSERVATIONS
	m	d.	time	mb	sh	M/m	d/w	v. p.	cm	type	dir.	0-10	speed	dir.		
BASE CAMP	4895	28	15.15	537.0	4.0					cu	SW	5	-	-		At 15.00 h short sl shower
•	4890	28	20.30	537.3	-5.0					-	-	0	1	N	sr	Ablation since yesterday 0.5 cm
•	4895	29	8.00	537.0	-1.0					cr cu	SE	2	1	N		
•	4911	29	15.30	535.9	1.0		/0.0	8.3/5.4		s cu	SW	9	-	-		In early morning
•	4902	29	20.15	536.2	-6.0					-	-	0	1	N	sr	
•	4900	30	8.00	536.7	0.0					cr cu	SE	2	-	-		In month of June 50 cm sn
•	4943	30	15.00	533.8	3.0					s cu	SE	9	1	W		(20 days of snow)
•	4958	30	20.45	532.8	-3.5					-	-	10	1	S	nv-nb	Began sn 20.00
•	4960	1	8.00	532.7	-1.0				2.5	-	-	10	1	S	nb	N 2.5 cm sn
•	4958	1	15.00	532.8	3.0					-	-	10	1	S	nv-nb	In melting as it settles
•	4952	1	20.00	533.2	-4.5					-	-	10	1	S	nv-nb	
•	4955	2	8.00	533.0	4.8				1.0	cr cu	SW	4	-	-		N 1 cm fresh sn - 07.00 h. temp. -2°
•	4970	2	15.00	532.0	1.5		/0.8	8.8/6.0		-	-	10	1	S	nv-nb	Since 12.00 h snow at intervals
•	4960	2	20.30	532.7	-4.0				0.5	s cu	SW	10	-	-	nv-nb	
•	4940	3	8.00	534.0	-1.0				3.0	-	-	10	-	-	nv-nb	N 3 cm fresh sn
•	4945	3	15.00	533.0	3.2		/0.8	6.3/4.5		cu	SW	10	2	S	nh-nb	M and aft sn on several occas.- low cloud
•	4930	3	20.30	534.7	-4.0				0.5	s cu	SW	5	1	S		fresh sn - 0.5 cm in total
•	4912	4	8.00	535.9	1.0					s	SW	9	1	W		N sn shower - 07.00 h. temp. -1°
•	4932	4	15.00	534.6	7.0		/1.8	3.5/5.5		s cu	SW	5	1	S		
•	4930	4	21.00	534.7	-4.0					s cu		2	1	S		
•	4910	5	8.00	536.0	1.0				1.5	s cu	S	5	1	W		N 1.5 cm sn - 06.30 h. temp. -2°
•	4912	5	15.00	535.9	4.0		/0.8	5.3/4.4		s cu	SW	10	3	W	nh	Aft. shower of sleet
•	4910	5	20.30	536.0	-0.5					s cu	SW	5	1	S		
•	4890	6	8.00	537.3	2.5				0.5	s cu	SW	5	1	S		N 0.5 cm until 07.30 h
•	4915	6	15.00	535.7	6.0		/0.2	3.7/3.5		s cu	SW	4	1	S		
•	4895	6	21.00	537.0	0.0					s cu	SW	5	1	S		
•	4915	7	15.00	535.7	7.5		/3.3	4.8/4.9		s cu	SW	5	2	S		M Metereological cage knocked
•	4915	7	20.30	535.7	1.0					s cu	SW	2	1	S		down by wind - position changed
•	4910	8	8.20	536.0	3.3					-	-	9	1	S	nh-nb	N short sn shower - 06.30 h. temp. -0.5°

Tab. 2 continued (6)

LOCALITY	ALT.	VII Month		PRESS.	TEMPERATURE °C			RH	PREC.	CLOUDS			WIND		ATMOS. STATE	GENERAL OBSERVATIONS
	m	d.	time	mb	sh	M/m	d/w	v. p.	cm	type	dir.	0-10	speed	dir.		
BASE CAMP	4922	8	15.30	535.2	6.0		/2.0	4.7/4.4		s cu	SW	7	2	S		
•	4920	8	20.30	535.3	0.0					s cu	SW	3	-	-		
•	4940	9	8.00	534.0	2.0					s cu	SE	9	2	SW	nb	Sl several timea
•		9	15.00		3.0		/2.0	2.8/6.4		s cu	SW	10	2	SW	nb	Aft sl several times
•	4928	9	21.00	535.1	-2.0					s cu	SW	6	1	SW		
•	4948	10	8.00	533.5	-1.0				0.5	cu	WSW	4	3	SW		N less than 0.5 cm sn 07.00 h temp. -2°
•	4942	10	15.00	533.9	1.7		/0.7	8.4/5.7		s cu	SW	10	2	SW	nb	M snowed repeatedly
•	4955	10	21.00	533.0	-1.5					s cu	SW	8	1	SW		same for Aft
•	4960	11	8.00	532.7	-2.0				1.5	S	SW	10	3	SW	nb	N sn on several occas. with strong wd
•		11	15.00		3.0					s cu	SW	10	1	SW		
•	4960	11	20.30	532.7	-2.0					s cu	SW	6	1	S		Aft sl shower
•	4935	12	9.00	534.4	5.0				0.5	s cu	SW	7	1	SW		N 0.5 cm sn
•	4945	12	16.00	533.7	4.0		/1.7	6.6/5.3		s cu	W	6	1	SW		
•	4927	12	21.00	534.9	-2.0					-	-	1	-	-		V clear evening
•	4910	13	6.30	536.0	-2.0					s cu	SW	7	-	-		
•	4925	13	21.00	535.0	0.0					-	-	1	-	-		
•	4930	14	8.00	534.7	2.5					-	-	0	1	SW	sr	
•	4950	14	16.00	533.4	9.5		/5.0	4.8/5.7		cu	SW	4	1	SW		Sl shower short while ago
•	4920	14	21.30	535.3	2.0		/1.0	8.4/5.8		s cu	SW	8	1	S		
•		15	8.00		2.0					s cu	SW	8	1	S		Sleet shower in early morning 06.30 h -0.7°
•	4940	15	15.00	534.0	6.0		/3.2	6.2/5.8		s cu	SW	7	1	S		Sleet shower at 14.30 h
•	4920	15	21.00	535.3	2.0					s	SW	10	-	-		
•	4936	16	8.00	534.3	1.0				5.0	s	SW	10	1	SW	nb	N 5 cm sn
•	4930	16	15.00	535.0	0.2					s	SW	10	2	SW	nv-nb	In at various times but didn't stay
•	4925	16	20.00	534.7	-0.8				3.0	-		10	2	SW	nv-nb	Aft sn 3 cm
•	4930	17	8.00	534.7	0.0				4.0	s cu	SW	9	2	SW	nv-nb	N 4 cm including yesterday evenings'
•	4940	17	16.00	534.0	4.0		/1.8	6.7/5.4		cu	SW	5	2	S		M sna and wd - 06.30 h: -0.2°
•	4910	17	21.00	536.0	-2.0					-	-	0	1	N	sr	Aft more wd
•	4900	18	8.00	536.7	2.0					-	-	0	1	N	sr	06.30 -3°

Tab. 2 continued (7)

LOCALITY	ALT.	VII Month		PRESS.	TEMPERATURE °C			RH	PREC.	CLOUDS			WIND		ATMOS. STATE	GENERAL OBSERVATIONS
	m	d.	time	mb	sh	M/m	d/w	v. p.	cm	type	dir.	0-10	speed	dir.		
BASE CAMP	4925	18	15.00	535.0	7.0		/1.8	3.5/3.5		-	-	0	1	SW	sr	Little cloud on K2
•	4900	18	21.00	536.7	0.0					c cu	SW	2	-	-		
•	4920	19	8.00	535.3	4.5					s cu	SW	6	-	-		
•	4945	19	15.30	533.7	5.6		/2.6	5.9/5.3		cr cu	W	6	1	SW		
•	4932	19	21.00	534.6	0.2					cr cu	-	5	-	-		Aft short sl shower
•	4938	20	8.00	534.2	2.0					s	SW	10	1	SW		N sl shower
•	4955	20	15.00	533.0	5.0		/2.0	5.8/5.0		s cu	SW	4	2	SW		
•	4935	20	21.00	534.4	-2.0				0.5	s cu	SW	4	1	SW		In until short time ago
•	4940	21	8.00	534.0	2.0				3.0	s cu	SW	6	1	SW		N another 3 cm sn
•	4942	21	16.00	533.9	3.2		/0.2	5.5/4.3		s cu	SW	4	1	SW		
•	4940	21	21.00	534.0	1.8					s cu	SW	2	1	SW		
•	4933	22	8.30	534.5	4.0				0.5	s cu	SW	7	2	SW	nh	N 0.5 cm sn
•	4940	22	15.30	534.0	6.0		/2.0	4.7/4.4		s cu	SW	5	2	SW		
•	4920	22	21.00	535.3	-1.5					-	-	1	1	E		
•	4910	23	8.00	536.0	3.0					cu	SW	5	1	S		A few flakes of snow
•	4890	23	20.30	537.3	-1.5					-	-	0	1	N	sr	
•	4880	24	8.00		2.0					-	-	0	1	SW	sr	
HIGH 1° CAMP	5205	24	19.00		-2.5					-	-	0	1	N	sr	
•	5205	25	5.30		-6.0					-	-	0	1	N	sr	
•	5447	25	20.15		-1.2					-	-	0	-	-	sr	
•	5467	26	6.00		-6.0					-	-	0	-	-	sr	
BASE CAMP	4950	26	9.00	533.4	2.0					-	-	0	-	-	sr	
•	4985	26	15.00	532.8	4.2		/2.0	6.8/5.6		s cu	SW	10	1	S	nh-nb	
•	4965	26	20.00	532.4	-2.0					-	-	0	1	N	sr	Snowed briefly
•	4972	27	8.00	531.9	4.0					cr cu	SW	6	1	SW		
•	4978	27	16.30	531.5	3.0		/3.0	100/7.6		-	-	10	1	S	nh-nb	
•	4960	27	21.00	532.7	-1.0					s cu	-	5	-	-		
•	4950	28	8.00	533.4	6.0				2.0	cu	SW	5	-	-		N 2 cm sn
•		28	15.00		6.0		/2.2	4.9/4.7		s cu	SW	9	2	SW		

Tab. 2 continued (8)

LOCALITY	ALT.	VII/VIII Month		PRESS.	TEMPERATURE °C			RH	PREC.	CLOUDS			WIND		ATMOS. STATE	GENERAL OBSERVATIONS
	m	d.	time	mb	sh	M/m	d/w	v. p.	cm	type	dir.	0-10	speed	dir.		
BASE CAMP	4921	28	21.00	535.3	-1.0					-	-	0	1	N	sr	
•	4900	29	8.00	536.7	6.2					cr	SW	1	-	-		06.30 h temp. -2°
•	4905	29	15.30	536.3	9.5		/3.0	2.7/3.2		cr cu	SW	7	2	SW		
•	4892	29	21.30	537.2	-2.0					-	-	0	1	N	sr	
•	4896	30	8.00	536.9	7.0					-	-	0	-	-	sr	06.15 h temp. -4°
•	4918	30	15.00	535.5	8.5		/4.0	4.6/5.0		-	-	0	1	N	sr	
•	4904	30	21.00	536.4	-2.0					-	-	0	1	N	sr	
•	4910	31	8.00	536.0	9.0					cu	SW	9	-	-		06.50 h temp. -2°
•	4945	31	16.00	533.7	10.5		/5.0	4.0/5.0		cr cu	SW	4	-	-		
•	4920	31	20.30	535.3	1.0					-	-	0	2	N	sr	
•	4930	1	8.00	534.7	7.0		/3.8	5.9/5.8		cr cu	SE	3	1	N		07.00 h temp. 2°
•	4988	1	15.00	532.2	14.0		/6.5	2.9/4.7		cr cu	NW	3	1	S		
•	4930	2	7.00	534.7	1.0				2.0	-	-	10	-	-	nb	Observatory moved
•	4940	2	16.00	534.0	2.5					-	-	10	2	S	pg-nb	
•	4922	2	21.30	535.2	0.0					s cu	SW	7	-	-		Aft r and sn
•	4922	3	8.30	535.2	3.0		/2.0	8.4/6.4		s	SE	8	-	-		N sl
•	4920	3	15.00	535.3	4.0		/2.0	7.0/5.1		-	-	10	2	S	nb	
•	4912	3	22.00	535.9	0.0					-	-	9	-	-	nb	
•	4918	4	8.00	535.5	3.2					s cu	SW	7	1	S		
•	4940	4	15.00	534.0	11.0					s cu	SW	5	1	SW		
•	4930	4	21.00	534.7	0.0					-	-	0	-	-	sr	
•	4945	5	8.00	533.7	6.0					cu	SE	7	1	N		Abundant hoar-frost
•	4965	5	15.30	532.4	8.0		/3.0	4.0/4.3		cu	SW	5	1	S		
•	4960	5	21.00	532.7	0.0					-	-	0	1	N	sr	
•	4948	6	8.00	533.5	4.0		/1.0	5.6/4.5	0.5	cr cu	SW	5	1	W	nv	N 0.5 cm sn
•	4965	6	16.30	532.4	3.8		/3.0	8.8/7.0		cu s	SW	7	-	-	nh	Aft sl sever times
•	4948	6	21.00	533.5	0.0					cu s	SW	5	-	-		
OSO BROAD P. CAMP	4800	7	17.30		6.0					s cu	SW	10	1	S	nh	
•	4800	8	8.30		1.0				1.0	s cu	SW	7	1	S		N 1 cm sn. Stopped snowing at 07.00 h

Tab. 2 continued (9)

LOCALITY	ALT.	VIII Month		PRESS.	TEMPERATURE °C			RH	PREC.	CLOUDS			WIND		ATMOS. STATE	GENERAL OBSERVATIONS
	m	d.	time	mb	sb	M/m	d/w	v. p.	cm	type	dir.	0-10	speed	dir.		
GASHERBRUM Gl.	4628	8	18.00		7.0					s cu	S	6	-	-		Several sn showers during day
•	4600	9	8.30		8.0				4.0	-	-	10	-	-	nv-nb	N up to now 4 cm of fresh sn
BALTORO HIGH C.	4713	9	18.30		6.0					s cu	S	7	2	SE		Stopped snowing at 09.30 h this morning
•	4682	10	6.00		−3.0					s cr	S	2	1	N		
BALTORO MID. C.	4462	10	18.30		8.0					cr cu	WSW	5	-	-		
•	4430	11	6.00		4.0					cr cu	S	4	-	-		
URDUKAS	4060	11	18.30	598.0	12.0					-	-	0	-	-	sr	
•	4080	12	9.00	600.0	16.0					-	-	0	-	-	sr	
•	4065	13	8.30	597.5	18.0					cr s	S	5	-	-	pg	Aft r
•	4070	13	21.00	597.0	10.0					-	-	0	-	-	sr	
•	4080	14	8.00	596.5	8.5					s cu	SW	7	-	-		Abundant snowfall
YOUNGH. Gl.	4295	14	18.30	580.0	9.5					s cu	S	8	1	S	pg	It rained a lot during the day
•	4285	15	8.30	578.5	6.0					s	-	10	-	-	pg	N continual rain
MUZTAGH TOW. C.	4644	15	19.00	553.0	6.0					s	SW	10	-	-	pg	r all day
•	4628	16	6.30	555.0	0.0				4.0	cr	SE	1	-	-		It snowed during the night
MANILA CAMP	5365	16	18.00		1.0					s cu	SW	5	-	-		40 cm fresh sn
•	5340	17	11.00		3.5					s cu	SW	8	2	N		N sl and for the whole day
LOWER YOUNGH. C.	4363	17	19.00	576.0	8.0					s cu	SW	4	1	N		
•	4370	18	7.00	571.5	2.0					-	-	0	1	N	sr	
LUNGKA	4182	18	15.30	589.0	18.0					cu	SW	3	1	SE		
•	4175	19	8.00	589.0	14.0					cu	SW	2	1	SE		
CHAGARAN	4450	19	16.30	570.5	15.0					cu	SW	6	2	S		
URDUKAS	4072	20	18.30	597.0	10.5					cu	SW	4	1	S	nv	N r
•	4050	21	8.30	600.5	9.0					cu	SW	2	-	-		
LILIGO	3810	22	21.00	606.0	9.0					-	-	0	-	-	sr	the readings when taken at 01.00 h by Liligo
•	3795	23	6.00	618.0	4.0					-	-	0	1	E	sr	
BRACK LUNGKA	3390	23	18.30	649.0	20.0					-	-	0	1	W	sr	
•	3365	24	6.00	652.0	7.0					-	-	0	1	E	sr	
DUMORDO BRIDGE	3242	24	19.30	660.5	17.0					s cu	SW	7	2	N		Aft. sandstorm

Tab. 2 continued (10)

LOCALITY	ALT.	VIII/IX Month		PRESS.	TEMPERATURE °C			RH	PREC.	CLOUDS			WIND		ATMOS. STATE	GENERAL OBSERVATIONS
	m	d.	time	mb	sh	M/m	d/w	v. p.	cm	type	dir.	0-10	speed	dir.		
ASKOLE	3032	26	8.00		12.0					s cu	SW	8	1	S		N R
•	3032	26	19.00		10.0					s cu	NW	8	-	-		Aft violent storm with lightning and rain
•	3032	27	12.00		17.5					cu	S	5	1	S	pg	N and N R
•	3032	27	21.00		10.0					cu	-	3	1	E	pg	Aft violent storm
•	3032	28	6.30		7.0					cr	SW	4	-	-		
•	3032	29	13.30		18.0					cu	SW	7	1	S		
•	3032	30	8.45	680.5	12.0					-	-	0	1	S	sr	
BIAFO FRONT CAMP	3100	30	15.30		24.0					-	-	0	1	E	sr	
•	3085	30	19.30		15.0					-	-	0	2	E	sr	
•	3075	31	6.00		10.0					-	-	0	2	NE	sr	
MANHO CAMP	3765	31	18.00	621.0	9.0					s cu	SW	2	1	N		
•	3732	1	6.00	623.0	-1.0					-	-	0	-	-	sr	N frost
HOBLUK CAMP	4033	1	18.00	599.0	4.0					-	-	0	1	N	sr	
•	4014	2	6.00	600.0	0.0					-	-	0	2	N	sr	
BIAFO HIGH CAMP	4442	2	18.00	571.0	1.0					-	-	0	1	N	sr	
•	4446	3	6.00		-2.0					-	-	0	1	S	sr	
HISPAR PASS CAMP	4958	3	18.00		1.0					-	-	0	2	E	sr	
•	4422	4	18.00	572.0	5.0					-	-	0	1	E	sr	
KANI BASA CAMP	4410	5	6.00		4.0					s cu	SW	6	1	E		
HAIGUTUN CAMP	4085	5	18.00	596.0	17.0					s	SW	3	1	W		
•	4070	6	7.00	597.0	8.0					-	-	0	1	E	sr	
HISPAR TOWER C.	3730	6	18.30		16.0					-	-	0	1	S	sr	
•	3160	7	18.00		16.0					s	SW	8	1	W		r little but continuous weather
•	3180	7	19.00		16.0					cu	SW	2	-	-		mainly clear
•	3170	8	7.30	667.0	15.0					-	-	0	2	E	sr	
HURÒ	2682	8	17.30							s cu	SW	7	1	E		Aft sand - storm and wd

3. Critical examination and processing of the data

All the processing of the meteorological data of the Italian expedition to the Karakorum is based on the original diary of Prof. Desio, which contains the meteorological observations taken by himself daily at base camp or assisted by Cirillo Floreanini. At first sight the diary looks incomplete and as if the data are conflicting, the tables give a lot of data and information, but the inaccuracies and uncertainties completely justified by difficult and unfavourable environmental conditions, such as the terrain and difficulty for movement.

The data for cloud-cover, wind and clouds were quite good and complete even if they weren't taken regularly or every day.

The question of temperature was a little more complicated; in fact daily maximus and minimums weren't measured because soon after the arrival of the expedition at camp on June 3rd, the maximum-minimum thermometer ceased to work properly. Thus for the daily averages in the absence of maximums and minimums, he contented himself with taking the averages of the temperatures at 08.00 and 20.00 hours. The measurements were taken three times a day, usually at 08.00, 15.00 and 20.00 hours.

Given the systematic nature of the observations it has been possible to make up daily tables with values and measurements at the above mentioned hours and therefore to make the possible comparisons, averages for ten day periods and months and to note the variations during the day as well as the behaviour of the daily averages. This holds for both the temperature and pressure, as well as for cloud type and direction, cloud-cover and wind speed and direction.

Only in a few cases it was possible to obtain the relative humidity and water vapour pressure from the temperatures recorded with the wet and dry bulb thermometer; in fact the observations available were few and imprecise, and that was because even in normal conditions it is not easy to take these measurements. Thus an attempt was made to include the above-mentioned measurements in a systematic research, but this was abandoned because of the poverty of data, and which was often of uncertain value.

There were considerable difficulties to be faced with regard to atmospheric pressure; first among these was to establish the average pressure at base camp. In fact the barometer didn't work well and the scale was to limited, and the altimeter underwent variations in height owing to changes in pressure.

Thus the data recorded in the place of pressures were altitude, in metres, and from these as will be seen shortly the atmospheric pressure was obtained in millibars on the bases of the average pressure, calculated in the following way.

Given that the average pressure and altitude of Concordia (563 mb and 4530 m) the station previous to the base camp, are valid, from the «Smithsonian Meteorological Tables» one gets the gradient Δ h to 1 mb, at 0° (at the height of 5430 m) = 14m/mb.

If we assume a height of 4941 m for the base camp, which is contained in Prof. Desio's diary and obtained by him from the average of 25 altimetric measures (June 4th – June 11th) and if we proceed in the same way as above, the gradient Δ h to 1 mb, at 0° (at a height of 4941 m) gives a result of 15.4 m/mb.

By taking the difference between the two heights, that of Concordia and that of the base camp, there is a difference in height of 410 m. The average value between the two heights is 14,7 m/mb obtained that is by the average of the two preceding gradients.

If we suppose that the average temperature, in the period June 4th - June 11th, the two, is -5°C, the average of Δ h between the two heights gives a result of 14.5 m/mb, still based on the «Smithsonian Meteorological Tables».

If we divide the difference in height between Concordia and the base camp by the gradient just found we get

$$410 \text{ m x } \frac{1}{14.5} \text{ mb/m} = 28.3 \text{ mb}$$

28.3 mb which are substracted from 563 mb of Concordia since at greater heights pressure diminishes and vice-versa, and since 28.3 mb is the value corresponding to the difference in height between Concordia and the base camp:

$$(563{,}0 - 28{,}3) \text{ mb} = 534.7 \text{ mb}.$$

This result in the average pressure at base camp calculated by means of the «Smithsonian Meteorological tables» and the data in the diary.

NOTE: If with such a pressure one wishes to obtain the height of the base camp, one can proceed in the following way.

a) to 534.7 mb correspond 5104 m; this with the altimetric formula without corrections.

$$h - h' = \frac{RT'}{g'} \log \frac{P'}{P}$$

To these metres it will be necessary to add all the other metres obtained by the correction of the average temperature (between that at sea level and that at base camp), of the relative humidity (calculated at about 50%), of gravity and latitude.

5104 m

+ 0 m (corrective average temperature $\frac{+20^\circ - 20^\circ}{2} = 0^\circ$; annual av. temp.)

+ 15 m (corrective relative humidity)
+ 5 m (corrective gravity)
+ 0 m (corrective latitude)

5124 m (altitude of base camp calculated with av. temp. = 0°)

b) If one now takes an average temperature of -10° (that is the average temperature at base-camp is -35°: $\frac{-35^\circ + 15^\circ}{2}$ on gets: 5104 x 0.037 = 188,9 m, to be substracted from 5104 since lower pressures correspond to higher temperatures (hot air is lighter) and vice-versa.

5104.0 m

-188.9 m (corrective average temperature)
- 20.0 m (other corrective factors)

4935.1 m (but this altitude isn't possible, since one an exclude an average temperature of -70°).

c) Assuming a resposable average temperature like -5°, the resulting altitude is about 5000 m.

It can be deduced from all these considerations that the altitudine of the base camp was about 5000 m, as was supposed by Desio, in the draft of this book «La conquista del K^2, seconda cima del mondo».

Let us now determine the pressures at the base camp during the expedition's stay. As has already been said, in the diary measures of altitude are found in place of those of pressure. Leaving out the data included in the period from May 26th to June 3rd in which it was necessary to operate differently, all the values of the heights from June 4th to August 6th have been taken.

It was a case of three surveys of altitudes a day, values which were added up and then divided by the total number of surveys. An average was thus obtained of 176 surveys. Each one of the 176 heights was substracted from this average 4929,67 m to obtain positive values, and negative values when the resulting average was lower than the height to be substracted.

All these differences were divided by the gradient 15.4 m/mb (Δ h to 1 mb at 0° at a height of 4941 m) obtaining the corresponding millibars to substract or add to the value 534.7 mb (the average pressure calculated at base camp) according to whether the heights were higher or lower than the average. In this way pressure values were determined at base camp in the period June 4th - August 6th.

The preceding data (May 26th - June 3rd) have been affected by a systematic error bacause of which it was necessary to modify them and carry them to values nearer to the 176 following ones by the following procedure. The difference was determined between the average of this series of values and that obtained from the 25 following ones. The difference (78.18 m) was added to each datum of the first series thus obtaining values homogeneous with the measurements taken in the following months. One then proceeded in the way described below. Curves were obtained from all these values which had been calculated, on which different equalizations were performed: 121 for the ten day period tables; 13431 and then the medians for the other tables until a homogeneous curve was obtained, according to the scheme drawn up by F. Vercelli.

	2a	a_2	a_4	a_6	a_8	a_{12}
2	$\frac{1}{4}$	$\frac{1}{5}$	$\frac{1}{8}$	$\frac{1}{20}$		
4	$\frac{1}{4}$		$\frac{1}{5}$		$\frac{1}{8}$	$\frac{1}{20}$

Only snow precipitations were considered since at such a height they don't fall in any other form.

«Light shower», «sleet» or «desultory snow» have been estimated in the order of 0.5 cm or 1.5 cm, but the values are merely indicative if one takes into account the ablation which has already been mentioned and the continual wind which was always present during the whole period of the expedition's stay at base camp. The ablation shown in the month of June wasn't recorded in the following month, but for reasons already given above, it has been hypothesized.

To transform the wind scale used at base camp including calm (shown by a bar in the original data) up to grade 4, reference has been made to the usual Beaufort scale, making grades 1 - 2 - 3 of this scale include grade 1 of the scale used at base camp, 4 - 5 - 6 include grade 2 etc. Thus the average velocity of the 4 groups on the Beaufort scale, that is 2 - 5 - 8 - 11, correspond to the grades of the expedition scale in the following way:

Expedition Scale	Beaufort Scale	m/sec	km/h
1	2	$\frac{1.8 + 3.3}{2} = 2.55$	$\frac{7 + 12}{2} = 9.5$
2	5	$\frac{7.5 + 9.8}{2} = 8.65$	$\frac{27 + 35}{2} = 31.0$
3	8	$\frac{15.3 + 18.2}{2} = 16.75$	$\frac{55 + 65}{2} = 60.0$
4	11	$\frac{25.2 + 29.0}{2} = 27.10$	$\frac{91 + 104}{2} = 97.5$

Two periods were under consideration both for wind (frequency of direction and velocity) and clouds (frequency of direction and type): the first from May 26th - June 30th, the second from July 1st - August 6th.

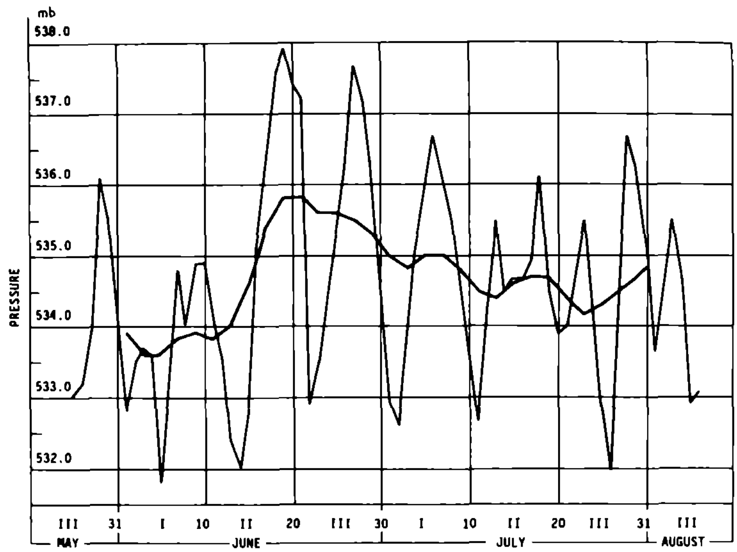

Fig. 31 - AVERAGE DAILY PRESSURES AND MEDIAN
Ordinates: pressure in mb, Abscissae: days - decades - months

Actual average daily pressures are shown without any equalization (thin line) and the median of the behaviour (thick line) obtained by the equalization 1/20 - 1/8 - 1/5 - 1/4 - 1/5 - 1/8 - 1/20 of the values already equalized according to the equalization 1/12 - 1/4 - 1/3 - 1/4 - 1/12.

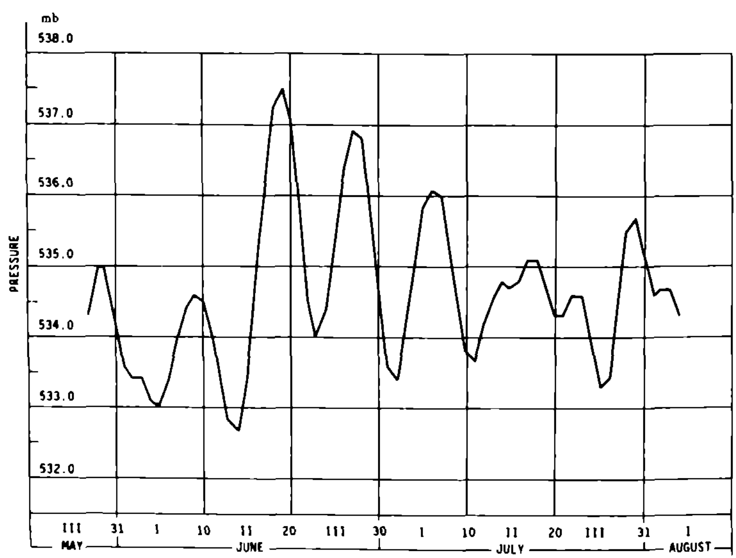

Fig. 32 - EQUALIZED AVERAGE DAILY PRESSURES
Ordinates: pressure in mb, Abscissae: days - decades - months

The curve is obtained from the above-mentioned values of the average daily pressures which have been thus equalized 1/12 - 1/4 - 1/3 - 1/4 - 1/12; such a curve has been included because it shows a 5-6 day period of the average daily pressures (see p. 118).

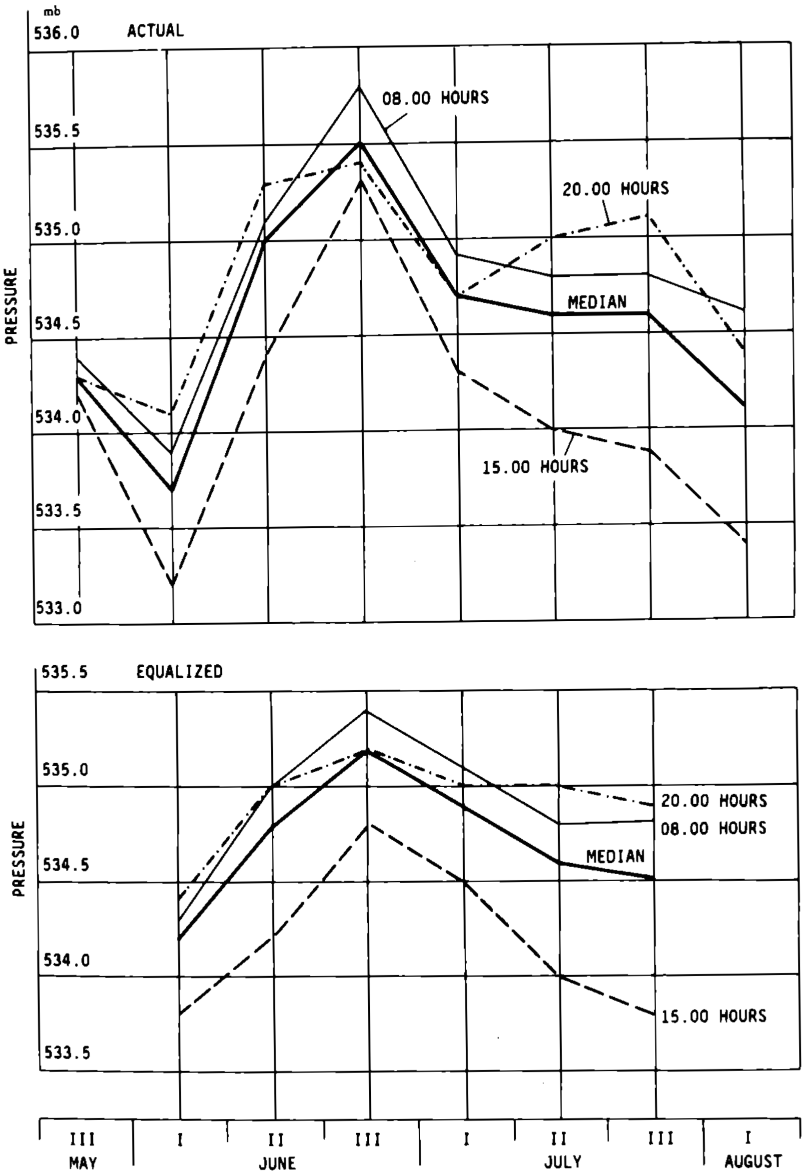

Fig. 33 - AVERAGE PRESSURES OF TEN DAY PERIODS, ACTUAL AND EQUALIZED, CALCULATED FROM THE DAILY AVERAGES AND FROM THE AVERAGES AT 08.00, 15.00 AND 20.00 HOURS
Ordinates: pressure in mb, Abscissae: decades - months

In the upper part of the figure are shown the curves of the actual average pressures of ten day periods; in the lower part the average pressures of ten day periods are equalized 1/4 - 1/2 - 1/4, taken from the daily averages (thick line) and from the averages at 08.00, 15.00 and 20.00 hours.

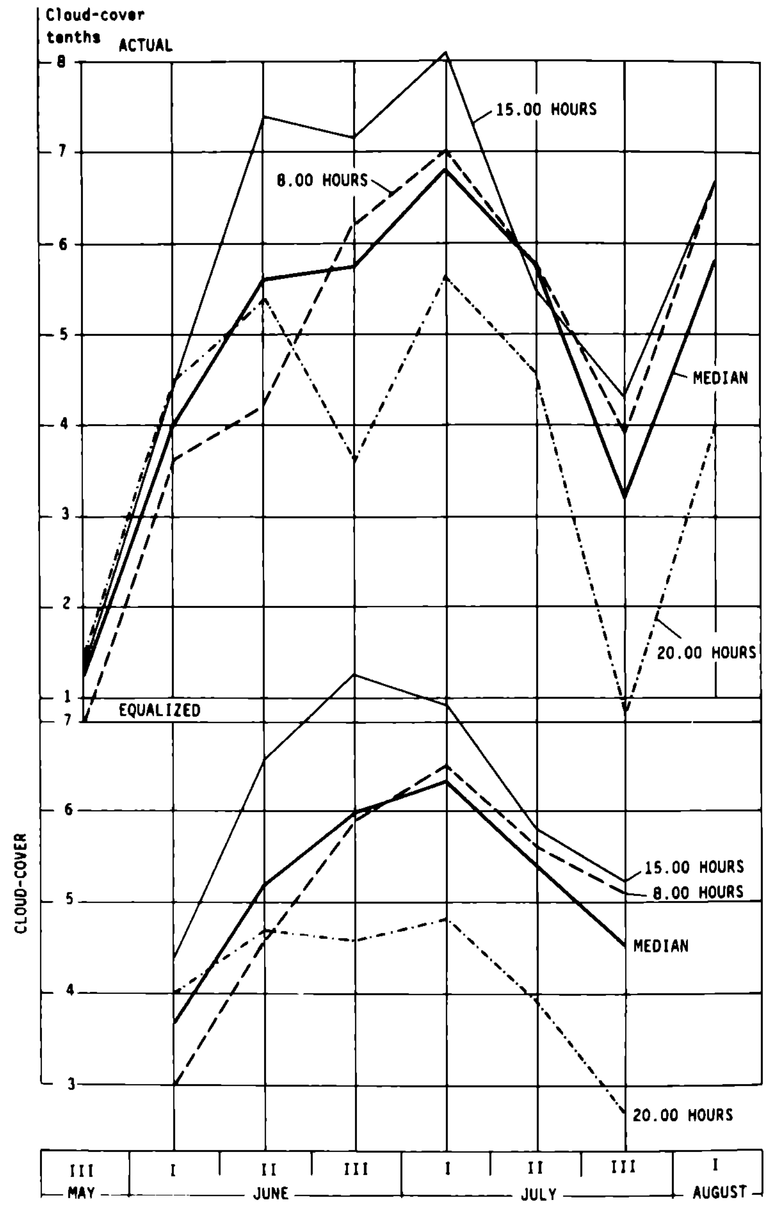

Fig. 34 - AVERAGE CLOUD-COVER OF TEN DAY PERIODS, ACTUAL AND EQUALIZED, CALCULATED FROM THE DAILY AVERAGES AND FROM THE AVERAGES AT 08.00, 15.00 AND 20.00 HOURS

Ordinates: cloud-cover in tenths. Abscissae: decades - months

The curves shown are those representing the actual average cloud-cover of ten day periods (upper part of the figure), and equalized (lower part of the figure), calculated from the daily averages and from the averages at 08.00, 15.00 and 20.00 hours.

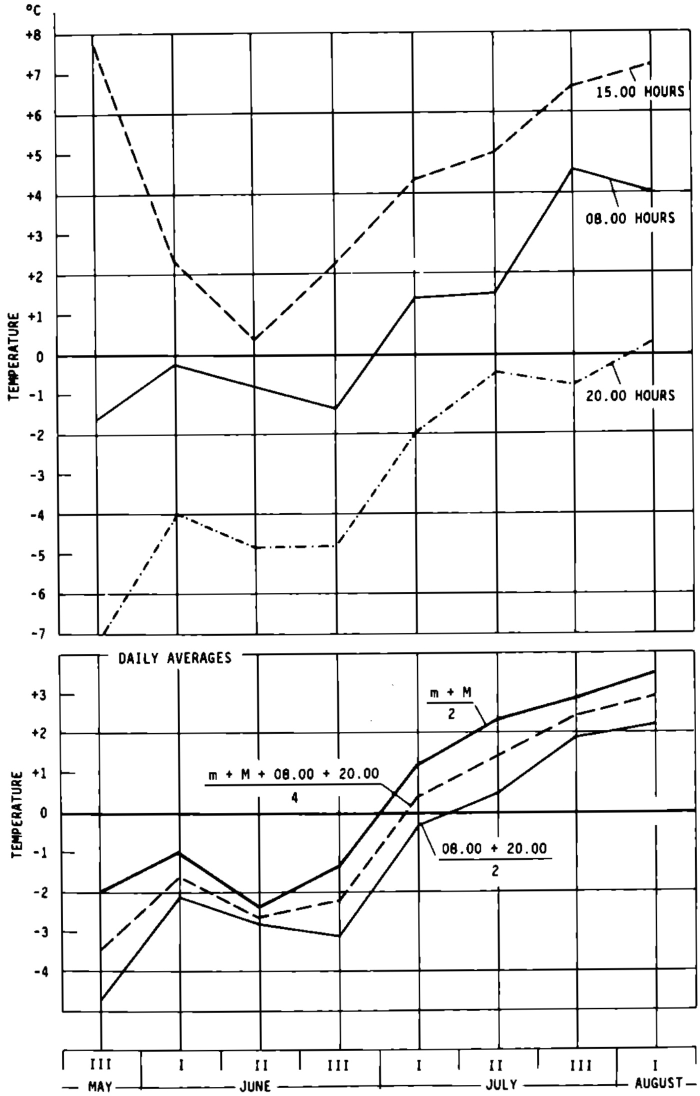

Fig. 35 - ACTUAL AVERAGE TEMPERATURES OF TEN DAY PERIODS CALCULATED FROM THE DAILY AVERAGES AND FROM THOSE AT 08.00, 15.00 AND 20.00 HOURS
Ordinates: temperature in °C, Abscissae: decades - months

In the upper part of the figure the average temperatures of ten day periods are shown, calculated from the averages at 08.00, 15.00 and 20.00 hours. In the lower part the average temperatures of ten day periods are shown, calculated from the daily averages $\frac{m+M}{2}$, $\frac{8+20}{2}$ and $\frac{m+M+8+20}{2}$ representing the averages obtained from halving the sum of the maximum and minimum temperatures and halving the sum of the temperatures at 08.00, 15.00 and 20.00 hours (see pp. 93-119 and N.B. tab. 8 p. 114).

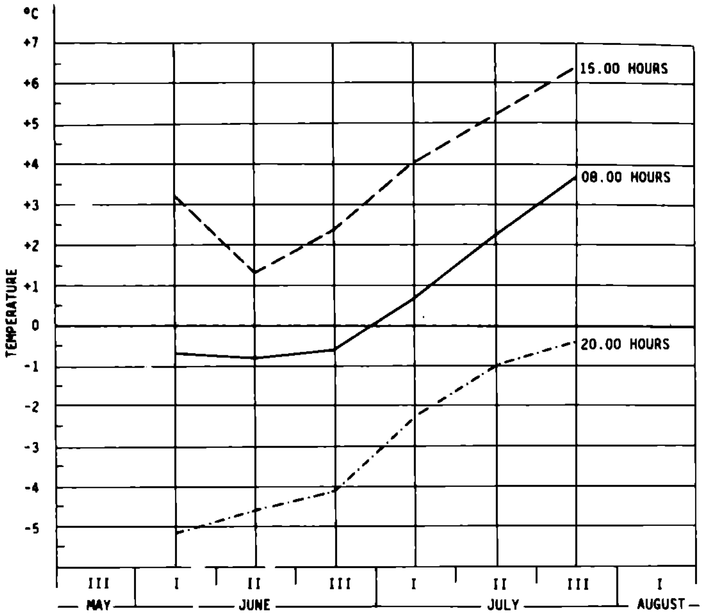

Fig. 36 - EQUALIZED AVERAGE TEMPERATURES OF TEN DAY PERIODS CALCULATED FROM THE AVERAGES AT 08.00, 15.00 AND 20.00 HOURS

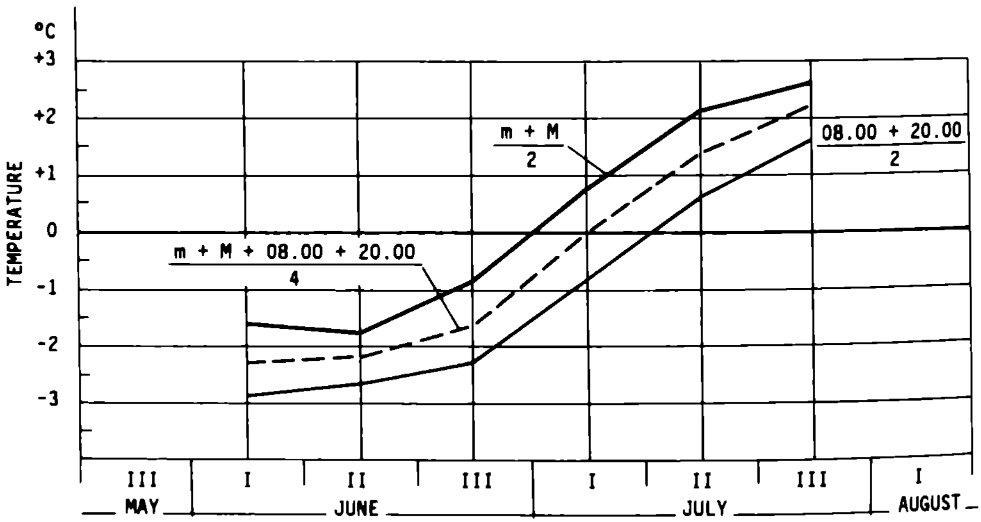

Fig. 37 - EQUALIZED AVERAGE TEMPERATURES OF TEN DAY PERIODS CALCULATED FROM THE DAILY AVERAGES

Ordinates: temperature in °C, Abscissae: decades - months

The figure shows the average temperatures of ten day periods equalized 1/4 - 1/2 - 1/4 calculated from the daily averages and from those at 08.00, 15.00 and 20.00 hours.

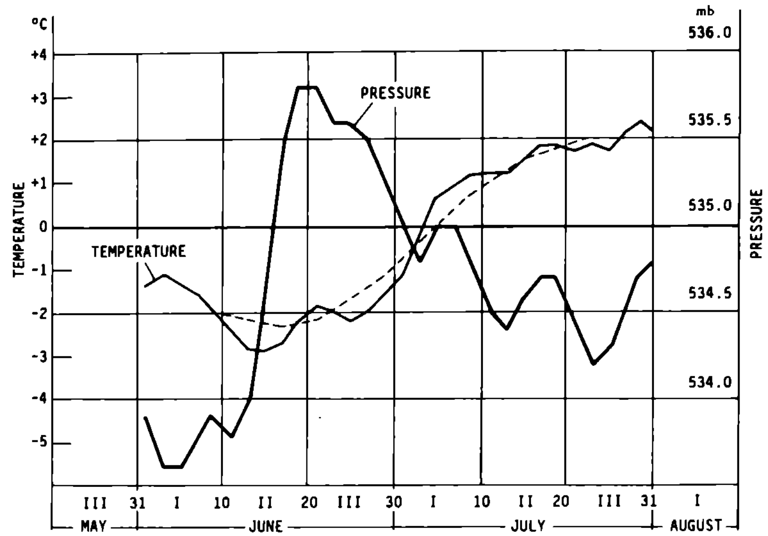

Fig. 38 - AVERAGE DAILY TEMPERATURES AND PRESSURES EQUALIZED ACCORDING TO THE MEAN AXIS
Ordinates: right: pressure in mb, left: temperature in °C
Abscissae: days - decades - months

The figure shows the average daily pressures, equalized according to 1/12 - 1/4 - 1/3 - 1/4 - 1/12 (thick line) compared with the average daily pressures equalized in the same way (thin line), and according to the median of these (broken line) after Vercelli's scheme shown on p. 96 (n. 4).

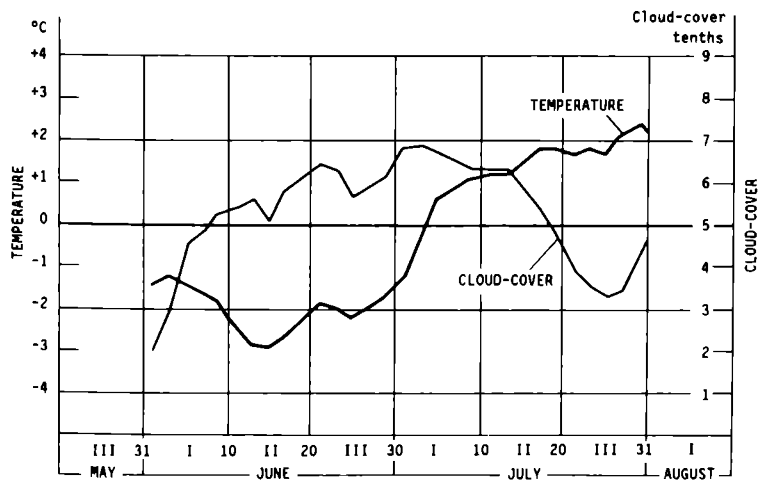

Fig. 39 - AVERAGE DAILY TEMPERATURES AND CLOUD-COVER EQUALIZED ACCORDING TO THE MEAN AXIS
Ordinates: right: cloud-cover in tenths, left: temperature in °C
Abscissae: days - decades - months

The average daily temperatures equalized 1/12 - 1/4 - 1/3 - 1/4 - 1/12 (thick line) are compared with the average daily cloud-cover equalized in the same way (thin line).

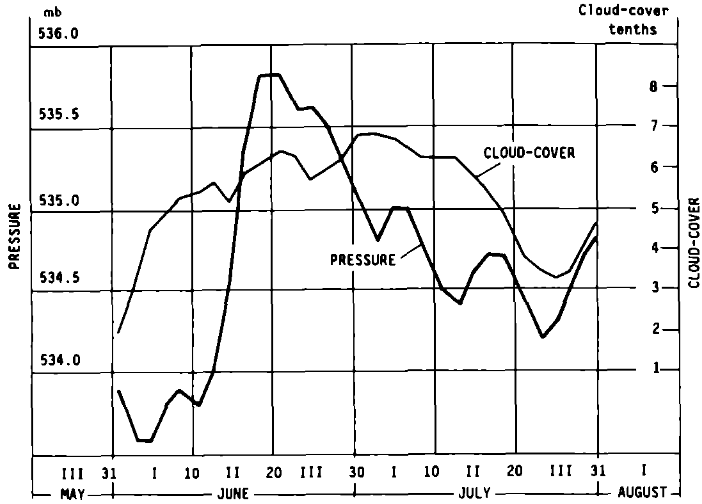

Fig. 40 - AVERAGE DAILY PRESSURES AND CLOUD-COVER EQUALIZED ACCORDING TO THE MEAN AXIS

Ordinates: right: cloud-cover in tenths left: pressure in mb

Abscissae: days - decades - months

The average daily pressures equalized 1/12 - 1/4 - 1/3 - 1/4 - 1/12 (thick line) are compared with the average daily cloud-cover equalized in the same way (thin line).

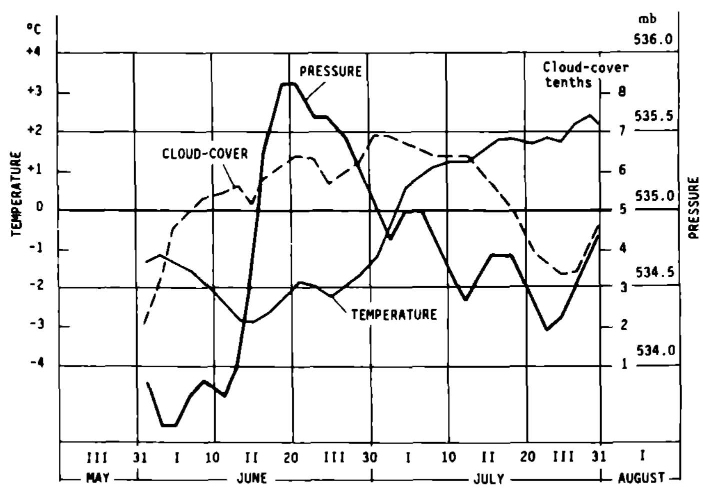

Fig. 41 - AVERAGE DAILY TEMPERATURES, CLOUD-COVER AND PRESSURES EQUALIZED ACCORDING TO THE MEAN AXIS

Ordinates: right: cloud-cover in tenths and pressure in mb left: temperature in °C

Abscissae: days - decades - months

The thick line shows the average daily pressures compared with the average daily cloud-cover (broken line) and with the average daily temperatures (thin line). The three curves under consideration are equalized according to the mean axis.

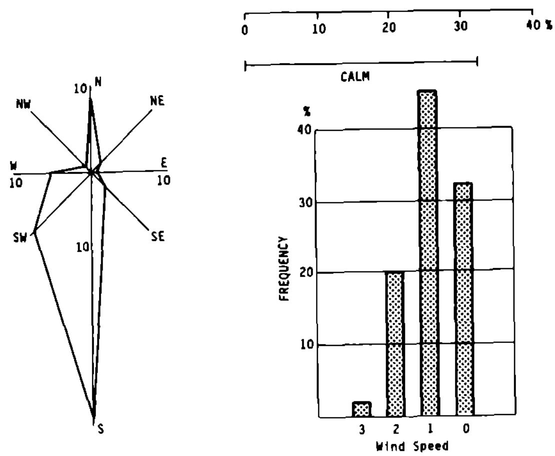

Fig. 42 - FREQUENCY IN % OF WIND DIRECTION AND SPEED DURING THE PERIOD 26/5 - 30/6

On the left the wind direction frequency (in %) is shown. On the right the wind speed frequency (in %) for the first period (May 26 - June 30).

Under the scale of wind direction frequency (in %) can be seen the frequency of the calm days at the base camp when no wind direction was noted.

The diagram for wind speed can be read by applying the wind speed scale used at the base camp to the abscissae (see p. 81) and the frequency (in %) to the ordinates.

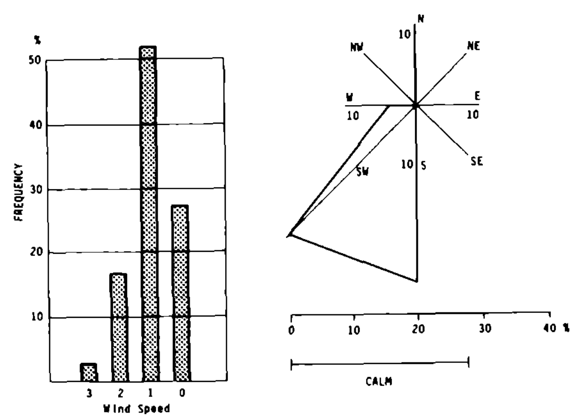

Fig. 43 - FREQUENCY IN % OF WIND DIRECTION AND SPEED DURING THE PERIOD 1/7 - 6/8

Wind speed frequency (in %) is shown on the left, and wind direction frequency (in %) during the second period (July 1 - August 6) is shown on the right.

Under the scale of wind direction frequency (in %) we can see the frequency of calm days. The diagram for wind speed can be read by applying the wind speed scale used at the base camp to the abscissae (see p. 81) and the frequency (in %) to the ordinates.

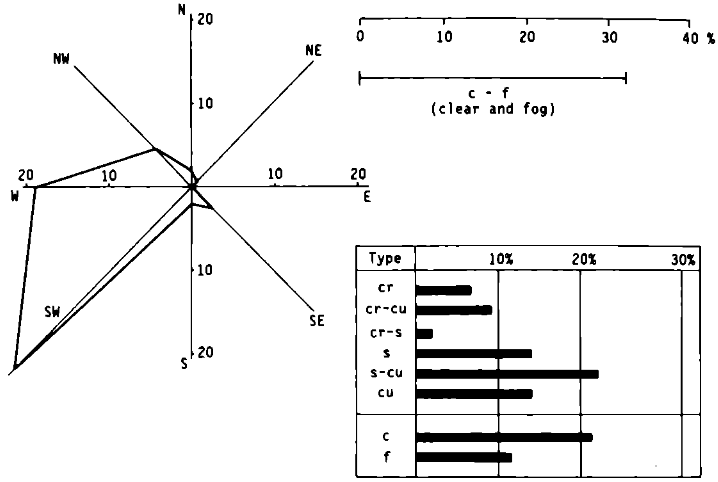

Fig. 44 - FREQUENCY IN % OF CLOUD DIRECTION AND TYPE DURING THE PERIOD MAY 26 - JUNE 30

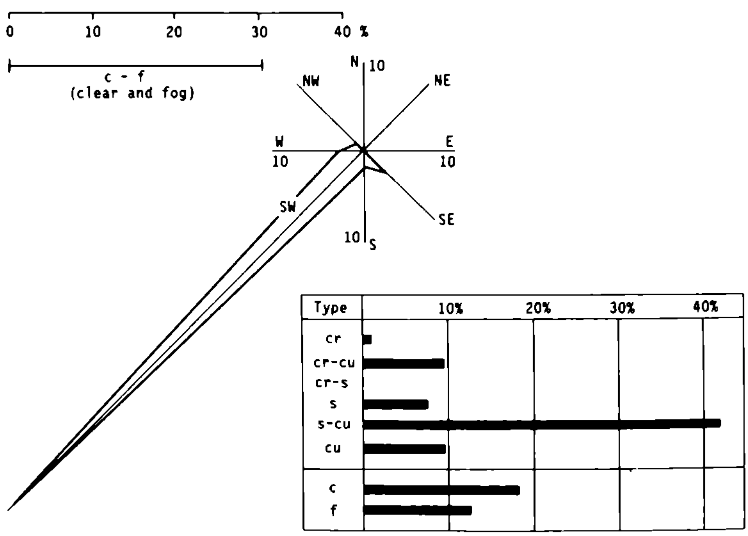

Fig. 45 - FREQUENCY IN % OF CLOUD DIRECTION AND TYPE DURING THE PERIOD JULY 1 - AUGUST 6

The frequencies (in %) of cloud direction are shown on the left while those of cloud type are shown on the right, for the two periods under consideration.

Below the frequency scale (in %) of cloud direction is shown the frequency of clear and foggy weather. For the diagrams of cloud type the frequency values (in %) are on the abscissae while the clouds, from highest to lowest, are on the ordinates.

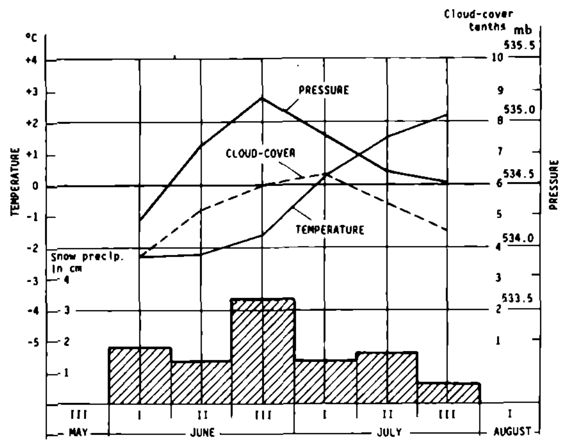

Fig. 46 - THE AVERAGE PRESSURE, TEMPERATURE, CLOUD-COVER AND PRECIPITATIONS OF SNOW OVER TEN DAY PERIODS
Ordinates: right: cloud-cover (tenths) and pressure (mb)
left: temperature °C and height (cm)
Abscissae: decades - months

The curves for the three parameters (temperature, pressure and cloud-cover) have been uniformly equalized 1/4 - 1/2 - 1/4 and are clearly shown in the diagram.

For the precipitations of snow it was preferred, for reasons of continuity with the diagrams which follow, to charge the mode of representation.

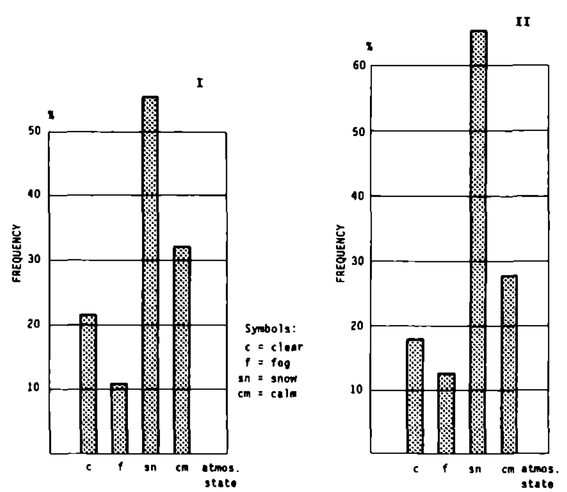

Fig. 47 - FREQUENCY IN % OF ATMOSPHERIC STATE DURING THE PERIOD MAY 26 - JUNE 30 AND PERIOD JULY 1 - AUGUST 6

The first period is on the left, the second is on the right. The frequency of the atmospheric state is represented (in %) by placing the frequency in the ordinates and the atmospheric state on the abscissae (with the symbols c = clear, f = fog, sn = snow, cm = calm).

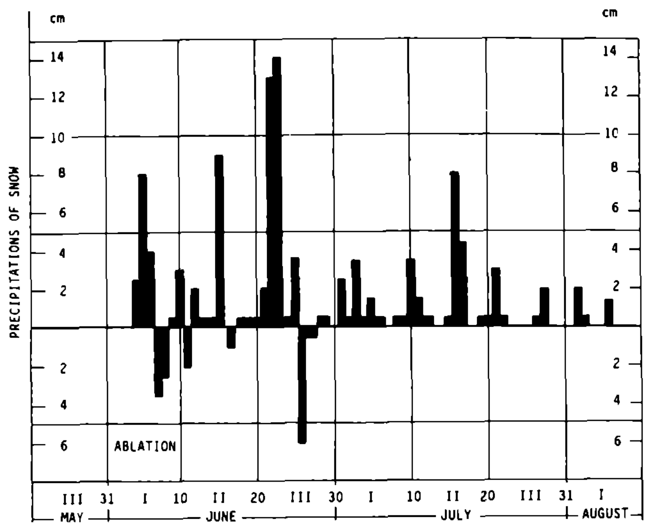

Fig. 48 - AVERAGE DAILY PRECIPITATIONS OF SNOW AND ABLATION

Daily precipitations and ablation are shown. The altitude, in cm., of the precipitations and ablation, is shown on the ordinates.

«Height» indicates the thickness of the precipitations of snow and of the ablation. The following figure has been drawn up from the values of this one.

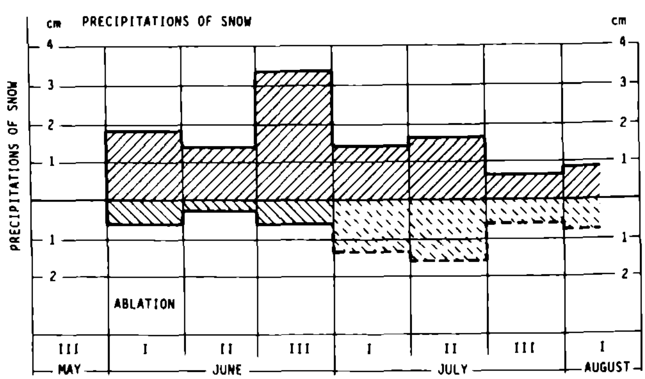

Fig. 49 - AVERAGE PRECIPITATIONS OF SNOW AND RELATION OVER TEN DAY PERIODS

The average precipitations of snow and ablation over ten day periods are recorded on the ordinates. The ten day periods and months are on the abscissae. The broken outline indicates, as stated on pp. 96-122, a hypothesized ablation.

Tab. 3 FREQUENCY OF WIND SPEED (1)

Period I (26/5 - 30/6)

SPEED	Absolute Frequency			Relative Frequency			AF	RF
	08.00	15.00	20.00	08.00	15.00	20.00	Σ	Σ
3	1	1	-	2.8	2.8	-	2	1.8
2	6	13	3	16.6	36.1	8.4	22	20.4
1	18	14	17	50.0	38.9	47.2	49	45.4
0	11	8	16	30.6	22.2	44.4	35	32.4
	36	36	36	100	100	100	108	100

Period II (1/7 - 6/8)

SPEED	Absolute Frequency			Relative Frequency			AF	RF
	08.00	15.00	20.00	08.00	15.00	20.00	Σ	Σ
3	2	1	-	5.7	2.9	-	3	2.9
2	3	13	2	8.6	37.1	5.8	18	17.1
1	18	17	20	51.4	48.6	57.1	55	52.4
0	12	4	13	34.3	11.4	37.1	29	27.6
	35	35	35	100	100	100	105	100

Tab. 4 FREQUENCY OF WIND DIRECTION

Period I (26/5 - 30/6)

DIR.	Absolute Frequency			Relative Frequency			AF	RF
	08.00	15.00	20.00	08.00	15.00	20.00	Σ	Σ
N	4	-	7	11.1	-	19.4	11	10.2
NE	1	1	-	2.8	2.8	-	2	1.8
E	1	-	-	2.8	-	-	1	0.9
SE	-	1	2	-	2.8	5.7	3	2.9
S	13	15	9	36.1	41.7	24.9	37	34.2
SW	3	7	2	8.3	19.4	5.7	12	11.1
W	3	3	-	8.3	8.3	-	6	5.6
NW	-	1	-	-	2.8	-	1	0.9
CALM	11	8	16	30.6	22.2	44.4	35	32.4
	36	36	36	100	100	100	108	100

Period II (1/7 - 6/8)

DIR.	Absolute Frequency			Relative Frequency			AF	RF
	08.00	15.00	20.00	08.00	15.00	20.00	Σ	Σ
N	3	1	8	8.6	2.9	22.9	12	11.4
NE	-	-	-	-	-	-	-	-
E	-	-	1	-	-	2.9	1	1.0
SE	-	-	-	-	-	-	-	-
S	6	15	8	17.1	42.8	22.9	29	27.6
SW	11	14	5	31.4	40.0	14.2	30	28.6
W	3	1	-	8.6	2.9	-	4	3.8
NW	-	-	-	-	-	-	-	-
CALM	12	4	13	34.3	11.4	37.1	29	27.6
	35	35	35	100	100	100	105	100

(1) The comments concerning the tables 3-10 are on the pages 116-117.

Tab. 5 FREQUENCY OF CLOUD TYPE

Period I (26/5 - 30/6)

TYPE	Absolute Frequency			Relative Frequency			AF Σ	RF Σ
	08.00	15.00	20.00	08.00	15.00	20.00		
cr	4	-	3	11.2	-	8.4	7	6.5
cr-cu	6	3	1	16.6	8.4	2.8	10	9.3
cr-s	2	-	-	5.6	-	-	2	1.8
s	7	5	3	19.4	13.9	8.4	15	13.9
s-cu	5	15	4	13.9	41.6	11.1	24	22.2
cu	5	7	3	13.9	19.4	8.4	15	13.9
sr	7	4	12	19.4	11.1	33.2	23	21.3
nb	-	2	10	-	5.6	27.7	12	11.1
	36	36	36	100	100	100	108	100

Period II (1/7 - 6/8)

TYPE	Absolute Frequency			Relative Frequency			AF Σ	RF Σ
	08.00	15.00	20.00	08.00	15.00	20.00		
cr	1	-	-	2.9	-	-	1	0.9
cr-cu	4	5	1	11.4	14.3	2.9	10	9.5
cr-s	-	-	-	-	-	-	-	-
s	5	1	2	14.3	2.9	5.7	8	7.6
s-cu	12	18	14	34.3	51.4	40.0	44	42.0
cu	5	4	1	14.3	11.4	2.9	10	9.5
sr	4	2	13	11.4	5.7	37.1	19	18.1
nb	4	5	4	11.4	14.3	11.4	13	12.4
	35	35	35	100	100	100	105	100

Tab. 6 FREQUENCY OF CLOUD DIRECTION

Period I (26/5 - 30/6)

DIR.	Absolute Frequency			Relative Frequency			AF Σ	RF Σ
	08.00	15.00	20.00	08.00	15.00	20.00		
N	-	2	1	-	5.6	2.8	3	2.8
NE	-	-	1	-	-	2.8	1	0.9
E	-	-	-	-	-	-	-	-
SE	3	1	-	8.4	2.8	-	4	3.7
S	1	1	1	2.8	2.8	2.8	3	2.8
SW	13	15	6	36.0	41.6	16.6	34	31.4
W	9	8	4	25.0	22.2	11.2	21	19.5
NW	3	3	1	8.4	8.4	2.8	7	6.5
sr-nb	7	6	22	19.4	16.6	61.0	35	32.4
	36	36	36	100	100	100	108	100

Period II (1/7 - 6/8)

DIR.	Absolute Frequency			Relative Frequency			AF Σ	RF Σ
	08.00	15.00	20.00	08.00	15.00	20.00		
N	-	-	-	-	-	-	-	-
NE	-	-	-	-	-	-	-	-
E	-	-	-	-	-	-	-	-
SE	4	-	-	11.4	-	-	4	3.8
S	1	-	1	2.8	-	2.8	2	1.9
SW	21	25	17	60.0	71.4	48.6	63	60.0
W	1	2	-	2.9	5.7	-	3	2.9
NW	-	1-	-	2.9	2.9	1	1	0.9
sr-nb	9	7	17	22.9	20.0	48.6	32	30.5
	35	35	35	100	100	100	105	100

Tab. 7 METEOROLOGICAL DATA AT 0.8.00, 15.00 AND 20.00 HOURS

V/VI	PRESSURE mb			TEMPERATURE °C			CLOUD COVER 0-10			CLOUD TYPE			CLOUD DIRECTION			WIND SPEED			WIND DIR.		
g.	08.00	15.00	20.00	08.00	15.00	20.00	08.00	15.00	20.00	08.00	15.00	20.00	08.00	15.00	20.00	08.00	15.00	20.00	08.00	15.00	20.00
26	532.8	532.2	534.1	-3.0	1.0	-9.0	0	1	5	-	cu	s cu	-	W	W	-	1	2	-	SE	S
27	533.5	533.2	532.8	1.0	-1.0	-10.00	2	2	1	cu	cu	cu	NW	NW	NW	1	1	1	S	S	SW
28	533.5	534.0	534.1	-7.0	3.0	-5.0	0	1	2	-	-	cu	-	-	SW	1	-	1	NE	-	SE
29	536.1	536.1	536.1	-1.0	17.0	-4.0	0	0	0	-	-	-	-	-	-	1	-	-	E	-	-
30	536.4	535.8	534.5	-2.5	17.0	-7.0	0	0	0	-	-	-	-	-	-	1	-	-	S	-	-
31	534.1	533.8	534.1	3.0	10.0	-12.0	1	4	1	cu	s cu	-	W	W	-	-	1	-	-	S	-
1	533.2	532.5	532.8	-4.0	5.0	-4.0	0	3	1	-	s cu	s	-	N	-	-	1	-	-	SW	-
2	534.1	532.5	533.8	0.0	4.0	-3.0	0	1	1	-	s cu	s	-	N	-	-	1	-	-	SW	-
3	533.9	533.2	534.1	0.5	2.0	-5.0	0	0	0	-	-	-	-	-	-	-	-	1	-	-	N
4	534.7	533.0	533.2	3.3	2.5	-1.5	1	4	10	cr cu	cr cu	-	W	NW	-	1	2	-	N	NW	-
5	531.4	531.7	532.2	1.5	-1.5	-3.0	8	8	9	cu	cu	s	W	W	-	2	3	1	W	W	SE
6	533.2	532.6	534.0	-2.0	0.0	-5.0	8	7	6	s cu	s cu	s cu	W	W	-	1	1	-	W	W	-
7	535.0	534.2	535.3	-4.0	3.0	-4.0	8	4	7	s	cu	cr cu	W	W	NE	1	1	-	W	NE	-
8	532.6	533.4	535.9	1.0	1.8	-5.0	2	4	1	cr	cr cu	cu	SW	NW	-	1	1	2	N	S	N
9	534.9	534.5	535.3	0.5	5.5	-4.0	1	3	0	cr cu	cr cu	-	SW	SW	-	-	2	1	-	S	N
10	535.7	534.4	534.7	0.8	0.5	-5.0	8	10	10	s cu	-	s cu	NW	-	-	-	-	-	-	-	-
11	535.0	532.7	534.7	-3.0	7.0	-3.0	4	5	2	cr	cu	cr	SW	SW	N	1	1	1	N	SW	N
12	534.0	532.7	534.0	1.5	3.0	-4.0	2	8	10	cr	s cu	cr	W	SW	S	-	2	1	-	S	S
13	532.7	531.7	532.7	-1.5	-2.5	-6.0	3	10	5	cu	s	s	SW	S	-	1	2	-	S	SW	-
14	532.6	531.5	531.9	-1.5	-3.5	-5.0	5	9	8	s	s	s	SE	SW	SW	2	2	2	S	S	S
15	531.7	532.6	534.0	-4.0	-3.0	-9.0	10	7	5	s	s cu	s cu	W	W	SW	1	1-2	-	S	S	-
16	535.3	534.4	536.0	-3.0	-2.0	-6.0	3	6	5	s cu	s cu	s cu	NW	S	W	1	2	1	S	S	S
17	536.3	536.0	537.3	-1.0	0,5	-6.0	3	5	1	cr cu	s cu	cr	W	W	W	1	1	1	S	SW	N
18	538.0	537.4	537.4	2.0	1.0	-3.5	3	9	1	cr s	s cu	-	W	W	-	1	1	1	S	S	S
19	538.0	537.6	538.1	1.0	1.5	-2.0	2	10	7	cr cu	s cu	s cu	SW	-	-	1	2	-	S	S	-
20	537.4	537.5	537.3	2.0	2.0	-3.0	7	5	10	s cu	s cu	s	SW	SW	SW	2	-	1	SW	-	SW
21	537.3	537.5	536.7	-1.8	2.0	-3.0	10	5	5	s	s cu	s cu	SW	SW	SW	1	1	1	SW	SW	S
22	534.4	534.0	530.4	-2.0	0.0	-4.0	10	10	10	s	s	s	SW	SW	SW	3	2	1	S	S	S

Tab. 7 continued (1)

VI/VII	PRESSURE mb			TEMPERATURE °C			CLOUD COVER 0-10			CLOUD TYPE			CLOUD DIRECTION			WIND SPEED			WIND DIR.		
g.	08.00	15.00	20.00	08.00	15.00	20.00	08.00	15.00	20.00	08.00	15.00	20.00	08.00	15.00	20.00	08.00	15.00	20.00	08.00	15.00	20.00
23	532.7	533.7	534.0	-2.0	0.5	-7.0	10	10	0	s	s	-	SW	SW	-	2	2	-	S	S	-
24	534.0	533.4	535.7	1.0	3.0	-7.0	8	4	0	cu	cu	-	S	SW	-	1	2	-	SW	S	-
25	535.7	534.6	536.0	-0.5	0.5	-4.0	10	10	10	s	s	s	SW	SW	-	2	2	1	S	SW	S
26	536.0	535.3	537.4	1.0	4.0	-4.0	5	5	0	cr s	s cu	-	SW	SW	-	2	2	-	S	S	-
27	537.4	538.1	537.5	-8.0	4.0	-4.0	4	5	1	s cu	s cu	-	SW	SW	-	-	1	-	-	S	-
28	537.2	537.0	537.3	-1.0	4.0	-5.0	1	5	0	cr	cu	-	SW	SW	-	-	-	1	-	-	N
29	537.0	535.9	536.2	-1.0	1.0	-6.0	2	9	0	cr cu	s cu	-	SE	SW	-	1	-	1	N	-	N
30	536.7	533.8	532.8	0.0	3.0	3.5	2	9	10	cr cu	s cu	-	SE	SE	-	-	1	1	-	W	S
1	532.7	532.8	533.2	-1.0	3.0	-4.5	10	10	10	-	-	-	-	-	-	1	1	1	S	S	S
2	533.0	532.0	532.7	4.8	1.5	-4.0	4	10	10	cr cu	-	s cu	SW	-	SW	-	1	-	-	S	-
3	534.0	533.0	534.7	-1.0	3.2	-4.0	10	10	5	-	cu	s cu	-	SW	SW	-	2	1	-	S	S
4	535.9	534.6	534.7	1.0	7.0	-4.0	9	5	2	s	s cu	s cu	SW	SW	SW	1	1	1	W	S	S
5	536.0	535.9	536.0	1.0	4.0	-0.5	5	10	5	s cu	s cu	s cu	S	SW	SW	1	3	1	W	W	S
6	537.3	535.7	537.0	2.5	6.0	0.0	5	4	5	s cu	s cu	s cu	SW	SW	SW	1	1	1	S	S	S
7	536.8	535.7	535.7	2.5	7.5	1.0	5	5	2	-	s cu	cu	-	SW	SW	-	2	1	-	S	S
8	536.0	535.2	535.3	3.3	6.0	0.0	9	7	3	-	s cu	s cu	-	SW	SW	1	2	-	S	S	-
9	534.0	534.4	535.1	2.0	3.0	-2.0	9	10	6	s cu	s cu	s cu	SE	SW	SW	2	2	1	SW	SW	SW
10	533.5	533.9	533.0	-1.0	1.7	-1.5	4	10	8	cu	s cu	s cu	W	SW	SW	3	2	1	SW	SW	SW
11	532.7	532.8	532.7	-2.0	3.0	-2.0	10	10	6	s	s cu	s cu	SW	SW	SW	3	1	1	SW	SW	S
12	534.4	533.7	534.9	5.0	4.0	-2.0	7	6	1	s cu	s cu	-	SW	W	-	1	1	-	SW	SW	-
13	536.0	535.4	535.0	-2.0	6.0	0.0	7	5	1	s cu	-	-	SW	-	-	-	-	-	-	-	-
14	534.7	533.4	535.3	2.5	9.5	2.0	0	4	8	-	cu	s cu	-	SW	-	1	1	1	SW	SW	S
15	534.7	534.0	535.3	2.0	6.0	2.0	8	7	10	s cu	s cu	s	SW	SW	SW	1	1	-	S	S	-
16	534.3	535.0	534.7	1.0	0.2	-0.8	10	10	10	s	s	-	SW	SW	-	1	2	2	SW	SW	SW
17	534.7	534.0	536.0	0.0	4.0	-2.0	9	5	0	s cu	cu	-	SW	SW	-	2	2	1	SW	S	N
18	536.7	535.0	536.7	2.0	7.0	0.0	0	0	1	-	-	cr cu	-	SW	SW	1	1	-	N	SW	-
19	535.3	533.7	534.6	4.5	5.6	0.2	6	6	5	s cu	cr cu	cr cu	SW	W	-	-	1	-	-	SW	-
20	534.2	533.0	534.4	2.0	5.0	-2.0	1	2	4	s	s cu	s cu	SW	SW	SW	1	2	1	SW	SW	SW

Tab. 7 continued (2)

VII/VIII	PRESSURE mb			TEMPERATURE °C			CLOUD COVER 0-10			CLOUD TYPE			CLOUD DIRECTION			WIND SPEED			WIND DIR.		
g.	08.00	15.00	20.00	08.00	15.00	20.00	08.00	15.00	20.00	08.00	15.00	20.00	08.00	15.00	20.00	08.00	15.00	20.00	08.00	15.00	20.00
21	534.0	533.9	534.0	2.0	3.2	1.8	6	4	2	s cu	s cu	s cu	SW	SW	SW	1	1	1	SW	SW	SW
22	534.5	534.0	535.3	4.0	6.0	-1.5	7	5	1	s cu	s cu	-	SW	SW	-	2	2	1	SW	SW	E
23	536.0	533.2	537.3	3.0	5.0	-1.5	5	4	0	cu	-	-	SW	-	-	1	-	1	S	-	N
24 25	542.5 534.7	533.0	534.9	2.5	4.0	-1.8	0	0	0	-	-	-	-	-	-	-	1	1	-	-	-
26	533.4	532.8	532.4	2.0	4.2	-2.0	0	0	0	-	s cu	-	-	SW	-	-	1	1	-	S	N
27	531.9	531.5	532.7	4.0	3.0	-1.0	6	10	5	cr cu	-	s cu	SW	-	-	1	1	-	SW	S	-
28	533.4	534.3	535.3	6.0	6.0	-1.0	5	9	0	cu	s cu	-	SW	SW	-	-	2	1	-	SW	N
29	536.7	536.3	537.2	6.2	9.5	-2.0	1	7	0	cr	cr cu	-	SW	SW	-	-	2	1	-	SW	N
30	536.9	535.5	536.4	7.0	8.5	-2.0	0	0	0	-	-	-	-	-	-	-	1	1	-	N	N
31	536.0	533.7	535.3	9.0	10.5	1.0	9	4	0	cu	cr cu	-	SW	SW	-	-	-	2	-	-	N
1	534.7	532.2	534.1	7.0	14.0	2.0	3	3	3	cr cu	cr cu	-	SE	NW	-	1	1	-	N	S	-
2	534.7	534.0	535.2	1.0	2.5	0.0	10	10	7	-	-	s cu	-	SW	SW	-	2	-	-	S	-
3	535.2	535.3	535.9	3.0	4.0	0.0	8	10	9	s	-	-	SE	-	-	-	2	-	-	S	-
4	535.5	534.0	534.7	3.2	11.0	0.0	7	5	0	s cu	s cu	-	SW	SW	-	1	1	-	S	SW	-
5	533.7	532.4	532.7	6.0	8.0	0.0	7	5	0	cu	cu	-	SE	SW	-	1	1	1	N	S	N
6	533.5	532.4	533.5	4.0	3.8	0.0	5	7	5	cr cu	s cu	s cu	SW	SW	SW	1	-	-	W	-	-
TEN DAY PERIODS																					
M. III	534.4	534.2	534.3	-1.6	7.8	-7.8	0.5	1.3	1.5							0.7	0.5	0.7			
JUNE I	533.9	533.2	534.1	-0.2	2.3	-4.0	3.6	4.4	4.5							0.6	1.2	0.5			
JUNE II	535.1	534.4	535.3	-0.8	0.4	-4.8	4.2	7.4	5.4							1.1	1.5	0.8			
JUNE III	535.8	535.3	535.4	-1.4	2.2	-4.8	6.2	7.2	3.6							1.2	1.3	0.6			
JULY I	534.9	534.3	534.7	1.4	4.3	-2.0	7.0	8.1	5.6							1.0	1.7	0.8			
JULY II	534,8	534.0	535.0	1.5	5.0	-0,5	5.8	5.5	4.6							1.1	1.2	0.6			
JULY III	534,8	533.9	535.1	4.6	6.6	-0,8	3.9	4.3	0.8							0.5	1.0	0.9			
A I	534.6	533.4	534.4	4.0	7.2	0.3	6.7	6.7	4.0							0.7	1.2	0.2			

Tab. 8 AVERAGE PRESSURE, TEMPERATURE, NUVOLOSITY AND WIND SPEED both daily and over tenday periods

V/VI	PRESS.	TEMPERATURE °C				CLOUD COVER	WIND
g.	mb	(8 + 20)/2	(m + M)/2	m.	M	0-10	VEL
26	533.0	-6.0	-7.0	-20.0	6.0	2.0	1.0
27	533.2	-4.5	-5.5	-14.0	3.0	1.7	1.0
28	533.9	-6.0	-5.0	-15.0	5.0	1.0	0.7
29	536.1	-2.5	1.5	-14.0	17.0	-	0.3
30	535.6	-4.8	4.5	-8.0	17.0	-	0.3
31	534.0	-4.5	-0.5	-14.0	13.0	2.0	0.3
	534.3	-4.7	-2.0	-14.2	10.2	1.1	0.6
1	532.8	-4.0	0.5	-4.0	5.0	1.3	0.3
2	533.5	-1.5	0.5		4.0	0.7	0.3
3	533.7	-2.2	0.5	(*)		-	0.3
4	533.6	0.9	0.5	-11.0	12.0	5.0	1.0
5	531.8	-0.8	-0.5			8.3	2.0
6	533.3	-3.5	-2.0			7.0	0.7
7	534.8	-4.0	-3.0	-9.0	3.0	6.3	0.7
8	534.0	-2.0	-4.1	-10.0	1.8	2.3	1.3
9	534.9	-1.8	-0.5	-6.5	5.5	1.3	1.0
10	534.9	-2.1	-1.5	-7.0		7.3	-
	533.7	-2.1	-1.0			4.0	0.8
11	534.1	-3.0	-1.7		7.0	3.7	1.0
12	533.6	-1.8	1.0		3.0	6.7	1.0
13	532.4	-3.8	-4.2			6.0	1.0
14	532.0	-3.2	-4.2			7.3	2.0
15	532.8	-6.5	-6.0			7.3	1.0
16	535.2	-4.5	-4.0			4.7	1.3
17	536.5	-3.5	-2.8			3.0	1.0
18	537.6	-0.8	-2.6			4.3	1.0
19	537.9	-0.5	-1.2			6.3	1.0
20	537.4	-0.5	-0.5			7.3	1.0
	535.0	-2.8	-2.3			5.7	1.1

VII/VII	PRESS.	TEMPERATURE °C				CLOUD COVER	WIND
g.	mb	(8 + 20)/2	(m + M)/2	m.	M	0-10	VEL
21	537.2	-2.4	-0.5			6.7	1.0
22	532.9	-3.0	-2.0			10.0	2.0
23	533.5	-4.5	-3.2			6.7	1.3
24	534.4	-3.0	-2.0			4.0	1.0
25	535.4	-2.2	-1.8			10.0	1.7
26	536.2	-1.5	0.0			3.3	1.3
27	537.7	-6.0	0.0			3.3	0.3
28	537.2	-3.0	-0.5			2.0	0.3
29	536.4	-3.5	-2.5			3.7	0.7
30	534.4	-1.8	-0.2			7.0	0.7
	535.5	-3.1	-1.3			5.7	1.0
1	532.9	-2.8	-0.8			10.0	1.0
2	532.6	0.4	-1.2			8.0	0.3
3	533.9	-2.5	-0.4			8.3	1.0
4	535.1	-1.5	1.5			5.3	1.0
5	536.0	0.2	1.8			6.7	1.7
6	536.7	1.2	3.0			4.7	1.0
7	536.1	1.4	4.2			3.5	1.0
8	535.5	1.6	3.0			6.3	1.0
9	534.5	0.0	0.5			8.3	1.7
10	533.5	-1.2	0.1			7.3	2.0
	534.7	-0.3	1.2			6.8	1.2
11	532.7	-2.0	0.0			8.7	1.7
12	534.3	1.5	2.0			4.7	0.7
13	535.5	-1.0	4.0			4.0	-
14	534.5	2.2	5.8			4.0	1.0
15	534.7	2.0	2.0			8.3	0.7
16	534.7	0.1	0.5			10.0	1.7
17	534.9	-1.0	1.0			4.7	1.7

VII/VIII	PRESS.	TEMPERATURE °C				CLOUD COVER	WIND
g.	mb	(8 + 20)/2	(m + M)/2	m.	M	0-10	VEL
18	536.1	1.0	3.5			0.7	0.7
19	534.5	2.4	2.9			5.7	0.3
20	533.9	0.0	1.5			6.0	1.3
	534.6	0.5	2.3			5.7	0.1
21	534.0	2.9	2.5			4.0	1.0
22	534.6	1.2	3.8			4.3	1.7
23	535.5	0.8	2.0			2.5	0.7
24	534.2	0.4	1.6			-	0.7
25							
26	532.9	0.0	1.1			3.3	0.7
27	532.0	1.5	1.5			7.0	0.7
28	534.3	2.5	2.5			4.7	1.0
29	536.7	2.1	3.8			3.3	1.0
30	536.3	2.5	3.2			-	0.7
31	535.0	5.0	5.5			4.3	0.7
	534.6	1.9	2.8			3.3	0.8
1	533.7	4.5	5.0			3.0	0.7
2	534.7	0.5	1.2			9.0	0.7
3	535.5	1.5	2.0			9.0	0.7
4	534.7	1.6	5.5			4.0	0.7
5	532.9	3.0	4.0			4.0	1.0
6	533.1	2.0	3.0			5.7	0.3
	534.1	2.2	3.4			5.8	0.7

(*) The mercury in the column of the thermometer became separated and it was impossible to join it up again (Desio)

N.B. From now on the average m+M will be obtained from the minimum temp. and that at 15.00 hours

Tab. 9 TEN DAY AVERAGE

MONTH	DEC	PRESS. mb			TEMP. °C			CLOUD COVER 0-10			WIND-SPEED		
		08.00	15.00	20.00	08.00	15.00	20.00	08.00	15.00	20.00	08.00	15.00	20.00
MA	III	534.4	534.2	534.3	-1.6	7.8	-7.8	0.5	1.3	1.5	0.7	0.5	0.7
JUNE	I	533.9	533.2	534.1	-0.2	2.3	-4.0	3.6	4.4	4.5	0.6	1.2	0.5
	II	535.1	534.4	535.3	-0.8	0.4	-4.8	4.2	7.4	5.4	1.1	1.5	0.8
	III	535.8	535.3	535.4	-1.4	2.2	-4.8	6.2	7.2	3.6	1.2	1.3	0.6
JULY	I	534.9	534.3	534.7	1.4	4.3	-2.0	7.0	8.1	5.6	1.0	1.7	0.8
	II	534.8	534.0	535.0	1.5	5.0	-0.5	5.8	5.5	4.6	1.1	1.2	0.6
	III	534.8	533.9	535.1	4.6	6.6	-0.8	3.9	4.3	0.8	0.5	1.0	0.9
AUG	I	534.6	533.4	534.4	4.0	7.2	0.3	6.7	6.7	4.0	0.7	1.2	0.2

MONTH	DEC	PRESS.	TEMP. °C			CLOUD	WIND
		mb	$\frac{8+20}{2}$	$\frac{m+M}{2}$	$\frac{8+20+m+M}{4}$	0-10	SPEED
MA	III	534.3	-4.7	-2.0	-3.4	1.1	0.6
JUNE	I	533.7	-2.1	-1.0	-1.6	4.1	0.8
	II	535.0	-2.8	-2.3	-2.6	5.6	1.1
	III	535.5	-3.1	-1.3	-2.2	5.6	1.0
JULY	I	534.7	-0.3	1.2	0.4	6.9	1.2
	II	534.6	0.5	2.3	1.4	5.3	1.0
	III	534.6	1.9	2.8	2.4	3.0	0.8
AUG	I	534.1	2.2	3.4	2.8	5.8	0.7

Tab. 10 MONTHLY AVERAGES (JUNE-JULY) AND AVERAGES FOR THE PERIODE SPENT AT BASE CAMP

MONTH	PRESS. mb			TEMP. °C			CLOUD COVER 0-10			WIND-SPEED		
	08.00	15.00	20.00	08.00	15.00	20.00	08.00	15.00	20.00	08.00	15.00	20.00
VI	534.9	534.3	534.9	-0.8	1.6	-4.5	4.7	6.3	4.5	1.0	1.3	0.6
VII	534.8	534.1	534.9	2.5	5.3	-1.1	5.6	6.0	3.7	0.9	1.3	0.8
Average VI-VII	534.8	534.2	534.9	0.8	3.4	-2.8	5.2	6.2	4.1	1.0	1.3	0.7
Average 8 dec.	534.8	534.1	534.8	0.9	4.5	-3.0	4.7	5.6	3.8	0.9	1.2	0.6

MONTH	PRESS.	TEMP. °C			CLOUD	WIND
	mb	$\frac{8+20}{2}$	$\frac{m+M}{2}$	$\frac{8+20+m+M}{4}$	0-10	SPEED
VI	534.7	-2.7	-1.5	-2.1	5.1	1.0
VII	534.6	0.7	2.1	1.4	5.1	1.0
Average VI-VII	534.6	-1.0	0.3	-0.4	5.1	1.0
Average 8 dec.	534.6	-1.1	0.4	-0.4	4.7	0.9

COMMENTS CONCERNING THE TABLES

Tab. 1 - COORDINATES AND ALTITUDE / PRESSURE / TEMPERATURE / PRECIPITATION

Tab. 2 - ORIGINAL METEOROLOGICAL DATA TAKEN DURING THE EXPEDITION

Tab. 3 - FREQUENCY AND WIND SPEED

Tab. 4 - FREQUENCY OF WIND DIRECTION

For the wind speed frequency and the wind direction frequency, two periods are under consideration (see p. 97). In the first period 36 measurements were taken at 08.00, 36 at 15.00 and 36 at 20.00 hours, while in the second 35 were taken. In total 108 measurements were taken in the first period and 105 in the second. An absolute frequency is shown (number of measurements referred to the 36 totals in the first period and the 35 in the second). There is also a relative frequency in %.

In the third column, for both the first and the second periods, the sums of the absolute frequencies at the various times are shown, thus representing the absolute average daily frequencies during both periods.

In the fourth column, again referring to wind velocity and direction for both periods, we can see the totals of the relative frequencies in %, obtained from the following ratio:

sum of the absolute frequencies: total number of readings = x : 100 (x = sum of relative frequencies).

Such values represent the relative average daily frequencies in % for the two periods. Figs. 42-43 p. 105 are obtained from the values recorded in tabs. 3-4 p. 109.

Tab. 5 - FREQUENCY OF CLOUD TYPE

Tab. 6 - FREQUENCY OD CLOUD DIRECTION

Two periods are also considered for cloud type and direction (see p. 97). As far as concerns the absolute and relative frequencies and the sums of the absolute and relative frequencies, the same considerations apply as those give in the explanations for tabs. 3-4 p. 109.

Cloud type has been shown, beginning with the highest and going down to the lowest (from cirrus at cumulus). The frequencies of clear and foggy weather are separated by a line. For obvious reasons, neither cloud type or direction were recorded on these days.

Fig. 44-45 p. 106 have been obtained from the contained in tabs. 5-6 p. 110.

Tab. 7 - METEOROLOGICAL DATA AT 08.00, 15.00 AND 20.00 HOURS (pp. 111-113)

This table shows meteorological data, systematically collected at 08.00, 15.00 and 20.00 hours, for pressure (mb), temperature (°C), cloud-cover (tenths), cloud type and direction and wind speed and direction.

The bar under the headings «cloud type and direction» means that the sky was clear or occluded, while under the headings «wind speed and direction» it signifies a calm day.

The values of the pressures and temperatures marked with a dot have been added by means of extrapolations and logical considerations obtained by comparing data and situations met during the present analytical study.

On page 113 (Tab. 7(2)) the average pressure, temperature, cloud-cover and wind speed for ten day periods have been shown separately for reasons of greater clarity.

Tab. 8 - AVERAGES OF PRESSURE, TEMPERATURE, CLOUD-COVER AND WIND SPEED, BOTH DAILY AND OVER TEN DAY PERIODS

The values of the daily and ten day averages of the pressure, temperature, cloud-cover and wind speed are shown.

For the temperature (see pp. 93-119) the averages obtained from half the sum of the maximum and minimum temperatures and those at 08.00 and 20.00 hours are considered (see also tab. 8 p. 114).

Tab. 9 - AVERAGE FOR TEN DAY PERIODS

Tab. 10 - MONTHLY AVERAGES (JUNE - JULY) AND AVERAGES FOR THE PERIOD SPENT AT BASE CAMP

In table 9 are shown the ten day averages from which all the figures of the day averages are derived (fig. 19 - 20 - 21 - 22 - 23 - 32).

The following table (tab. 10) is drawn up from the values in the above mentioned table (tab. 9) showing the monthly averages for June and July, the total average for the two months and for the 8 ten day periods under consideration in the present study. These represent, in their entirety, the whole period spent by the expedition at the base camp: May 26 - August 6.

4. Results of the study

4.1. Atmospheric pressure

The average daily atmospheric pressure (fig. 31) ranges between a minimum of 531.8 mb and a maximum of 537.9 mb. Daily changes in pressure, however, varied between slightly wider limits, as can be seen in tab. 7, where one can see minimums of 530.4 mb and maximums of 538.1 mb.

In fig. 32 one sees the repetition of high and hence low pressures at periods of 5-6 days, while if one considers the median of the daily average pressures (fig. 31) one notes an increase of the median up to the end of the second decade of June folowed by a steady drop until halfway through the third decade of July; at this point the median tends to go up.

If we refer to the average pressures of ten day periods calculated from the daily averages and from the averages of 08.00, 15.00 and 20.00 hours (fig. 33) one can see that the curves for 08.00 hours, 15.00 hours and the median are almost parallel. The curve for 20.00 hours, on the other hand, has a behaviour all of its own: it generally gives high pressure values compared with those of other times, resulting from the fact that towards evening the weather in the base camp area often cleared up which gave those on the expedition cause to hope that there might be suitable clear weather for carrying on the ascent to the summit.

They would be disappointed promptly at 9.00 hours the following day, and this is shown in fig. 33 where we can see that the curve gives lower values than those at 20.00 hours except in the period between the third decade of June and the first of July.

Fig. 34 shows average cloud-cover over ten day periods, and confirms what has already been said: the sky became clear towards evening after having been completely overcast at 15.00 hours. In fig. 38-41 the average daily temperature, pressure and cloud-cover have been compared, and one sees how the cloud-cover was always rather high even when the pressure increased as, for example, during the second and third decades of June, while the temperature (fig. 41) was constantly rising after a drop from halfway through the second decade of June until halfway through the next one, coinciding with the rise in atmospheric pressure. During the whole of the expedition's stay at base-camp, the atmospheric pressure kept around an average of 534.6 mb (tab. 10).

4.2. Temperature

Unlike the pressure, the temperature gives curves at 08.00 and 20.00 hours which are parallel to the median.

In fig. 35-37 one can see three median curves: $\frac{m + M}{2}$ (thick line), $\frac{8 + 20}{2}$ (thin line) and $\frac{m + M + 8 + 20}{2}$ (broken line), this one being the average between the first two which is then taken into consideration for the following diagrams.

The curve for 15.00 hours shows, in the second decade of June, a drop which is not found at 08.00 and 20.00 hours. The continual rise in temperature between the third decade of June and the first decade of June should be stressed, which reaches and exceeds 0°C, and then continues to rise fairly consistently.

The temperature values for 15.00 hours are the highest, as this time was when the temperature was highest. Sometimes, of course, the temperature at this time is not the highest of the day, because of atmospheric disturbances, sudden storms or winds. Temperature and cloud-cover (fig. 39) behave normally: as long as the temperature remains a few degrees below zero the cloud cover is dense, then halfway through the first decade of July the temperature rises above zero and begins to increase, while the cloud-cover decrease.

Temperature and pressure, as already been seen, are illustrated in fig. 38 and it is interesting to note how the diagram can be divided into three parts: the first, which lasts until halfway through the second decade of June, shows a simultaneous drop in temperature and rise in pressure which increases, in the second part, until halfway through the first decade of July, while the temperature, although always low, gives signs of going up. Finally there is a third part in which the temperature is above 0°C and the pressure tends to have values as low as an average daily minimum of 534.4 mb. So in the months of July and August, temperatures above 0°C correpond to low pressures, while fairly low temperatures and dense cloud-cover correspond to high pressures.

If one takes fig. 41 into consideration where the three parameters (temperature, pressure and cloud-cover) are compared, the three parts described above become even more meaningful and clear:

1st part - pressure vises while the temperature goes further and further below zero and the cloud-cover increases, creating unfavourable meteorological conditions.

2nd part - period of high pressure with dropping temperature and a constant cloud-cover, despite two decreases; the weather, then, was even more unfavourable to the expedition.

3rd part - the pressure goes down and the temperature does the opposite, while the cloud-cover drops to even lower values. In this periods (at the end of the third decade in July), K^2 was conquered by A. Compagnoni and L. Lacedelli.

The average temperature at the base camp during the period May 26th to August 6th was about $-0^{\circ}.4$, with maximums of 17° and minimums of -20° , always bearing in mind the great changes in temperature during the day.

4.3. Cloud-cover

The behaviour of the cloud-cover has already been described and compared in the course of the preceding chapter. It should be stressed again that the cloud-cover decreased in the evening; towards 20.00 h the sky became clear and the stars could often be seen.

In the morning the cloud-cover was still limited to a few small clouds around K^2 but then this increased until there was maximum cloud-cover at 15.00 h, coinciding with precipitation and strong winds (fig. 34).

4.4 Wind and clouds

There was a constant wind at the base camp, although it was of limited velocity, because the camp was protected, as opposed to the surrounding peaks which were exposed to the wind. During the period of the expedition's stay at the base camp the prevailing winds are s and sw (tab. 4 and fig. 42-43), and this can be explained by the mountainous contours of the area.

As for the clouds there is a clear difference between the two periods: in the first (May 26th - June 30th) the clouds are mainly s and sw while in the second period (July 1st - August 6th) they are almost exclusively sw which has a frequency of 60% (tab. 6 and fig. 44-45).

With regard to cloud-type, strato-cumulus is the most frequent, and are mainly sw in the second period. Cloud type and direction were obvously not noted on misty or calm days, of which there were about 30% in both periods (tab. 5 and fig. 44-45). Wind speed was limited to grade 1 on the scale used at the camp, and has the following values in terms of km/h during the months of June an July.

Month	08.00 h	15.00 h	20.00 h	Average
June	9.5 km/h	12.4 km/h	5.7 km/h	9.5 km/h
July	8.6 km/h	12.4 km/h	7.6 km/h	9.5 km/h

As can be seen, the wind was strongest at 15.00 h, while at 20.00 h it was lighter. If one now compares the average for June and July on one hand and the average for the eight decades on the other (that is for the whole period of the expedition's stay at the base-camp) one gets in terms of km/h.

Period	08.00 h	15.00 h	20.00 h	Average
June-July	9.5 km/h	12.4 km/h	6.6 km/h	9.5 km/h
8 decades	8.6 km/h	11.4 km/h	5.7 km/h	8.6 km/h

(vis tab. 10 from the above cited values have been taken).

The windiest decade was the first decade of July in which winds reached an average velocity at 08.00 h of 9.5 km/h, at 15.00 h of 16.2 km/h and at 20.00 h of 7.6 km/h (tab. 9).

Maximum wind speed was on stormy days and in particular on June 5 and 22 July 10 when they reached and exceeded speeds of 90 km/h (tab. 7).

4.5. Precipitations and atmospheric state

There was twenty days in June on which it snowed while during the following month and until August 6th there were 23, thus giving frequencies of 55,5% and 67,5% (fig. 47). There were few totally clear days, while calm and foggy ones exceeded 30%.

The almost daily precipitations of snow had maximums in the third decade of June, as can be seen in fig. 46, accompanied by an increase in cloud-cover, pressure and temperature. Even if there were a lot of precipitations of snow, they were not very severe on the whole. On average daily snowfalls did not amount to 2 cm (fig. 46-48).

4.6. Ablation

As has already been said, the ablation was such that the moraine under the snow on which the tents were pitched reappeared in the month of July. In the direct light of the sun, the greater power of absorbation of heat by the rocks made the ablation even more active.

Thus the level of the parts exposed to the sun was reduced in height, as opposed to those parts in the shade of the tents, which didn't melt so that, in the course of three or four days, the tents would end up on a snowy base which was more than half a metre higher than the surrounding land. Thus it was continuosly necessary to move them.

Even if the ablation in the month of July was not noted in the diary, it was decided to equate it with the precipitation. That is, all the snow which fell during the day on the night melted or was blown away by the wind in a few hours (fig. 49); in fact, although there were many precipitations, they never formed a substantial layer of snow.

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ERRATA CORRIGE

Page	*Line*	*Errata*	*Corrige*
7	29	Karakorum	Karakoram
7	31	Karakorum	Karakoram
8	2	Karakorum	Karakoram
8	6	Karakorum	Karakoram
8	7	Karakorum	Karakoram
10	13	Karakorum	Karakoram
15	19	Karakorum	Karakoram
21	26	trasversal	transversal
23	5	alinements	alignements
26	14	instrusion	intrusion
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41	16	at the time of	after
48	13	1989	1889
61	39	«Relaz. Spedizione	«Relaz. Scient. Spedizione
123	27	*degli Abruzzi del*	*degli Abruzzi nel*

III. GEODETIC AND TOPOGRAPHIC SURVEY OF DESIO'S 1954 EXPEDITION (1)

1. Introduction

The region explored by the expedition is not completely without cartographic coverage. Preceding mountaineering-geographic expeditions as well as the Indian and subsequently Pakistan Survey Service have already made more or less accurate partial surveys. For this reason, care was taken to prepare a working programme that, though not of a purely geodetic and topographic nature, would be something more than a simple and rapid graphic survey. The instrumentation was, therefore, chosen and prepared to offer the largest operational facilities: the execution of expeditious astronomic stations, small local triangulations, graphic and stereophotogrammetric surveys, barometric and thermobarometric height determinations.

2. Working programme

The working programme established by the leader of the expedition considered:
- A 1:100,000 scale graphic survey of the Stak and Turmik valleys;
- A 1:100,000 scale stereophotogrammetric survey of the Kuthia glacier basin;
- A 1:10,000 scale stereophotogrammetric survey of the Chogo Lungma, Biafo and Baltoro glacier fronts for the determination of possible glacial retreats;
- A 1:5,000 scale stereophotogrammetric survey of the K^2 massif;
- A 1:50,000 or 1:100,000 scale stereophotogrammetric and graphic survey of the following zones:
  - Lower-central part of the Chogo Lungma glacier;
  - Various lateral basins of the Baltoro glacier not surveyed during the preceding expeditions and required to interconnect the various surveys made during the Baltoro, Siachen glaciers and Shaksgam valley explorations.

In view of the fact that the extent of the above working programme covered

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(1) By Francesco Lombardi. The English translation was kindly revised by the Gen. Mario Carlà of the Italian Military Geographic Institute.

zones lying at a considerable distance from each other and requiring long and frequent transfers, it was decided to include both a Pakistani surveyor and two operators of the Italian Military Geographic Institute, one to be employed essentially for geodetic and barometric height measurements, the other to attend to direct stereophotogrammetric surveying. It was, however, understood that besides their specific tasks, both of them should be prepared to integrate their work, so as to be «interchangeable». Unfortunately, a few weeks before leaving Italy, it was decided for contingent reasons to send only one operator. Obviously, this resulted not only in the reduction of the programme, but also in the need to modify in the field the operational procedure studied at the beginning, apart from considerations regarding the important loss of reciprocal help and comfort that can often be a determining factor for the desired success of the work in such impervious and isolated zones. It was, however, my good fortune to enjoy the collaboration of Prof. A. Marussi, the expedition's geophysicist, to whom I should like here to express my most sincere thanks. In spite of the serious limitations mentioned above, we succeeded in carrying out a considerable part of the programme, i.e.:

1) Stereophotogrammetric survey, on a 1:40,000 scale, of the Kuthia and Gorophа valleys and the upper Stak valley;

2) Expeditious graphic survey, on a 1:158,400 scale, (1" equal to 2.5 miles), of the lower Stak valley and the Askore and Turmik valleys made by the Pakistani surveyor Badsha Jan;

3) Stereophotogrammetric survey, on a 1:12,500 scale, of the K^2 massif limited to the east, south and west slopes;

4) Stereophotogrammetric survey, on a 1:25,000 scale, of the areas of the upper Godwin Austin and upper Baltoro glaciers;

5) Expeditious graphic survey of the Liligo glacier by the surveyor Badsha Jan.

The above-mentioned works involved the setting up of two expeditious astronomical stations, in close collaboration with Prof. Marussi, as well as several thermobarometric height determinations covering zones not directly concerning the survey. These will be described in the report relating to the geophysical work (1).

(1) A list of the maps of the same areas published previously is reported in the I section of this book at the pages 46-60.

3. Instruments

The instrumental equipment was supplied by the Italian Military Geographic Institute with the exception of the Thommen precision altimeter (property of the expedition) and the instruments of the Pakistani surveyor (consisting of a plane table with an alidade and a pocket altimeter). This instrumentation included:

- 2 Wild T2 theodolites (Nos. 9886-10639) with astronomical equipments;
- 1 Nardin chronometer, cup type, for sidereal time (No. 3315);
- 6 pocket Nardin half chronometers for sidereal time (Nos. 200849-200850-201302-201316-201342-607897);
- 1 pocket Nardin half chronometer for mean time (No. 607919);
- 1 Second-Counter to 1/50th of a second (No. 7100);
- 1 Second-Counter to 1/10th of a second (No. 2112);
- 4 Centigrade thermometers;
- 2 Paulin barometers;
- 1 Radio receiving set for long and medium waves, RCA Type AR 8510;
- 1 Radio receiving set for medium and short waves Mod. Hallicrafters S.72;
- 1 Zellewegher crank generating set;
- 2 Zeiss 13x18 plate type cameras;
- 2 Wild 2 meter subtense bars;
- 2 Vertical staffs with centimeter scale;
- 2 Ghertz 1m monostatic range finders;
- 1 Zeiss Alpina diopter (No. 48);
- 2 Thermobarometers Type I.G.M.;
- 2 Assman, type psychrometers;
- 2 Sets of centigrade thermometers for thermobarometry:

1st Set:	Fues	No 1853	from	78.0°	to	84.0°
	Fues	No 1854	from	81.8°	to	88.2°
	Fues	No 3217	from	83.2°	to	90.4°
	Fues	No 3204	from	89.4°	to	96.4°
	Fues	No 3211	from	95.2°	to	102.2°
2nd Set:	Fues	No 3207	from	77.4°	to	84.2°
	Fues	No 1855	from	81.8°	to	88.2°
	Fues	No 3206	from	85.4°	to	92.4°
	Janar	No 1689	from	88.2°	to	95.0°
	Fues	w.No.	from	94.8°	to	102.2°

A third set comprising five 1:50 centrigrade thermometers made by the Milan firm FITBEA was not used because the glass, even though artificially aged, did not ensure satisfactory stability;
- 2 Thommen pocket altimeters;
- 1 Thommen altimeters for geodetic work (No. 26320), provided by Prof. Desio, chief of the expedition;
- Various accessories such as equipment for developing and printing photograms, surveying sunshade, transportation equipment for materials and instruments, etc.

4. Collection of Geodetic elements

The ellipsoidal coordinates and trigonometric heights of the official triangulation points to be used as control points were taken from «Synopsis of the Results of the Great Trigonometrical Survey of India», published in 1880. They were previously transferred by the isotransitive method from the Everest ellipsoid to the international one and then transformed on the Gauss plane (using the Army Map Service tables) by assuming as the origin meridian the value +75° from Greenwich; however, the plane coordinates in fact refer to the meridian +74°57'32", 82, because the value of the starting longitude was altered by a constant quantity equal to +2'27", 18 (as a result of the new value of the longitude of the point of origin of the Indian net: Madras, definition 1877). This value was assumed also for calculation of the plane coordinates of the astronomical stations (1).

5. Operational procedures

As already mentioned, despite the serious limitations caused by the work now being entrusted to one single person, the idea of making a survey somewhat more precise than a simple graphic survey was not abandoned. It was therefore decided to adopt the stereophotogrammetric method, except for the work to be carried out by Bashad Jan, the Pakistani surveyor. In addition to its great simplicity and practicality, this method offers one really outstanding advantage over the direct method in that it largely disengages the surveyor from the landforms, avoiding long stays in inhospitable zones and also eliminating the need to reach points of difficult access.

A further advantage lies in the fact that after adequate concatenation has been assured between the stations and the corresponding control points on the

(1) Geodetic data have been collected by geographer engineer Piero Bencini, of the Italian Military Geografic Institute.

ground, the survey will be perfectly homogeneous: the ground description can then be taken care of even down to the smallest details at leisure in the office, thus ensuring the best rendering of real conditions.

The most exacting part of the work, apart from the determination of the end points of the bases, was the choice of the places where the bases should be set up and their size and orientation according to the landscape to be surveyed.

It is possible, even with a limited but well chosen number of bases, to survey a considerable portion of the ground and to largely reduce the dead zones.

Whenever possible one of the end points of the base lines was established by intersection from trigonometric points of the official net or from points determined by preceding expeditions (as in the Baltoro case).

In addition, considerable care was always taken to intersect and measure zenithally from both end points of the base other points within the stereoscopic zone of the exposure and also within zones likely to be included in order to ensure the perfect dimensioning of the optical model and, at the same time, the connection of the survey.

In those cases where determination by intersection was not possible, the astronomical azimuth of the base line was used, preferably by observation of the pole-star (in some exceptional cases, of the sun too) and by collimating points already triangulated from preceding photogrammetric bases or, in more favourable cases, connecting the new station with one or more already determined stations.

With this procedure and despite the uncertainty of collimation to peaks devoid of signals or presenting themselves in widely differing forms in relation to the point of observation, it was possible to ensure satisfactory planimetric and altimetric returns from the various stations, facilitated also by the optimum performance of the stereocartograph set Santoni Model III, used at home to plot the stereograms.

6. Stereophotogrammetric survey on a 1 : 40,000 scale, in the Kuthia, Gorompha and upper Stak valleys

The purpose of the topographic survey made in this zone was to document the morphologic characteristics of the Kuthia glacier.

It is a known fact that this glacier, having recently started to expand, had completely invaded the bottom of the valley by 1953, advancing by about 10 km in only three months so as to obstruct the underlying Stak valley.

The phenomenon was interesting if only because of this fact (it completely changed the features of the valley, previously a richly wooded area with meadows and farmland), but it also deserved cartographic documentation because, in view of the existing prominent morainic formations upstream, a periodic recurrence could not be excluded.

In addition, the local authorities, seriously concerned for the safety of the villages immediately downstream of the glacier, asked for a map of the zone to be made which could enable them to keep the progress of the glacier itself under observation.

The survey was also extended to cover the Goropha valley and the upper Stak valley up to the homonymous pass, bringing in the Turmik valley. This survey was accompanied by a hasty reconnaissance together with Prof. Marussi, at the Goropha-la on the ridge separating the Goropha valley from the valley containing the Chogo Lungma glacier. It was unfortunately impossible to make any measurements on this col, the bearers having deserted in mass because of the difficulties of the ascent, leaving us without the necessary instrumentation. It was, however, very useful to have for the first time the opportunity to ascertain the existence of a direct passage between the Indus and Chogo Lungma valleys, since until then this had only been possible by a round about route taking several days. In fact, even though the ascent of this col is rather steep from the Stak slope, the other side (Chogo Lungma basin) rises gently and is easy to walk up.

Entering the Stak valley it was immediately clear that the cartographic representation of the zone (see sheets 43 I and 43M, of the «Survey of Pakistan Map» on a 1:253,440 scale) was completely fictitious. The very ridge line originating from the southern slopes of the Haramosh (7397 m) and forming the western limit of the Stak valley basin, though recently surveyed, appeared to be too poorly defined to allow the use of the most salient points as control points. The only way out was to make use of those few trigonometric points which, though established within a limited sector, were the only elements of a certain reliability.

As will be outlined in another part of the report, two astronomic stations were set up in the Stak valley. The positions of the trigonometric points and the astronomic stations are show on Tab. 1.1.

Tab. 11

No.	Denomination	Coordinates N/E	Elevation
121	PK. 57/43 I (Thanmari)	3,968,373.21 500,481.56	6684
122	PK. 58/43 I (Haramosh)	3,966,181.31 494,420.59	7397
123	PK. 59/43 I (Korangkar)	3,961,126.81 499,437.72	6070 (1)
124	PK. 60/43 I (Shinka Mashkila)	3,957,956.55 500,690.54	6050
1	PK. 1/43 M (Paraber)	3,968,987.68 508,865.54	6321
Astronomic station Camp III		3,957,692.28 (2) 510,523.71	3923 (1)
Astronomic station Camp IV		3,960,500.80 (2) 504,765.63	3787 (1)

(1) Elevation resulting from the stereophotogrammetric survey.

(2) The plane coordinates are obtained from the transformation of the astronomic coordinates; for the trigonometric observations, see page 138.

Altogether 19 stereophotogrammetric stations were set up in this zone in less than two months (3rd June to 29th July). However, only 15 were utilized for the survey because stations Nos. 3, 16 and 17 concerned zones already covered by preceding stations, while station No. 9 was set up only to determine the speed of the Kuthia glacier. Their location is shown in the accompanying 1:50,000 map «Kuthia and Goropha valleys».

Station No. 1

Close to the Kulankae camp a short base was measured by means of a traverse, making use of a Wild T2 theodolite and two horizontal 2m Wild subtense bars, and then trigonometrically developed, on a calculated baseline of 1013, 54m representing the photogrammetric base.

A large pyramid of stones was erected at each end of the base to allow the intersection from easily determinable points. In fact, from this base located at a relatively low height, it was possible to see only three trigonometric stations.

During the survey, for this reason, the left end of this base was intersected from the astronomic stations of camps III and IV as well as from points B_{08}, A12 and A13.

In addition, before leaving this locality, a resection station was set up on the extreme left (A_{01}) sighting to the trigonometric stations 121, 122 and 123 as well as to the above-mentioned points.

The height of A_{01} was trigonometrically determined from the ends of the stereophotogrammetric base No. 13, resulting in 3239m; we made use of the same point also for checking the result obtained by trigonometrically transferring the thermobarometric height of the Kulankae obtained from numerous observations and resulting in 3232 m. However, for reason of homogeneity, the survey was based on the first value and not on the average value from the two sources.

In conclusion the positional elements of the station are as follows:

$$N = 3{,}957{,}250 \quad E = 509{,}925 \quad H = 3239\,m$$

The astronomic azimuth of the base is 20°56′26″.

Station No. 2

This station was only utilized to plot the front of the Kuthia glacier. The placing of the stereograms was carried out using some ground details already determined from other stations and pointed azimuthally and zenithally from both extremes of the base.

Stations No. 4-5-6-7

These stations were set up in the locality of Shoman; the relative position of the single bases can be taken from the following diagram, in which the letter «A» indicates the left-hand ends and the letter «B» the right-hand ends.

To ensure the homogeneity of the different bases, in addition to making some of the base end points coincide, for example B_{06} with A_{07} and A_{04} with B_{05}, point A_{07} was connected by traverse with A_{05} and B_{07}, and point A_{05} with B_{04} and with the astronomic station SA. Each base was parallactically measured with a Wild theodolite and Wild subtense bar, except for base No. 6 which was calculated by solving the triangle A_{06}-A_{07}-B_{07}, whose known side was the base No. 7 (A_{07}-B_{07}).

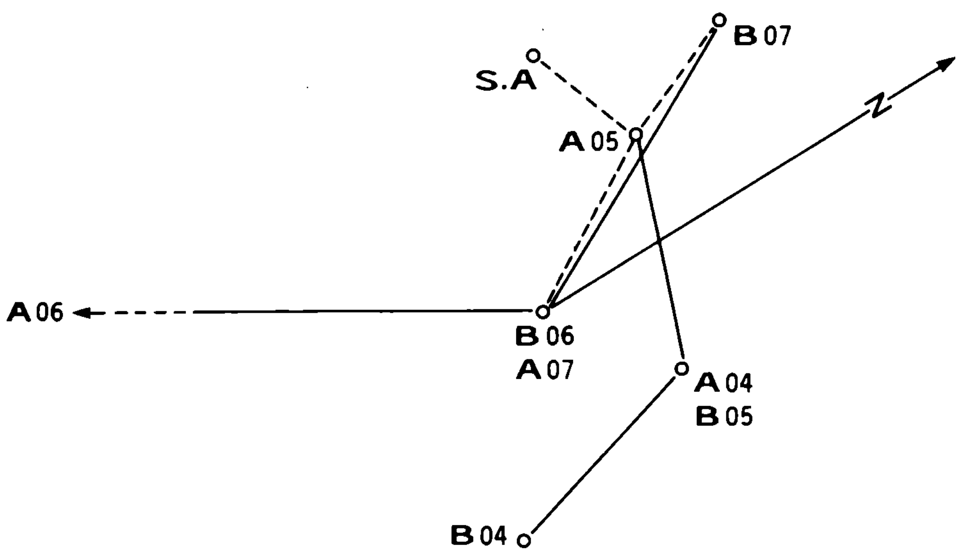

Fig. 50 - *Connection scheme between the stereophotogrammetric stations executed in Schoman locality for the drawing of the upper Stak valley.*

In this way it was possible to calculate the position of the above-mentioned points by polar coordinates starting from A_{06}, on which a resection was made collimating to the trigonometric stations 1, 121, 122 and 124. As a check, a resection point was established at the astronomic station SA. From a comparison of the coordinates obtained directly and those obtained by traversing from A_{06}, the differences were 8m for Y and 33m for X. Given the uncertainty of the collimation to the trigonometric points, such a result may be considered more than satisfactory also with regard to the survey scale.

A similar procedure was utilized for the altimetric determination; in fact, having determined the height of the point A_{06} by collimations to the trigonometric points 1, 121, 122 and 124, it was possible to determine the height of the remaining points indirectly. As a check, the determination of the elevation of B_{06} was obtained by collimation to the same trigonometric points and the two results were in perfect agreement.

Before leaving this locality, a cairn, consisting of a pyramid made of uncemented stones about 2m high, was erected on each point.

The planimetric and altimetric data of the above-mentioned stations are shown on Tab. 12.

Tab. 12

	X	Y	Q
$A_{04} = B_{05}$	3,957,325	511,556	3962
A_{05}	3,957,383	511,401	3972
A_{06}	3,956,475	510,958	3932
$A_{07} = B_{06}$	3,957,265	511,469	3997

The definition of these stations enabled us to consider the general control net of the zone as complete; in fact, the remaining stations were mostly utilized for net densification. However, their determination was carried out by reference to the preceding stereophotogrammetric stations or even by direct «plotting» with the stereocartograph, when they were indubitably localizable on the stereograms (see the accompanying tables). An exception is point B_{08} which, for control purpose, was determined both ways, trigonometrically from the points 121-123-124 and from the net points A_{07} and A_{05}) and with the stereocartograph from base No. 6. The results obtained by both methods appear to be in perfect agreement. The coordinates and height defined trigonometrically have the following values:

$X = 3,960,292$ $Y = 504,140$ $Q = 4071$

7. Astronomic stations

As mentioned above, two astronomic stations of the expedition were set up, which are described in detail in the special report on the geophysical work (1).

(1) Marussi A. (1964) - *Geophysics of the Karakorum.* «Desio's Italian Expeditions to the Karakorum (K²) and Hindu Kush Scientific Reports». II.

Here, we shall briefly describe the procedure employed for obtaining the ellipsoidal coordinates of the stations trigonometrically together with brief considerations regarding the comparison with the corresponding astronomic coordinates.

ASTRONOMIC STATION AT PHOTOGRAMMETRIC CAMP III. The plane coordinates of the station were obtained in two ways:

1° - By resection made at the station by collimating the trigonometric points 1, 121, 122 amd 123, resulting in: X = 3,957,321 Y = 511,310.

2° - Transferring by traverse the coordinates from the left point A_{06} of the photogrammetric base to the astronomic station with the following results: X = 3,957,354 Y = 511,318 (1).

By trasforming these values the following ellipsoidal coordinates hare been obtained: $\varphi_e = 35°45'34''.5$ $\lambda_e = 75°05'03''.5$.

ASTRONOMIC STATION AT PHOTOGRAMMETRIC CAMP IV. On this station it was not possible to execute the resection owing to the insufficient number of visible trigonometric points. Therefore its plane coordinates were obtained by traverse from the coordinates of photogrammetric vertex B_{08}, resulting in: X = 3,960,246 Y = 504,643.

The transformation of these values resulted in the following ellipsoidal coordinates: $\varphi_e = 35°47'08''.6$ $\lambda_e = 75°00'37''.8$ which, when compared with the astronomic coordinates: $\varphi_e = 35°47'16''.8$ $\lambda_e = 75°00'42''.7$ show a difference in φ of ÷ 8".2 and in λ of + 4".9 originating from the same causes mentioned previously.

As a check the astronomic azimuth of the origin, common to both the astronomic station and point B_{08}, was calculated: a comparison of the two values shows a difference of 10", more than acceptable in works of this kind.

The elevations of the above-mentioned astronomic stations are given on Table 11.

8. Stereophotogrammetric surveys in the Turmik valley

During transfer from the Stak valley to the K² base-camp, taking advantage of some days of rest or even interrupting the trek for the time strictly necessary, 9 stereophotogrammetric shots were made in the Turmik valley. Owing to the

(1) The plane coordinates obtained through direct transformation of the astronomic coordinates are given in Table 11, page 131.

limited number of shots taken in relation to the extension of the zone crossed, it was not possible, when plotting, to draw even a hastily executed complete map.

However, the stereophotographic collection, oriented to and connected with astronomic azimuths or by collimations to points of known position, could well be used for particular geographic or morphologic studies to improve knowledge of a zone with virtually no cartography at all. In any case the stereophotograms, mentioned above, were utilized in the preparation of the 1:200,000 scale map for integrating and improving, especially with regard to the description of the terrain, the expeditious graphic survey made to 1:158,400 scale by the Pakistani surveyor Badsha Jan.

The stereophotograms, and particularly Nos. 20, 21, 22 and 23 were taken at the head of the valley (No. 20 at the Stak pass itself); nos. 24, 25 and 26 from a ridge dominating the Harimal village and the last two on the Ganto-la pass.

The work was carried out as follows:

STATION No. 20. A reception point was determined by collimating the trigonometric points 122, 123, 124 and point A_{04}. The height was obtained by zenithal collimation with the same points and proved equal to 4620 m.

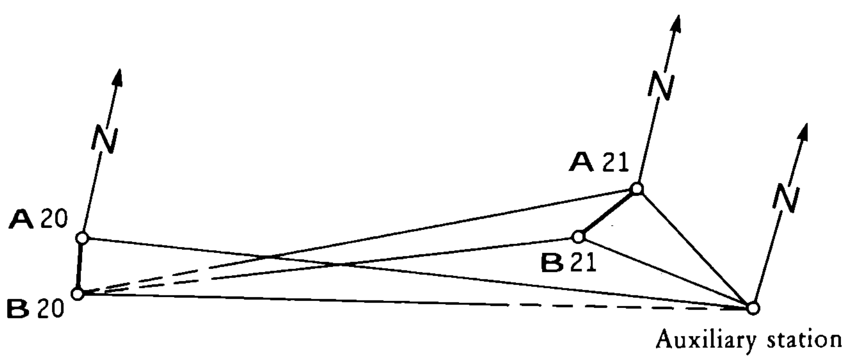

Fig. 51 - *Interconnection between stations Nos. 20 and 21.*

From the end point different points of the panorama were intersected as well as a boulder, on which an auxiliary station was erected on the following day to connect stations Nos. 20 and 21. This subsidiary station was also used to determine the astronomic azimuth of points A_{20} and A_{21} for orienting the relative bases.

Station No. 21. It is connected to point A_{20} through the auxiliary station as shown in the diagram. In addition, some salient points of the terrain appearing on the stereograms of this station are also found on those of station No. 20.

Stations No. 22 and 23. Station No. 23 and consequently also Station No. 22, is connected to the north ridge of the Stak-la (plotted from Station No. 4) and to the end points of base No. 21, azimuthally and zenithally collimated.

These two stations are interconnected as shown in Fig. 52.

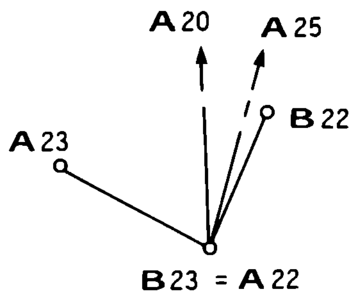

Fig. 52 - *Interconnections between stations 22 and 23.*

Stations No. 24, 25, 26. These three stations are located on the orographic left side of the Pakore gorge and precisely on the high ridge immediately dominating the Harimal village.

The arrangement of the stations and their reciprocal connection are shown in the diagram (Fig. 53).

Base No. 26 was oriented by means of an astronomic azimuth taken on point B_{26}; the orientation of base No. 24 and also of base No. 25, was checked by transferring the azimuth of base No. 26 through the auxiliary station.

Stations No. 27 and 28. These two stations were set up during a stop of a few hours on the Ganto-la pass (4457 m). Because of the limited time available it was not possible to determine the position of the end points of the base. For this reason the photographs were not utilized for the relief map, but are to be considered simply as photographic documentation.

9. Surveys in the Baltoro glacier valley

In this region, in view of the short time at our disposal, we had to be content with a «minimum» program: the already very advanced season and the gravimetric Rome-Karachi-Delhi connection due in a short time and requiring my collaboration, meant that we were unable to complete the set programme.

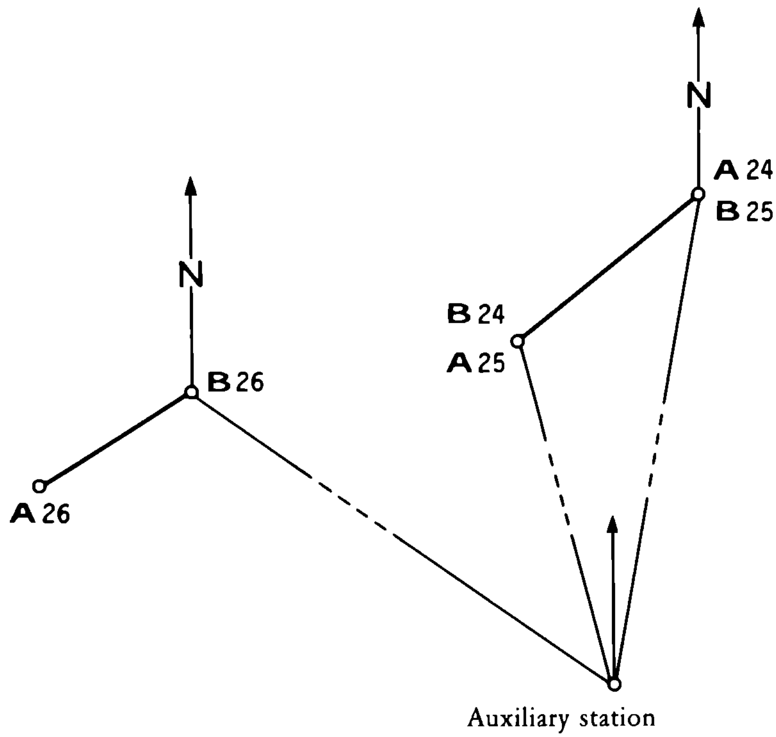

Fig. 53 - *Interconnetions between stations Nos. 24, 25 and 26.*

In about three weeks we made 17 stereophotogrammetric stations involving the K^2 massif (east, south and west slopes), the Falchan Kangri (Broad Peak), the Chogolisa Kangri (Bride Peak, north slope), the Gasherbrum group (south slope) and the Conway saddle. These surveys, except for the K^2 survey, should be considered an integration of previous surveys made in 1909 and 1929 by the expeditions of the Duke of Abruzzi and the Duke of Spoleto respectively. Our new survey, in fact, was based upon the control points determined during these two previous expeditions. Obviously, whenever possible, the trigonometric points fixed by the Indian triangulation were also collimated, but these points were rarely visible in sufficient number to ensure adequate determination of the stations. On the other hand, we did not have sufficient time to provide the control-points occurring for this particular need through a local triangulation.

For this reason, only a few stations were determined through resection and their position on the drawing plane was established as a first approximation by the tracing paper method and then perfected with the stereocartograph, employing the dimensioning of the bases and the reciprocal orientation of the camera on the base ends (an operation carried out with the utmost care) as well as the numerous azimuthal and zenithal measurements of points defined on the available 1:75,000 map. This process was facilitated by suitable positioning of the stations studied so as to obtain considerable overlapping of stereoscopic zones; this, in turn, in the plotting phase ensured a good connection of the many different stations and the homogeneity of the work.

The work was carried out in particular in the following manner. During the stop at Urdukas on the 17th August, stereophotogram No. 29 was taken and repeated again under the same conditions (No. 47) on the 12th September; the purpose was to determine the glacier speed through the photogrammetric system. This consists essentially in taking a section of the glacier under identical conditions, but at different times to determine by plotting the movements of the same details of the glacier due to its flow. The relevant results are the object of a special note published in the volume on geophysics (1).

The real survey began on the 22nd August, the day after our arrival at the K^2 base camp.

STATION No. 30. A few kilometers downstream from the confluence of the Savoia glacier with the Godwin Austen we laid out a base of 385.01 m oriented so as to cover the whole extension of the south slope of the K^2. A resection point was made at the left end of the base by collimating to the trigonometric points K^2, Bride II, and Mitre, as well as to different points of the 1:75,000 map, among others the Angelus and the Black Point. The height obtained from these collimations agreed with that resulting from the solution of the triangle A_{30}-B_{30}-K^2, a circumstance guaranteeing the optimum approximation of the determination of the station.

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(1) A. Marussi (1964). Op. cit.

The same method was utilized for determining the remaining stations, from No. 31 to No. 41, settled on the upper Goldwin Austen glacier, which flows at the foot of the eastern slope of the K^2, the Skyang Kangri (Staircase), Skyang-la, the Vittorio Sella saddle and the northern slope of the Falchan Kangri; while station No. 42 was made on the upper Savoia glacier to survey the western K^2 slopes, the Angelus and the Black Point as well as the Savoia saddle.

Having thus finished the survey around K^2 in 16 days, I decided to return on the 7th September to the Concordia cirque. Though the weather was not very promising I decided, having a few days off, to try to collect some stereophotograms of the upper Baltoro. Thus, with the secret ambition of reaching the Conway saddle and making the connection between the Baltoro reliefs and those of the Siachen basin, I went right up to the base of Conway saddle. There I thought it best to employ the 9th day for working at the base of the saddle, also because a heavy snowfall during the night had covered the slope of the saddle with so much snow that the approach was rather dangerous. Unfortunately, the morning of the next day brought particularly bad weather so that I had to give up and return to Urdukas where I arrived during the night of the 11th day.

I managed, however, to take some photograms (No. 43, 44 and 45) concerning the Chogolisa Kangri, Gasherbrum I and Conway saddle and in part also the Gasherbrum group. The above-mentioned photograms were plotted to 1:25,000 scale reduced photomechanically to 1:50,000 scale and inserted into the available 1:75,000 after enlargement of the latter to the same scale.

The integral redrawing of the cartoons followed with a further photomechanic reduction to obtain the currently published 1:100,000 map.

As far as the K^2 photograms are concerned, they were plotted it 1:12,500 scale and covered nearly 85% of the terrain shown in the relevant map; the remaining 15%, consisting of dead angles and the top of the north wall of the K^2, are covered by panoramic photos and two photograms from the film taken from the airplane which show the zones that could not be plotted exploiting the stereophotogrammetric ground stations. The two photograms of the film (1), suitably spaced out to assure sufficient stereoscopy, were enlarged and transferred onto glass slides to allow placing on the stereocartograph. Since the focal distance of the camera was known, and it was possible to distinguish on the photograms certain details whose spatial position was already known thanks to the plotting, it was then possible to ensure the presentation of the dead-angle zones. Obviously, such a representation

(1) The film was shot by Mario Fantin, expedition's photographer, during the recognition flight around the K^2 with Prof. Desio.

was contained within the restricted limits compatible with the distortions resulting from the increasing distance of the details to be surveyed from those of known position. This is essentially the reason for limiting the representation of the north wall to the top part only.

The plotting of K^2, to conclude, was made by tracing the altimetry of the surveyed terrain with contour lines for both the rocky parts and those covered by glaciers in order to prepare a relief map, when desired.

10. Remarks concerning the longitude of the map of K^2

The geographical coordinates of K^2 indicated on Sheet 52 A of the Survey of India (1921) are: latitude $\varphi = 35°52'55''$, longitude $\lambda = 76°30'51''$. Earlier determinations (Sheet n. 21 of 1877) instead indicate: latitude $\varphi = 35°52'55''$, longitude $\lambda = 76°33'18''$.

Comparison indicates a shift in longitude of 2'27".18 which is simply due to the definition of the origin meridian. Lombardi's determination is referred to the «old» meridian and can be transferred to the «new» one by subtracting the value 2'27".18 from his value of the longitude. The latitude instead remains unaffected by this transformation.

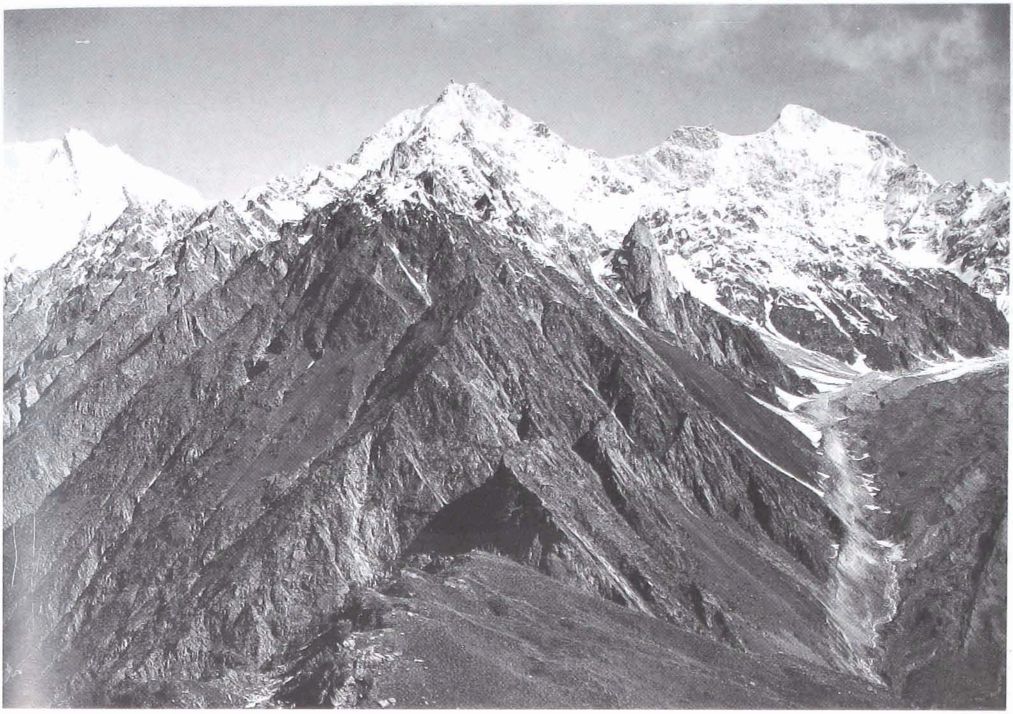
PLATES

PLATE IIA

STEREOPHOTOGRAM BL_{06} – *The Kuthia valley, a richly wooded area with meadows, and the homonymous glacier by which it was completely covered in 1953, in about three months.*
On the orographic right side are evident the tongue of the Kotsomber glacier and (upstream) of the Nong one.

PLATE IIB

STEREOPHOTOGRAM BL_{08} – *The position of the stereophotogrammetric station A_{11}.*



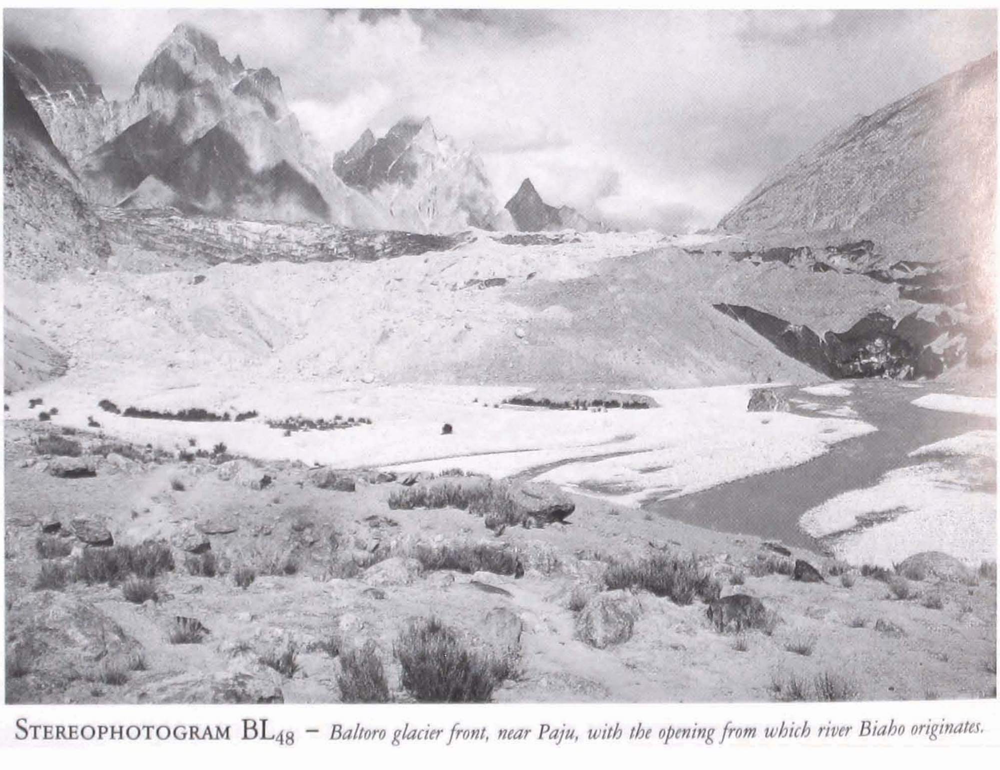
STEREOPHOTOGRAM BL_{06} - *Goropha valley with the homonymous glacier. The depression on the background is the Goropha pass through which one enters in the basin of the Chogo Lungma glacier. It is visible the position of the stereophotogrammetric station B_{17}.*

STEREOPHOTOGRAM B_{23} – *The upper Turmik valley with the Stak-la and the stereophotogrammetric stations A_{21} and A_{20}.*

PLATE IVA

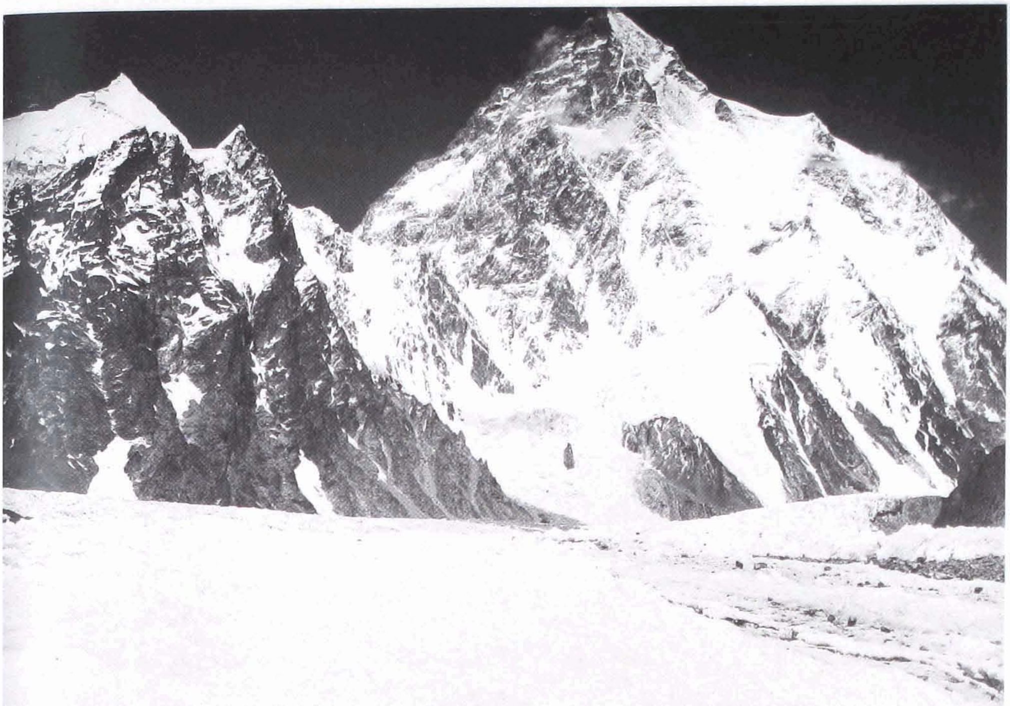
STEREOPHOTOGRAM B_{24} – *View of the middle and upper Turmik valley from the stereophotogrammetric station B_{24}, sited on the ridge overhanging Harimal. On the bakground is visible the Haramosh group and the position of A_{21} station.*

PLATE IVB



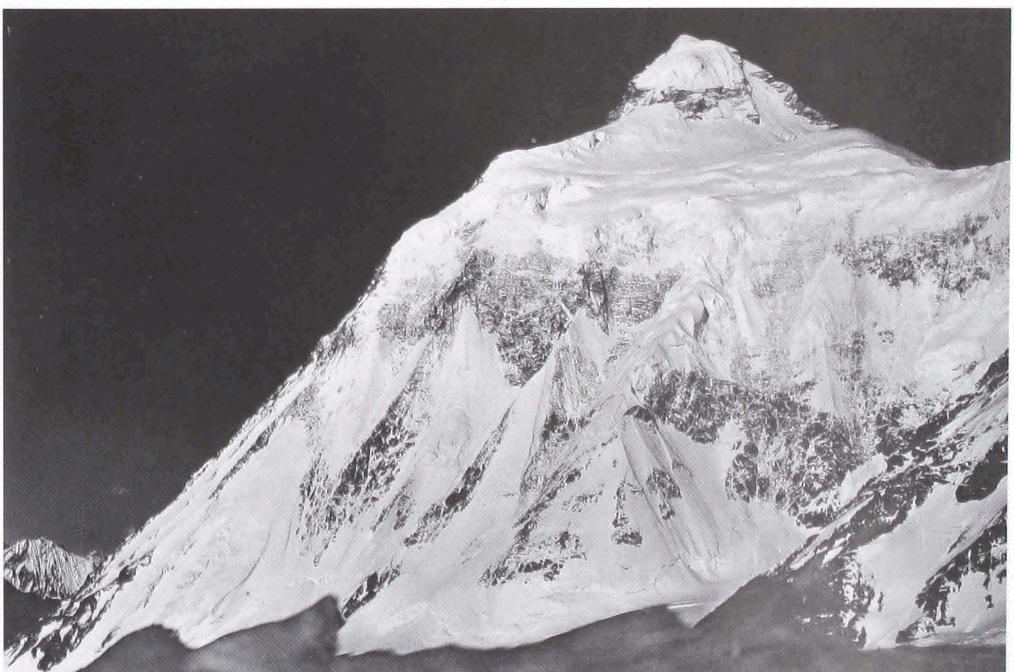
STEREOPHOTOGRAM BL_{48} – *Baltoro glacier front, near Paju, with the opening from which river Biaho originates.*

PLATE VA



STEREOPHOTOGRAM B_{30} – *View of southern side of K^2: on the left in the background is the white pyramid of Angelus, in the foreground, is the Black Peak.*

PLATE VB

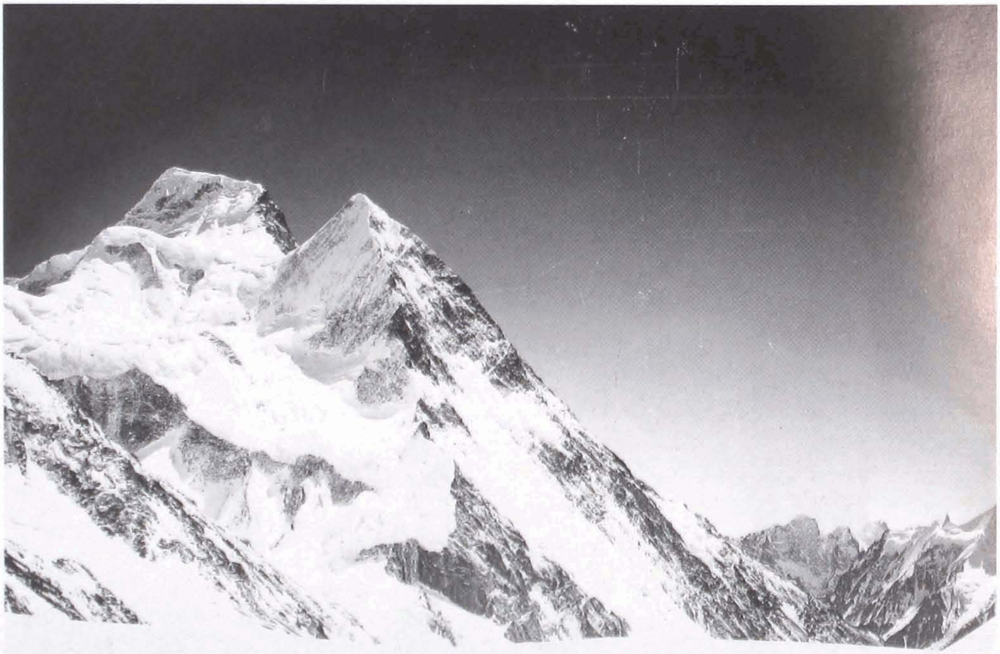


STEREOPHOTOGRAM A_{37} – *View of the eastern K^2 side taken from the Skyang-la, showing the position of the last camps.*

PLATE VIA

STEREOPHOTOGRAM B_{42} – *View of western K^2 side from upper Savoia glacier.*

PLATE VIB



STEREOPHOTOGRAM A_{39} – *View of northern side of Falchan Kangri.*

Stereophotogram BR_{43} – *The mountains between the Chogolisa Kangri and the Vigne glacier seen from the Abruzzi glacier.*

Stereophotogram AR_{45} – *Gasherbrum group and its southern glacier.*

PLATE VIIIA

STEREOPHOTOGRAM A_{44} – *The mountains between the Gasherbrum I and the Conway saddle (right side).*

PLATE VIIIB

STEREOPHOTOGRAM A_{44} bis – *Conway saddle.*

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