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Note on the Geology of the Palaeozoics and Mesozoics of the Tibetan Zone of the Dolpo Region (Nepal—Himalaya)

(With one map, see page 8)

By GERHARD R. FUCHS

The author, member of the Austrian Dhaula Himal Expedition 1963, could do geological work in the area N and NW of the Dhaulagiri group (Nepal). This region belongs to the Tibetan sedimentary zone N of the main range of the Himalayas.

As the detailed determination of the fossils is not yet fully available, the following is to be considered as preliminary note on the geology of this region *).

Stratigraphy: The palaeozoic beds rest on the crystalline rocks of the uppermost thrust sheet of the Kathmandu "nappes" (T. HAGEN), but no unconformity is visible. The front of the metamorphism apparently has altered the basal limestone series up to different stratigraphic niveaus, and converted the rocks into marble and lime schists.

The thick basal series consist of some thousands of meters of banded partly arenaceous and argillaceous, sometimes dolomitic limestones. Brachiopods, crinoid ossicles, lamellibranchs and *Orthoceras* could be found. These fossils point to an Ordovician age. The thick uniform series seem to have been deposited in a geosyncline of Caledonian age. They show no change in facies over a distance of 90 km in strike direction.

As the lower parts of the formation seem to have become metamorphic up to different levels and for the absence of fossils in these parts, the presence of Cambrian cannot be excluded.

There are similarities with the Garbyang series (A. HEIM and A. GANSSER, 1939).

The geologists of the Dutch Himalaya Expedition 1962 kindly informed me that they were fortunate to find Lower Silurian (Llandoverian) Graptholites in their "Dark Band formation". Similar black shales, dark limestones and dolomites in the topmost beds of the basal limestone series were found in our expedition area too. So it is most probable that Silurian is also present here in a position between the Ordovician limestones and the Devonian beds.

The beds found in superposition to this series show marked difference in facies:

a) In the NW of the mapped area (Ringmo Lake) there is a series of grey dolomites (up to 1000 meters) with an intercalation of limestones, shales and sandstones. Corals of Middle Devonian age, bryozoa, brachiopods and crinoids were found.

b) More to the E, in the area around the Tarap Khola a thick series of limestones and marls with only two intercalated bands of dolomite (ca. 70 m each) was found. In this carbonaceous series in which sandy-shaly beds are not seldom, crinoids, bryozoa and corals were collected. The age of the corals is presumably Middle Devonian.

*) Prof. Dr. H. FLÜGEL, Graz, studied the palaeozoic corals, Prof. Dr. R. SIEBER, Vienna, examines the rest of the fossil material. To both I am deeply indebted for many hints and for the rapid determination of a part of my collection.

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c) Farther in the E (Mukut Himal, Hidden Valley etc.) some hundred meters of phyllites, shales, slates and sandstones were found, instead of the limestones and dolomites in the W. In a band of grey limestone, which is interbedded in an apparently distinct stratigraphical niveau of the sandy shaly series, ammonoids of presumably Middle or Upper Devonian age were found.

In the uppermost part of the series sandstones, quartzites and seldom breccias are intercalated which show deposition of coarser material towards the end of this sedimentary period.

The Devonian beds are overlain by ca. 50—250 meters of dark bituminous, sometimes marly or shaly limestone, very rich in fossils. Everywhere this marly limestone is full of crinoid stems, bryozoa (fenestellids etc.) and corals. Brachiopoda, lamellibranchs, gastropoda and seldom cephalopoda were also found. The fauna indicates Carboniferous age.

Near Tarap this series is found in a thickness of 6 meters only, while in the NW and N of the mapped area it is missing at all. The question is not yet settled, wether this is due to a stratigraphical gap in the Carboniferous or wether there are changes in facies.

The Permian is represented by a series of thick bedded light quartzites and sandstones with intercalated dark slates and shales. The total thickness is of about 80—300 meters. In the quartzites a *Calamites* was found, while in the sandstones and shales brachiopoda (*Productidae* and *Spiriferidae*), crinoids and bryozoa could be collected. The upper part of the series (20—50 meters) consists mainly of sandy shales, which have yielded big brachiopoda, crinoids and a footprint of a tetrapode.

About 15 meters below the Lower Triassic, thin layers of dark, fossiliferous limestone are found interbedded in the sandy shales (upper Barbung Khola).

In the uppermost Palaeozoic of the area N of Charka limestones rich in bryozoa, brachiopoda and crinoids seem to be comparable with this horizon and not with the carboniferous limestone.

In the Barbung Khola SW of the village Barbong in the basal part of the grey limestone bank (1.5 meters) which contains Lower Triassic ammonites in its upper part, a rich Upper Permian fauna was found. The distinct palaeozoic bryozoa, crinoids, brachiopods and corals of this horizon are separated from the Triassic ammonites by ca. 1 meter of limestone without fossils.

For the palaeogeography of the Upper Palaeozoic it is interesting that the permian quartzite series is missing in the N. Instead of the coarse arenaceous sediments, shales containing the same Permian fossils are found. So the mapped area seems to belong to the southern border region of the Thetis during Upper Palaeozoic times.

The beds of the Lower Triassic form a marked easily recognizable band of 10—25 meters thickness.

At the base there is the already mentioned blue-grey limestone bed of ferruginous weathering (1.5—2.5 meters). Its lowermost part is still Permian (see above), while in the upper layers the first ammonites were found: *Meekoceras* sp., *Aspidites* sp., *Ophiceras* sp. etc. In the northern part of the mapped area this hard limestone bed shows brownish violet colours due to its high iron and manganese content.

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5—8 meters of grey shales with a few thin layers of limestone follow above.

3—5 meters of light grey, platty limestones rich in ammonites (mainly Meekoceratids) are found in superposition.

Between this bed and the overlying dark bluish nodular limestones of 3—6 meters thickness, shale intercalations are found frequently. In this upper part of the Lower Triassic lamellibranchs are not seldom. Besides ammonites and lamellibranchs *Orthoceras cf. campanile* was found.

This dark limestones of the uppermost Lower Triassic grade into a platty series of dark blue limestones and marls (100—300 meters). The fossils are often coated by pyrite. The determination of the fossils is not yet finished but there are hints for the age of the formation.

Ptychites sp., *Gymnites* sp., *Ceratites* sp. and the transition from the Lower Triassic make it most probable, that the lower parts of the series are Anisian. Ladinian are the rocks containing *Daonella indica* BITTN., *D. lommeli* WISSM., *Protrachyceras spitiense* DIEN. etc. *Joannites cymbiformis* WULF. and *Traumatocrinus* sp. show, that the upper part of the sequence must have Carnic age.

Seen from a distance this limestone series shows light weathering colours which contrast with the dark brownish talus of the overlying arenaceous shales, sandstones and dark shales. These rocks nearly always contain black concretional nodules and flysch-like structures. In this sequence of 100—500 meters thickness, fossils are rather scare. Lamellibranchs and globular ammonites with *Halorites*-like sculpture were found. The age of the formation seems to be Upper Carnic—Noric.

These soft rocks are followed by a thick bedded sequence of quartzites, carbonaceous sandstones, arenaceous limestones, grey marls and blue limestones with layers of oolith and fine grained breccia of undeterminable fossil remains. These arenaceous beds grade into a sequence of well bedded limestones and dolomites several hundred meters thick.

Syngenetic breccia, crossbedding in the arenaceous—carbonaceous beds show, that the deposition occured in shallow water.

NNE of Mukut between the lower arenaceous and the higher limestone series a few meters of orange, yellow, green and purple shaly marls and limestones were found containing lamellibranch beds.

Crinoids, brachiopoda and rare lamellibranchs were found in the whole complex. From the present state of the fossil determination it is not yet possible to indicate the age of the formation, but the petrographic similarities with the Quartzite beds and the Kioto limestone of the northwestern Himalayas are so strong that there is no doubt of correspondence; so a Rhaetic—Liassic age is assumed.

From the topmost beds of the Kioto limestone a thin bedded sequence of yellow weathering sandstones, marls, grey and black shales and dark, blue limestones develops. A characteristic feature of the series is the frequent occurence of lumachelles. Fossils such as *Trigonia* cf. *costata*, *Exogyra* sp., *Kallirhynchia* sp., *Rhynchonella* cf. *nobilis* and belemnites show a Jurassic age (presumably Dogger). The possibility that the sequence is partly Liassic can not be excluded.

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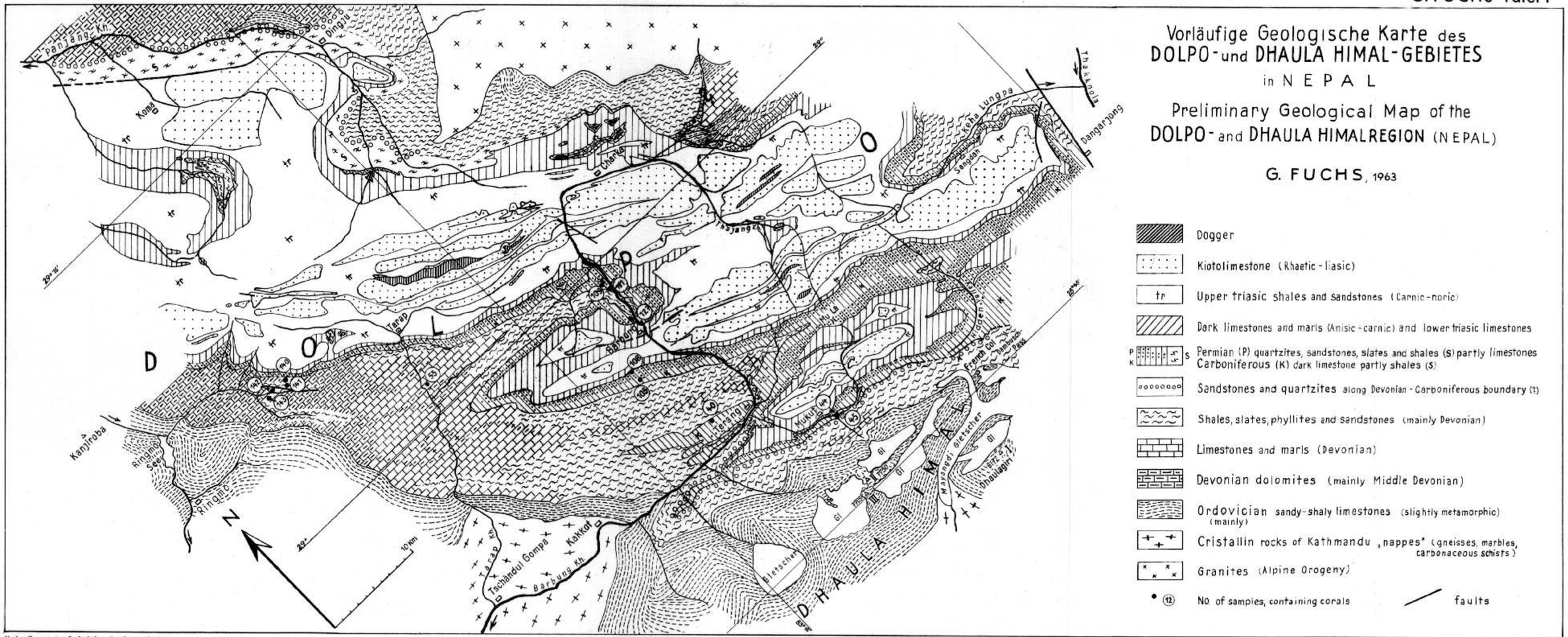

Vorläufige Geologische Karte des DOLPO- und DHAULA HIMAL-GEBIETES in NEPAL

Preliminary Geological Map of the DOLPO- and DHAULA HIMALREGION (NEPAL)

G. FUCHS, 1963

- Dogger
- Kiotolimestone (Rhaetic - liasic)
- tr — Upper triasic shales and sandstones (Carnic - noric)
- Dark limestones and marls (Anisic - carnic) and lower triasic limestones
- P / K / S — Permian (P) quartzites, sandstones, slates and shales (S) partly limestones; Carboniferous (K) dark limestone partly shales (S)
- Sandstones and quartzites along Devonian - Carboniferous boundary (?)
- Shales, slates, phyllites and sandstones (mainly Devonian)
- Limestones and marls (Devonian)
- Devonian dolomites (mainly Middle Devonian)
- Ordovician sandy-shaly limestones (slightly metamorphic) (mainly)
- Cristallin rocks of Kathmandu „nappes" (gneisses, marbles, carbonaceous schists)
- Granites (Alpine Orogeny)
- • (12) No. of samples, containing corals
- faults

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The mentioned Jurassic beds seem to be the youngest sediments in the mapped area. In the transverse graben of the Thakkhola the author could observe ferruginous, belemnite bearing limestone beds of small thickness, Spiti shales and analoga of the Giumal sandstone. As we could visit the named area only in a rapid way and the Dutch Himalaya Expedition 1962 could do detailed work there, we refer to their publication which is in press.

Tectonics (see map enclosed)

The sedimentary sequence of the Thetis Himalaya trough described, about 5000—7000 meters thick, was folded during the Alpine Orogeny into WNW—ESE striking, not too complicated anticlinal structures.

Along the North face of the Dhaula Himal in the basal limestone series a big, N-vergent fold is exposed. Around Mukut we find a syncline overturned to the N, all beds dipping isoclinally to the S. The youngest beds are Kioto limestone forming the core of the syncline.

N of Terang the Barbung Khola is crossed by a N-vergent anticline, which may be followed over the Hidden Valley as far as near Dangarjong.

The region S of the village Barbong is built up by thick mesozoic sediments of another syncline. To the E it can be traced to the area S of Sangdah and here it is cut off by the Dangarjong fault (T. HAGEN 1959).

N of Barbong a complex anticline brings up palaeozoic beds. Towards the E it is hidden under mesozoic sediments, but it reappears in the deeply eroded Keha Lungpa.

The Charka-Tarap area is built up by thick mesozoic sediments belonging to a syncline of large extension. The axial dip to the ESE causes an ending of the southern mesozoic synclines towards the WNW, but this one extends far to WNW. The direction of the movements is towards S.

Some kilometers N from Charka an anticline consisting of palaeozoic rocks develops. A transversal fault causes the Southward extension of the palaeozoics in the region ESE of Charka. To the W the anticline can be traced to the area 7 km S from Koma.

The Kioto limestones SE of Koma, in the NW of the mapped area, form the core of a syncline, which ends towards the SE (S of Dingju). The area around the Panjang Khola is built up by palaeozoic beds.

The granite of Mustang (T. HAGEN, 1954), a light granitic rock rich in tourmaline, is found in the mountains near the Tibetan border. It is a late orogenic Alpine granite.

Faults are especially frequent in the cores of the synclines formed by Kioto limestone. These faults mostly follow the strike direction of the beds and seem to be related with the fold movements *). They seem to be older than the Dangarjong fault, which cuts all the structures.

The geology of this region will be described in detail in a more extensive publication after all the material is worked out.

*) There are so many faults of this kind that they could not be indicated in the generalized map of this publication.

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