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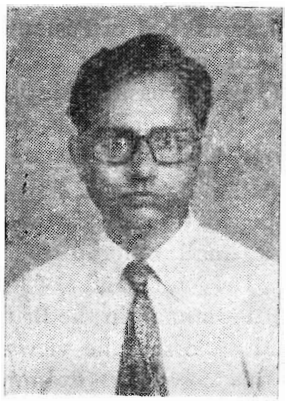

PASTANNAH SECTION OF KASHMIR WITH SPECIAL REFERENCE TO 'OPHICERAS' BED OF MIDDLEMISS[1]

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ABSTRACT

The stratigraphic position and the age of the 'Ophiceras' bed of Pastannah section, Kashmir discovered by Middlemiss (1910) were doubted from the beginning. A thick strata of the lower division of the Lower Triassic, now recorded underlying the so-called 'Ophiceras' bed establishes the position of this bed as that of the Meekoceras bed of the Guryul ravine section. The ammonoid, bivalve and conodont fossils from the bed favour a Smithian (Owenitan) age.

The paper also records the presence of Lower Gondwana bed in the Tral valley (Pastannah section).

INTRODUCTION

The position of the 'Ophiceras' bed of Pastannah discovered by Middlemiss (1910) in Kashmir Himalaya has been disputed for long in the Triassic Scheme. Some workers believe it to be Giresbachian (Otoceratan) while others regard it much younger, i.e. Smithian (Owenitan). To resolve this controversy, the author investigated the Pastannah area and made use of his experience of the Guryul ravine section, where the stratigraphy of Late Permian (Zewan 'Series') and Early Triassic has been recently revised and reviewed by Teichert, Kummel and Kapoor (1970) and Nakazawa *et al.* (1970, 1975). Investigation of the Guryul ravine indicates a possible misinterpretation of the age and the fauna of some of the Lower Triassic beds in Kashmir. It also appears that a similar faunal sequence may be present in other parts of the region including Pastannah.

The Pastannah area was considered to show a well defined complete Triassic succession and was, therefore, viewed to be the strato-type for Kashmir for this system. This is also well known for the abundant fauna in the 'Ophiceras' bed and for the presence of Prohungarites bed, which is the only record of the Spathian (Prohungaritan) stage in the Himalaya (Middlemiss, 1910 ; Diener, 1913 ; Verma and Sastry, 1961-62). Dense forest growth and thick soil cover in the area have concealed most of the outcrops and therefore, the order of the superposition of the different rocks can only be built from the scattered exposures. This is the reason, why this geological section remained problematic, even after several attempts.

The Pastannah area lies in the northern part of the Tral valley, where a sequence from Late Permian to Trias extending possibly upto Jurassic, is exposed. It includes important localities like Pastun (34°00′ : 75°05′), Lam (34°01′ : 75°06′) and Narastan (34°04′ : 75°06′). The geological section of Pastannah, however, is exposed on the hill and slope, adjoining west of Pastun (Pastuni= Pastannah).

Dr. Bernhard Kummel, Dr. Keiji Nakazawa and Dr. Yuji Bando have been associated with this work from the beginning of the project. The details of the fossils are still under critical study with Dr. Kummel. The ammonoid and conodont fossils referred in the text were identified by Dr. Kummel and Dr. W. C. Sweet. Their conclusions were communicated to the author and are incorporated here.

HISTORICAL REVIEW

Noetling (1905, p. 172) discovered the Trias in Pastannah and suspected the presence of Hedenstroemia bed. Middlemiss (1910), later produced a detail geological map and a geological section demarcating a number of fossiliferous horizons.

Middlemiss (*Op. cit.*) recognition of the 'Ophiceras' bed was based on the large percentage of Diener's ampli-

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fication of Griesbach's genus "*Ophiceras*", although he had pointed some differences in characters of Pastannah forms. Diener (1913) from Middlemiss collection isolated 20 species of Cephalopods and 6 species of bivalves and pointed out that majority of the "*Ophiceras*" as considered by Middlemiss are *Xenodiscus*. He, therefore, stressed that '*Xenodiscus*' plays the important role in Kashmir. Moreover, the contributions of the species of bivalve *Pseudomonotis* (*Claraia*) is significant for Lower Triassic correlation. The *Claraia* from Pastannah suggests the position of the bed as the lower Lower Triassic. Middlemiss (1910) and Diener (1913) both, therefore, believed that the 'Ophiceras' bed of Pastannah is paracontemporaneous with *Otoceras-Ophiceras* Zones of Himalayas.

In 1914, Bion discovered *Otoceras* from two localities (not from Pastanah) of Kashmir and noticed that 'Ophiceras' bed of Pastannah and Meekoceras bed of the Guryul ravine are at the same stratigraphical position and lie about 61 to 91 metres above the Otoceras bed. The Meekoceras bed of the Guryul ravine, according to Diener (1913) suggests a Hedenstroemia stage (Smithian =Owenitan).

Spath (1930, pp. 73, 79 ; 1934, p. 28) did not consider the '*Ophiceras*' horizon of Pastannah to be synchronous with the zone of *Ophiceras tibeticum* at Painkhanda ; rather its fauna was slightly younger than the Ophiceras fauna of Spiti and likely to be transitional to the next higher zone. Sahni (1939, p. 163) also believed that this bed of Kashmir to be not absolutely synchronous with that of other Himalayan sections.

Verma and Sastry (1961-62) made first attempt to resolve the controversy of the position of the 'Ophiceras' bed. They thought that this bed is in the normal stratigraphic position and the underlying thick unfossiliferous limestone (Cliff limestone) is likely to be the 'Otoceras' bed. Kummel (1970) also visited Pastannah in 1968, but was unsuccessful in locating this bed. He, however, doubted Bion's correlation of the Ophiceras bed with the Meekoceras bed of the Guryul ravine. This is because the details of the stratigraphic succession of the Triassic System are not yet fully known.

Tozer (1969, 1971) rejected the view that the so-called 'Ophiceras' bed of Pastannah is in any way equivalent to *Otoceras-Ophiceras* Zone of Tethys Himalaya. He opined that the "*Xenodiscus*" *comptoni* Diener from this bed is actually a Smithian genus *Xenoceltites*. This, he also supported by an unrecorded form "*Pseudomonotis*" *himaica* Bittner from this horizon lying in the British Museum of Natural History. This is a characteristic bivalve form which occurs at the top of the Hedenstroemia bed (Smithian) of Spiti and Painkhanda. According to him the '*Ophiceras*' of Pastannah could just as well be assigned to the Smithian genus *Dineroceras* ; the *Claraia griesbachi* Bittner from Pastannah does not appear to be correctly identified. *Pseudosageceras* should be rejected as it is related to *Hedenstroemia* (ceratid).

McTavish and Dickins (1974) agreed with Tozer (*op. cit.*) in considering the 'Ophiceras' bed of Pastannah to be Smithian. They based their conclusions on *Subinyoites kashmiricus* (Diener) of Perth basin, Australia which indicates a Smithian age. This species was originally described from the '*Ophiceras*' horizon of Pastannah by Diener (1913).

Nakazawa *et al.* (1975) happened to visit Pastannah in 1969, and could examine a small outcrop of the 'Ophiceras' bed of Middlemiss. Dr. Yuji Bando of their party examined the collections of Pastannah in the British Museum of Natural History and endorsed the views of Tozer (1971). Nakazawa and his coworkers examined the types in the Geological Survey of India in addition to their own material they pointed out that '*Pseudomonotis*' *griesbachi* Bittner of this bed described by Diener is allied to "*Ps.*" *decidens* Bittner from Meekoceras bed of the Guryul ravine ; "*Ps.*" *tenuistriata* Diener is conspecific with *Leptochondria minima* (Kiparisova) that occurs from *Otoceras-Glyptophiceras* Zone to the *Owenites-Kashmirites* Zone in the Guryul ravine. *Ps. multiformis* by Diener is more properly referred to *Leptochondria bittneri* Kiparisova. They thus suggest 'Ophiceras' bed to be of Smithian age, roughly correlatable to the Meekoceras bed (*Owenites-Kashmirites*) Zone. They however noticed no common ammonoid species between the two and consider that probably the Pastannah horizon is slightly lower than the *Meekoceras* horizon of the Guryul ravine.

GEOLOGY

The area falling north of the Pastun village (Figure 1) has tightly folded and faulted Triassic sequence. The underlying Zewan Formation, Lower Gondwana and Panjal Trap are on contrary, less disturbed. The outcrops of the Zewan Formations and the Early Triassic, in most of the parts of the area are concealed under thick alluvial cover.

At Yangawain (34°01′ : 75°05′), the flaggy shale of the Lower Triassic with profusely well developed *Claraia concentrica* Yabe and *Glyptophiceras* (*?*) is exposed in the ravines and canal cuttings passing in the close vicinity of the village. At Narastan, the geological section is comparatively better exposed than Yangawain. One is struck, in this locality, with the boulders of limestones lying on the slopes, particularly with those which show embedded ammonoids—some of them resembling with *Otoceras ;* though this genus so far could not be located *in-situ*. The extremely hard nature of the limestone makes it difficult to extract fossils from the matrix.

The details of the lithology, as observed on Pastannah hill are included in the geological section and geological column given in Figures 2 and 3. The present geological

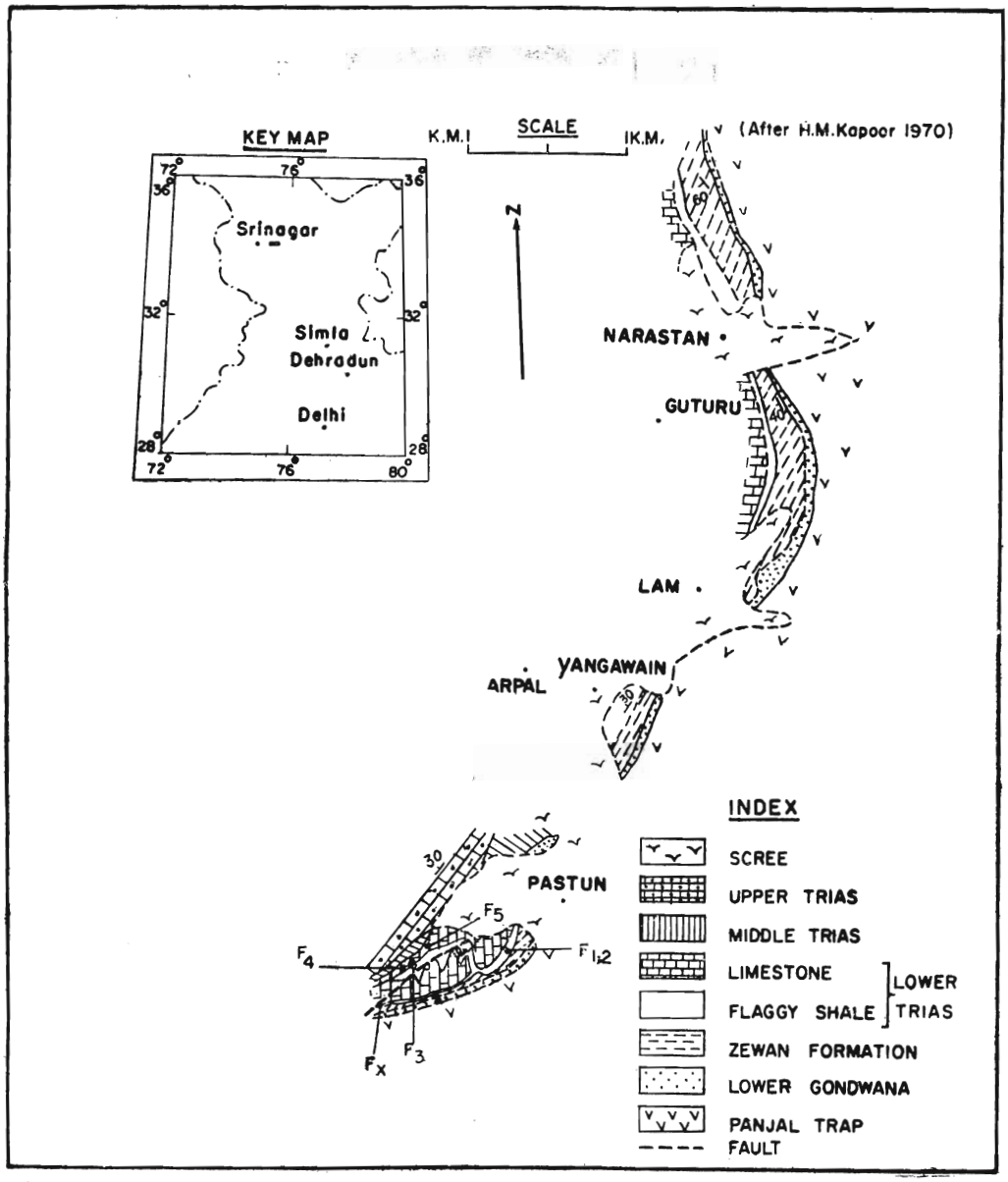

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Fig. 1. Geology of Pastannah (Pastun), Kashmir showing Late Permian and Early Triassic Formations. *Inset*—Key Map.

section line, is further west of the section, described by Middlemiss (1910) and Verma and Sastry (1961-62). The stratigraphy of the geological section is described below :

Lower Gondwana (Gangamopteris bed) : The volcanic Panjal Trap, in a ravine of Deo *nar*, S. W. of Pastun, is overlain by novaculite siliceous shale, tuff and chert. The tuff layer shows fragmentary *Gangamopteris kashmirensis* Seward, *Psygmophyllum* and vertebrate remains (mainly fish scales). The sequence, though thin (16 metres) is the continuity of 'Gangamopteris bed' of Vihi area. The Lower Gondwana was not known earlier in the Tral valley. (Plate I—1, 2 ; Figure 2-C).

Zewan Formation : The Lower Gondwana follows upwards to a sequence of fossiliferous beds included here under Zewan Formation. The Zewan 'Series' of Middlemiss (1910) has been modified by Nakazawa *et al.* (1970, 1975) to Zewan Formation. It is Late Permian in age.

The base of the formation is characterised by limestone rich in bryozoans, crinoids, corals and a few brachiopods. The contact of this unit with the underlying Gangamopteris bed shows slight crushing and fracturing but no visible horizontal or vertical dislocation.

The limestone of the base of the formation is succeeded by alternations of thin sandy shale and sandy limestone, rich in bryozoans, crinoids and rare in brachiopods.

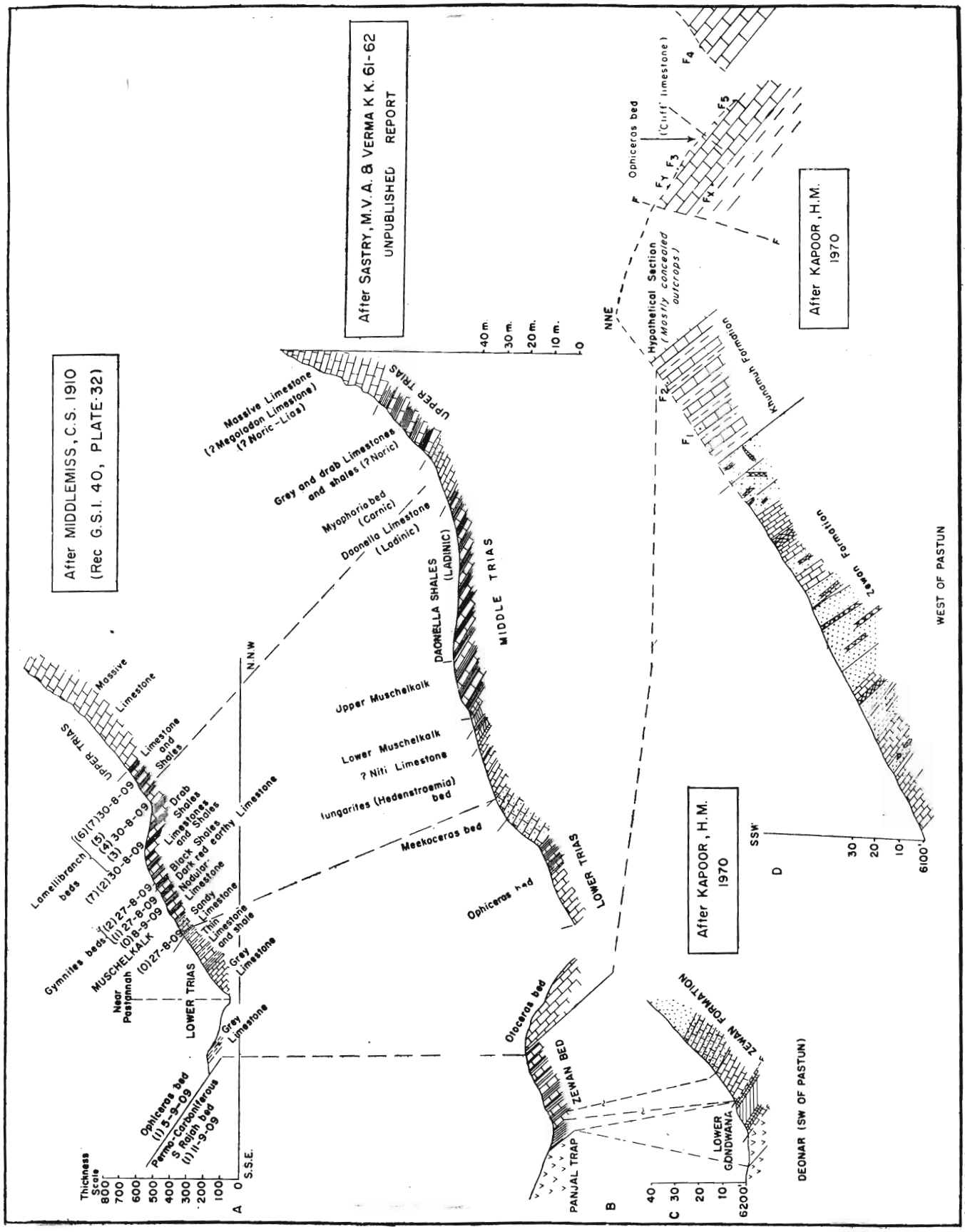
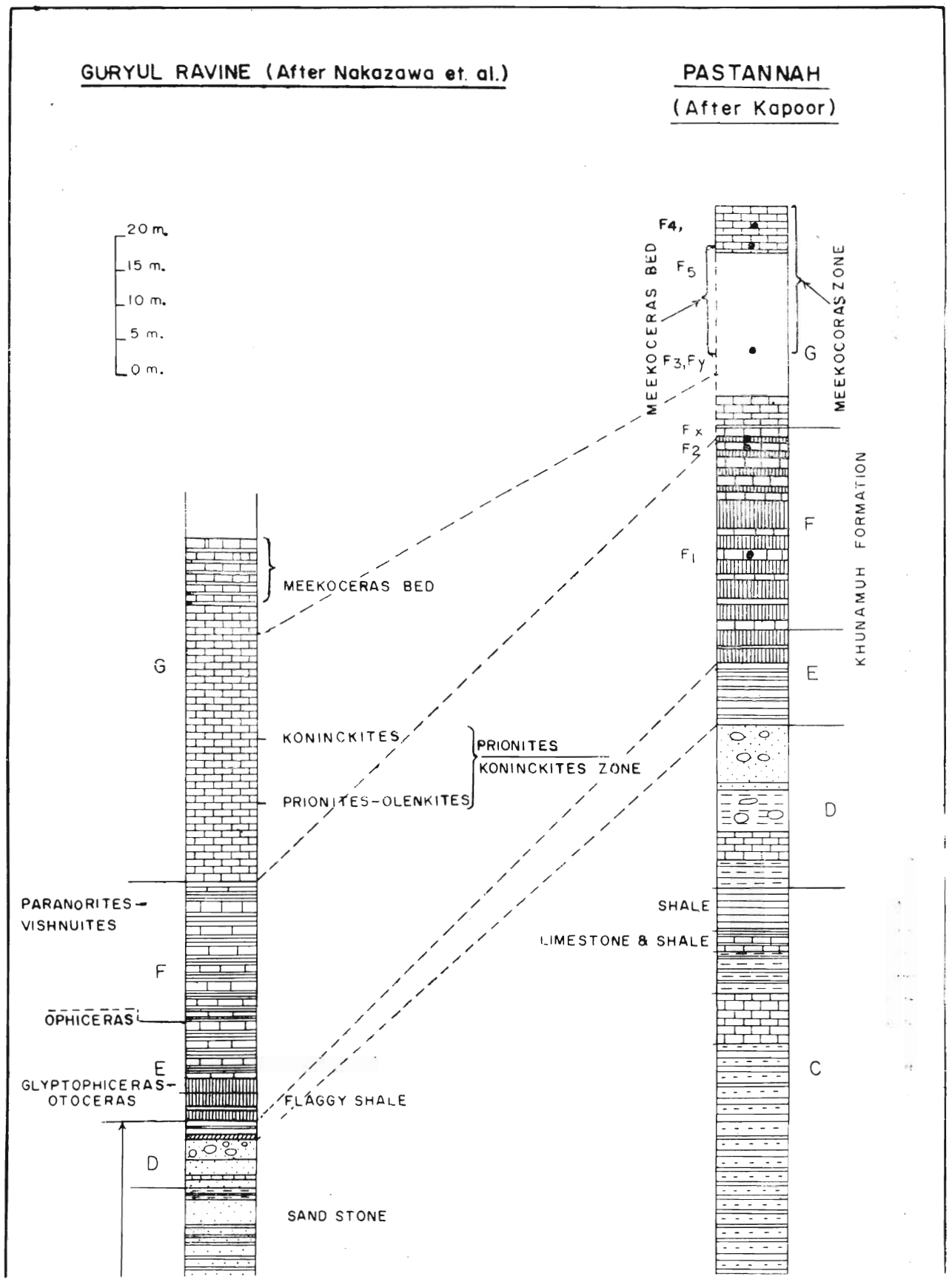


Fig. 2—Pastannah geological section after Middlemiss (1910), Verma and Sastry (1961-62) and Kapoor (1970). C. Deo *nar* D. Pastannah geological section.


GURYUL RAVINE (After Nakazawa et. al.)
PASTANNAH
(After Kapoor)
20 m.
15 m.
10 m.
5 m.
0 m.
MEEKOCERAS BED
G
KONINCKITES
PRIONITES-OLENKITES
PRIONITES
KONINCKITES ZONE
PARANORITES-
VISHNUITES
F
OPHICERAS
E
GLYPTOPHICERAS-
OTOCERAS
FLAGGY SHALE
D
SAND STONE
F4,
F5
F3,Fy
MEEKOCERAS BED
G
MEEKOCORAS ZONE
Fx
F2
F
F1
E
KHUNAMUH FORMATION
D
SHALE
LIMESTONE & SHALE
C

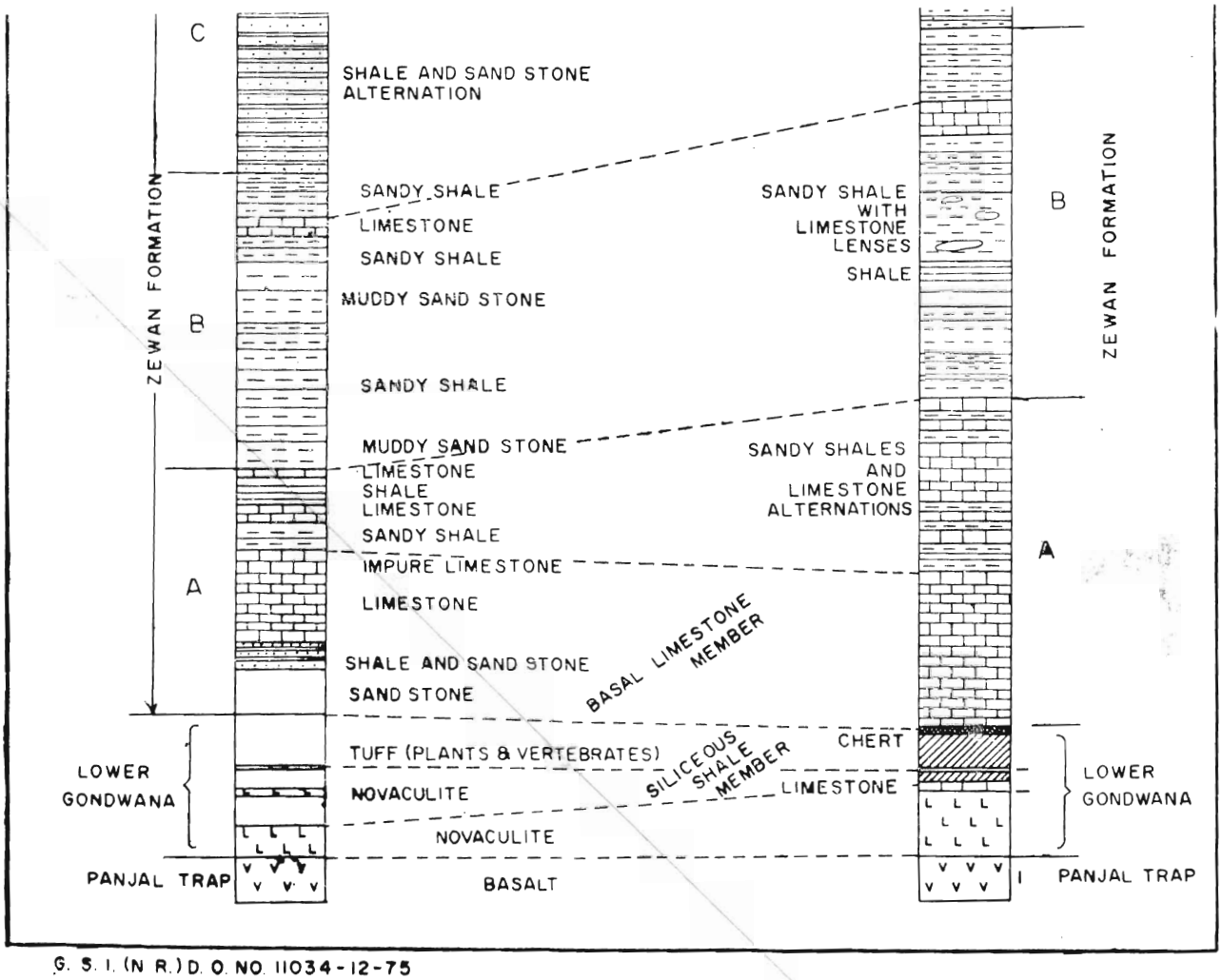


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Fig. 3—Guryul ravine and Pastannah geological columns—a comparison.

Polypora ampla is most abundant among bryozoans. The lithological similarity, and stratigraphic position as well as the fauna favours this bed to correspond with the zone of *Protoretepora ampla* recognised by Middlemiss (1910) in other sections of Kashmir.

The overlying beds are mainly shale and calcareous sandstone with numerous fossil layers, mainly of brachiopods and rarely of bivalves. The youngest bed included in the formation is arenaceous limestone with shaly interbands and nodules of limestone.

The Zewan fauna at Pastannah includes bryozoans, brachiopods, bivalves, corals and crinoids ; a few worth mentioning are *Polypora ampla*, *Spiriferella rajah*, *Waagenoconcha gangetica*, *Cyrtorostra*, "*Rhynchonella*", *Athyris*, *Dictyoclostus*, *Etheripecten*, etc.

Middlemiss (1910) failed to recognise *Protoretepora ampla* Zone in this section ; Verma and Sastry (1961-62) however recognised this zone but put *Waagenoconcha gangetica* layer below this, which in fact overlies it.

The correlation of the Pastannah section with that of the Guryul ravine is given in Figure 2. Nakazawa *et al.* (1975) divide Zewan Formation into four lithostratigraphic members, A to D in the Guryul ravine section. The biostratigraphic correlation of Pastannah with the three faunal subdivisions (I—III) of the Guryul ravine is rather difficult at present, due to limited faunal data.

Khunamuh Formation: The Zewan Formation is succeeded by shale and limestone sequence of Khunamuh Formation (Nakazawa *et al.*, 1975). The Khunamuh Formation in the Guryul ravine section, has a basal part (Unit E_1) (*op. cit.*) as latest Permian, while remaining succession as Lower Triassic. In Pastannah, however, black shale with no visible limestone intercalation, lithologically corresponds with the above, but the fauna represented only by *Claraia* sp. indet. and *Etheripecten* sp., is insufficient to correlate it with the latest Permian faunistic Division IV of the Guryul ravine.

The shale unit of the base, gradually passes to a sequence of flaggy shale with thin limestone interbands of 10 to 15 cm. The flaggy shale is fissile and weather purple. The *Claraia* sp. indet. could only be observed in this bed. It is likely to represent the zone of *Otoceras-Glyptophiceras* and *Ophiceras* of the Guryul ravine, though any ammonoid could not be found.

The next succeeding bed, more pronounced in limestone with subordinate flaggy shale, is poor in fossils, although in some shale layer *Claraia concentrica* Yabe is present. This species is particularly abundant in the youngest shale layer, exposed in one of the ravine cuttings marked F_x in Figure 1-4. Two limestone samples (Nos. P/70/25 and P/70/26) from points F1 and F2 were macerated by Dr. W. C. Sweet for conodonts. F2 is the youngest limestone layer of this bed, while F1 is 17 metres below the other. F2 shows only fragmentary *Ellisonia* but F1 has *Neospathodus dieneri* Sweet (abundant) and fragmentary *Ellisonia*. On the basis of conodonts the bed is likely to represent *Neogondolella dieneri* Zone or *Neospathodus cristagalli* Zone recognised by Sweet (1970) and Nakazawa *et al.* (1975), *i.e.* almost corresponding with *Paranorites-Vishnuites* ammonoid zone.

The above beds of the Khunamuh Formation were not reported earlier at Pastannah and the sequence upto this was included within the Zewan Formation.

The immediate overlying is a thick bedded, unfossiliferous limestone (apparently) of grey to bluish grey in nature. It forms a small cliff and further continues as dip slope on the Pastannah hill. It is often spoken as 'Cliff Limestone.' This unfossiliferous (Cliff) limestone gradually passes upwardly to fossiliferous limestone—rich in ammonoids and bivalves. This represents the so-called 'Ophiceras' bed of Middlemiss. The present work is confined up to this bed only. Its fauna will be dealt in the next chapter.

The newly recorded Lower Triassic beds underlying the 'Cliff Limestone', confirm Bion's view of 1914 that the position of the so-called 'Ophiceras' bed of Pastannah is much higher in the stratigraphic position than the Otoceras bed. This position is the same as that of the Meekoceras bed (of Middlemiss) of the Guryul ravine section. It may be noted that the 'Cliff limestone' in the Guryul ravine section was considered by Middlemiss (1909) as the basal Lower Triassic, while the same limestone in another section, at Pastannah was considered to be the Permian, by the same author in 1910. Recently the work of Nakazawa *et al.* (1975) has established the boundary of the latest Permian and the earliest Triassic. It is much below in the sequence than what Middlemiss considered.

STRUCTURE

The Pastannah geological section described by Middlemiss (1910) and Verma and Sastry (1961-62) was supposed to be structurally undisturbed. The recent observations, however show dislocation of beds, due to a number of faults in the area.

One fault runs some way in the middle of the Pastannah hill-slope (Figure 1, 3 and Plate I—3). It is a strike fault of high angle and has brought northern block about 15 metres up ; this shifting is very clear in one of the ravines where sides of N-S spurs show a five metre fault zone.

Another fault is, however, not very clear. It is suspected to run almost at the foot of the Pastannah hill, running along the main dry channel. The topography indirectly favours this inference and also the fossils, indicating a slightly older interval on the northern side (F4), while they should be younger. The effects of these faults

do not interfere much with our main problem of the position of the 'Ophiceras' bed.

FOSSILS FROM THE SO-CALLED 'OPHICERAS' BED

The fossils from the 'Ophiceras' bed of Middlemiss are collected at localities F3, F4 and F5 (Figure 1 and 4). FY is the locality (1) 5—9—09 of Middlemiss (1910).

The locality F3 is not far from the locality FY ; at the most a few metre north on the dip slope. An outcrop of fossiliferous limestone, about one metre thick with ammonoids is exposed on the western wall, along the ravine cutting. Over the fossiliferous layer is overburden but underlying it, is about 40 metre 'Cliff Limestone.' The following ammonoids (by Dr. B. Kummel) and conodonts (by Dr. W. C. Sweet) are recognised from this layer (Sample No. P70/27) which suggest a *Meekoceras-Anasibirites* interval known from Nevada, Idaho, etc. :—

Owenites, Meekoceras and *Pseudosageceras ; Neogondolella milleri* (Müller), *Neospathodus conservativus* (Müller), *Neospathodus waageni* Sweet, *Neogonodolella* n. sp. and *Ellisonia triassica* Müller.

The locality F4 is about 250 metres from locality F3 and is exposed in another ravine (Text Figure 4). A small outcrop (20 m × 15 m) runs across the ravine and shows a three metre thick fossiliferous limestone (P70/29). There is a possibility of this being the locality of Noetling (1905), which he considered to be the Hedenstroemia bed. Middlemiss (1910, p. 243) however, believed Noetling's collection from loose material and at a different location (Hungarites bed-Diener, 1913). It has yielded '*Glyptophiceras*' among ammonoids, but conodonts include *Neogondolella milleri* (Müller), *Neospathodus waageni* Sweet, *Ellisonia triassica* Müller and a new *Neogondolella* Sweet etc. The frequency of the assemblage of conodonts, somewhat differs from F3, but undoubtedly favours a *Meekoceras-Anasibirites* interval.

The third locality, F5 shows outcrop of limestone at the foot of Pastannah hill (Figure 4) along the main channel. Srivastava and Mandawal (1966) made first record of conodonts from India from this locality and tentatively identified *Gondolella* cf. *phospriensis, Neogondolella carinata* (Clark), *Gondolella* aff. *denuda* Ellison, *Parachirognathus* cf. *geiseri* Clark and *Neogondolella triassica* Müller. Sweet (1970) showed the similarity of this fauna with the *Neogondolella carinata* zone of the Guryul ravine. Subsequently, Sweet *et al.* (1971), McTavish (1975) reconsidered this assemblage to represent *Furnishius-Parachirognathus* Zone—a cenozone of the Smithian. The views of these authors, further get support from the collection made by Nakazawa *et al.* (1975) from this locality. Their material, although from loose blocks, contain Smithian bivalves (given in the Historical Review), ammonoids recently communicated to the author by Dr. Bando (*Olenikites, Meekoceras, Prinolobus, Keyserlingites,*

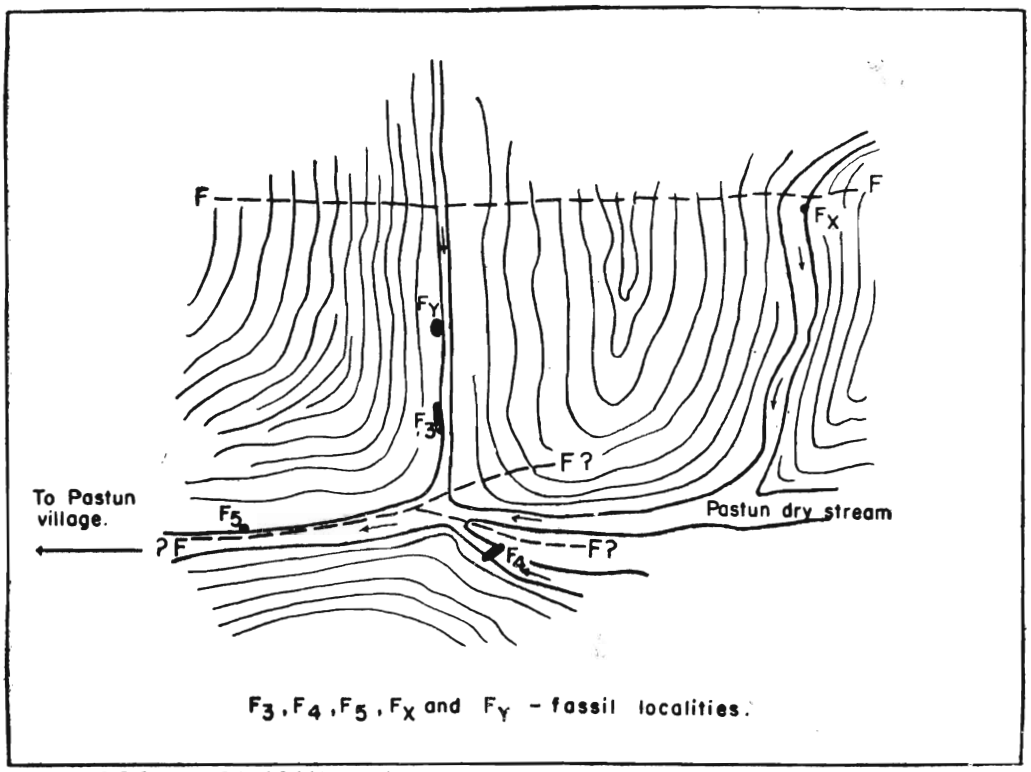

Fig. 4—Hypothetical sketch showing the localities of the samples from the 'Ophiceras' bed of Pastannah.

Hemiprionites, *Xenoceltites aequicostatus* (Diener), *Kashmirites*, *Owenites koeneni* Hyatt and Smith, *Dieneroceras*) and conodonts recognised by Dr. Nogami (*Neogondolella milleri* (Müller), *N.* aff. *carinata* (Clark) and *Neospathodus waageni* Sweet). The *in situ* collection of the author (P 70/31) from this locality, however could not be analysed. The ammonoid fauna according to Dr. Y. Bando (*pers. comm.*) is correlatable to *Meekoceras gracilitatis* Zone of Smithian.

The total thickness of the so-called '*Ophiceras*' bed, by summing up the different layers, is about 20 metres and is in quite agreement with the thickness considered by Middlemiss (1910).

REMARKS

1. The shortcoming of the exact stratigraphic position and not proper interpretation of the fauna of the 'Ophiceras' bed of Middlemiss at Pastannah kept the problem of its position and the age lingering for about sixty years. In recent years, the Guryul ravine section of Kashmir has emerged as an ideal section for the Lower Triassic, where lithostratigraphy and faunal zones are now well established. A comparison of both of Pastannah and the Guryul ravine sections in above chapters and also in Figure 3, has established that 'Ophiceras' bed of Pastannah is in the same stratigraphic position as Meekoceras bed of the Guryul ravine.

2 A recent collection made by Nakazawa *et al.* (1975) from the Meekoceras bed of the Guryul ravine includes a Smithian fauna of bivalves, ammonoids and conodonts worth mentioning are *Claraia decidens*, *Owenites koenini*, *Wasatchites*, *Meekoceras gracilitatis*. In Pastannah also the 'Ophiceras' bed includes Smithian species namely *Owenites koenini*, *Meekoceras*, *Xenoceltites aequicostatus* etc. besides bivalves and conodonts, favouring its faunistic similarity with that of Meekoceras bed of the above area.

3. The review of the fauna, described by Diener (1913) from the 'Ophiceras' bed including the specimens present in the British Museum of the Natural History, London and also the types in the Geological Survey of India from Pastannah, were mentioned by Tozer (1969, 1971), McTavish and Dickins (1974, 1975) and Nakazawa *et al.* (1975). Nakazawa *et al.* (1975) have in addition made their own collection. All of them fully support the fauna of this bed to be of Smithian age. The misinterpretation of age of the bed by Diener (1913) was mainly due to wrong identifications of the important fossils. The study of the author's collection from Pastannah bed by Profs. Kummel and Sweet also suggests a Smithian age.

4. Middlemiss (1909) recognised Meekoceras bed in the Guryul ravine, considering this bed to be equivalent to the Meekoceras bed of Spiti and Painkhanda. Diener (1913) however, suggested that its fauna is of younger *i.e.* of Hedenstroemia bed. Nakazawa *et al.* (1975) from the collection of this bed found a number of common elements which are present in the type *Meekoceras* Zone of America (*Meekoceras gracilitatis* Zone). Therefore, it is justified to retain the term Meekoceras bed for the Guryul ravine, although it was wrongly correlated with the different older bed. This has already been indicated by the author elsewhere (MS) that the Meekoceras bed of Spiti and Painkhanda needs revision to Koninckites bed, to avoid confusion from the American type.

Kummel and Steele (1962) have also shown, a common faunal similarity of Hedenstroemia bed of Spiti and Painkhanda with that of the *Meekoceras gracilitatis* Zone of America. Therefore it has become necessary to replace the term Hedenstroemia bed of the Himalayas by the Meekoceras bed (*sensu stricto*).

5. The presence of ammonoid fauna of the Meekoceras bed of the Guryul ravine in the 'Ophiceras' bed of Pastannah in localities FY, F3 and F5 suggests the inclusion of the sequence of fossiliferous limestone upto this point within the Meekoceras bed. No characteristic ammonoid fauna has been found in locality F4, though conodonts have given its support for inclusion within this horizon ; therefore, at present the entire 'Ophiceras' bed of Middlemiss has been included within *Meekoceras* Zone.

The revisions suggested by the author for Himalayan Ophiceras, Meekoceras and Hedenstroemia beds are tabulated below. The original names are given within the brackets.

Pastannah	Guryul ravine	Spiti	Painkhanda
Meekoceras Zone ('Ophiceras' bed)	Meekoceras bed	Meekoceras bed (Hedenstroemia bed)	Meekoceras bed (Hedenstroemia bed)
Koninckites Zone	Koninckites bed	Koninckites bed (Meekoceras bed)	Koninckites bed (Meekoceras bed)
Ophiceras Zone	Ophiceras bed	Ophiceras bed	Ophiceras bed

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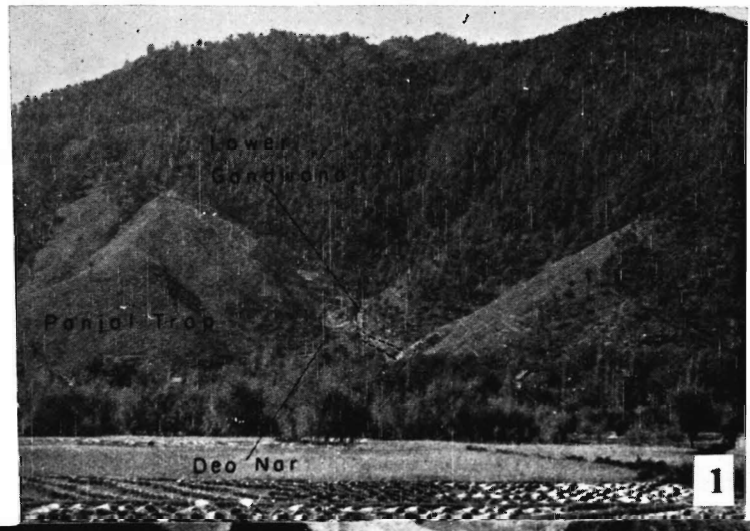

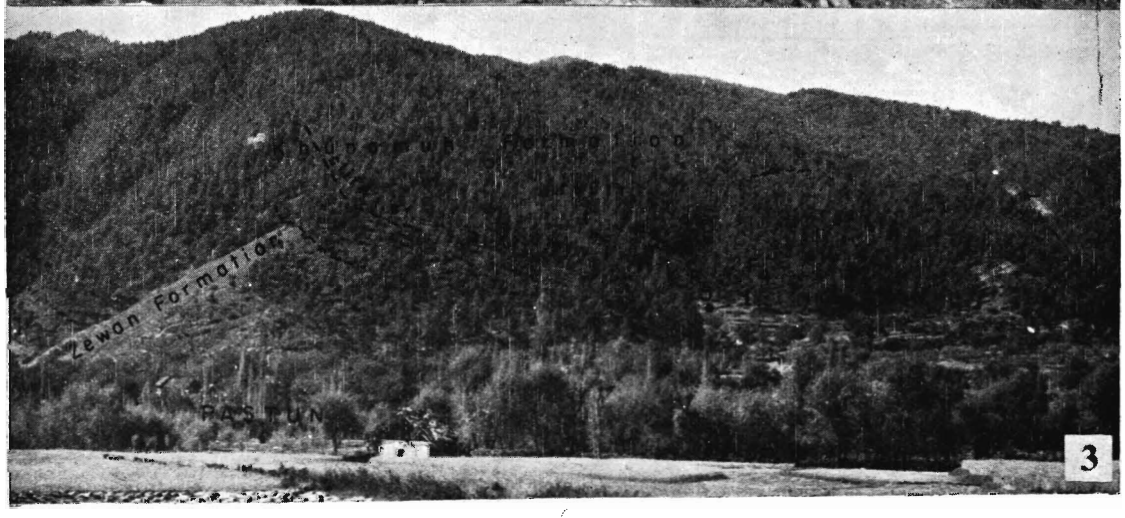

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EXPLANATION OF PLATE

PLATE I

1. Deo *nar*, near Pastun, showing Lower Gondwana bed.
2. Fossil layer of Lower Gondwana in Deo *nar*.
3. Pastannah hill showing Zewan and Khunamuh Formations and fossil localities F3, F4 and F5.