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# First find of the Early Permian Lower Gondwana plant remains and palynomorphs from the Chhongtash Formation (Upper Shyok valley), eastern Karakoram, India

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## ABSTRACT

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A sedimentary sequence mainly consists of black shale, siltstone, calcareous sandstone and dark argillaceous limestone overlying a pillow lava and thinly bedded limestone of the Chhongtash Formation near Chhongtash locality (Upper Shyok valley, eastern Karakoram, India) contains abundant, but poorly preserved plant fossils and palynomorphs probably referable to the Early Permian or Late Asselian (~275 Ma) interval. The plant fossils and associated palynological assemblages of eastern Karakoram show a marked similarity to the marine Lower Gondwana assemblages of the Salt Range and Talchir-Karharbari assemblages of Central India. Based on the present discovery it is suggested that, before the accretion of Cimmerian microplates to the Eurasian continent, the Karakoram microplate in its incipient state was not far from the Salt Range and located along the northern margin of the Indian subcontinent as Peri-Gondwanan microplate.

**Key-words**—Lower Gondwana, Plant fossils, Early Permian, Chhongtash Formation, India.

## सारांश

**भारत के छोंगताश शैलसमूह (उपरि श्योक घाटी) की पूर्वी कराकोरम सूक्ष्म प्लेट से प्रथम प्राप्त आरम्भिक परमियन अधोगोंडवानायुगीन पादप अवशेष एवं परागाणुरूप**

**राजीव उपाध्याय, राकेश चन्द्रा, हकीम राय, नीरजा झा, शैला चन्द्रा, रंजीत कुमार कर एवं अंशु कुमार सिन्हा**

छोंगताश संस्थिति के निकट छोंगताश शैलसमूह (उपरि श्योक घाटी, पूर्वी कराकोरम सूक्ष्म प्लेट, भारत) के एक शिरोधान लावे तथा तनु संस्तरित चूना पत्थर पर उपरिशयित एक अवसादी अनुक्रम, जिसमें काला शेल, पांशु प्रस्तर, चूनामय बालुकाश्म तथा गहरे मृण्मय चूना पत्थर समाहित हैं, में प्रचुर किन्तु अत्यल्प मात्र में संरक्षित पादपाश्म एवं परागाणुरूप हैं, जिन्हें सम्भवतः आरंभिक परमियन अथवा अन्तिम एसीलियन (27.5 करोड़ वर्ष पूर्व) अन्तराल से सन्दर्भित किया जा सकता है। पूर्वी कराकोरम के पादपाश्म तथा सहयुक्त परागाणु समुच्चय लवण मालारेखा के समुद्री अधोगोंडवाना

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समुच्चय तथा मध्य भारत के तालचीर-करहरबाड़ी समुच्चयों के साथ उल्लेखनीय समरूपता प्रदर्शित करते हैं। वर्तमान खोज के आधार पर प्रस्तावित किया जाता है कि सिमेरियन सूक्ष्म प्लेटों के यूरेशियाई महाद्वीप में सहवर्धन से पूर्व कराकोरम सूक्ष्म प्लेट अपनी प्रारंभिक अवस्था में लवण मालारेखा से अधिक दूर नहीं थी तथा वह परिगोंडवाना सूक्ष्म प्लेट की भाँति भारतीय उपमहाद्वीप के उत्तरी उपांत के पार्श्व में स्थित थी।

## INTRODUCTION

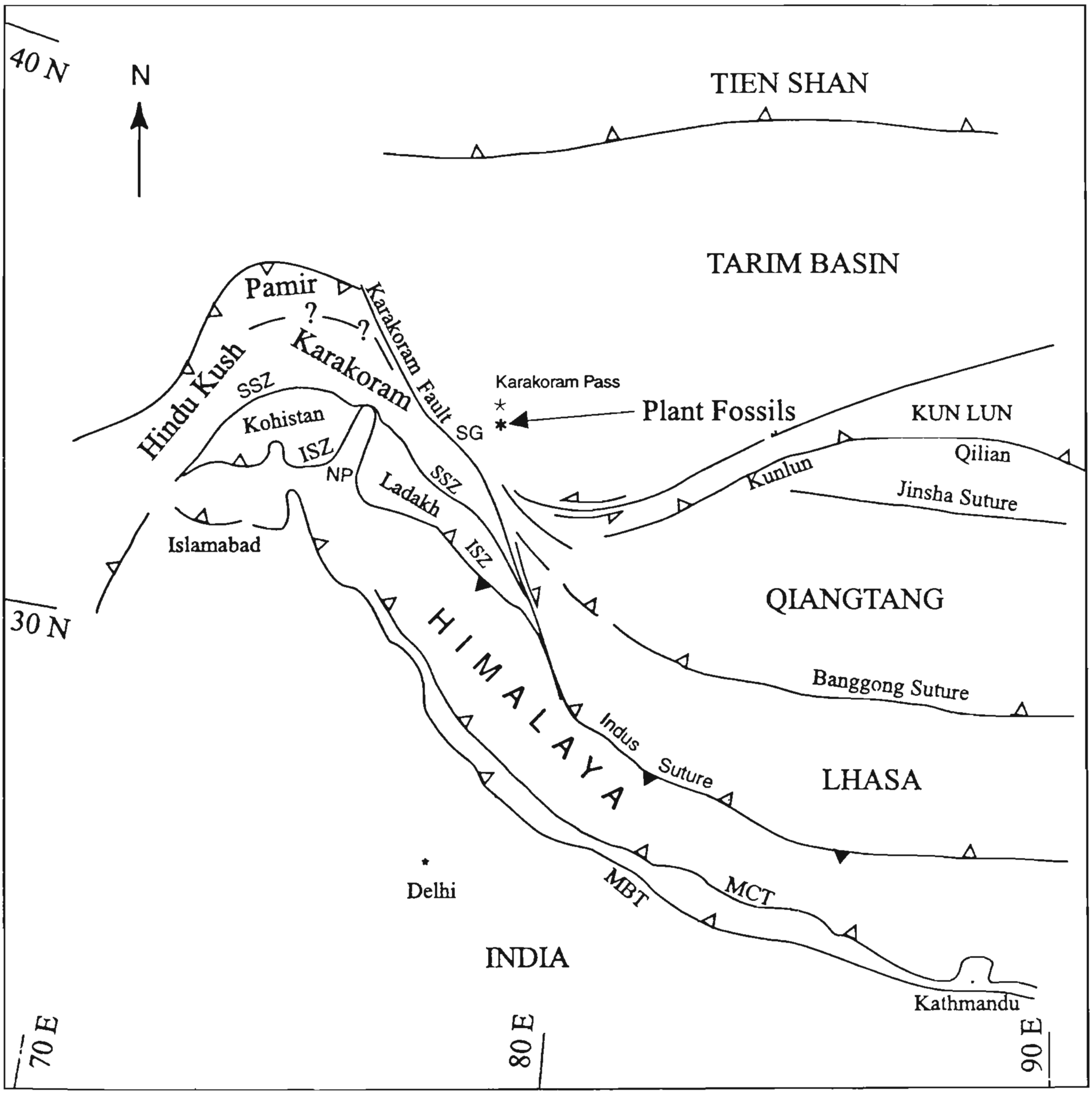
The Karakoram, situated in the very heart of Central Asian highlands is a ~800 km long and ~150 km wide tectonic terrane and occupies an intermediate position between north Pamir and northwestern Tibet (Searle, 1991; Gaetani, 1997; Sinha *et al.*, 1999) (Text-figure 1). The Karakoram terrane also lies along a critical geological juncture immediately to the north of the two major suture zones - the Shyok and Indus sutures, that mark the closing of Tethys ocean and the collision of India with Asia around ~50 Myr ago (Searle, 1991; Upadhyay & Sinha, 1998; Sinha *et al.*, 1999). Since the collision, mountain building processes have been operative and are still ongoing both in the Himalaya to the south and in the Karakoram to the north. All the mountain ranges in the north and east, including the northern Pamirs, the Tien Shan and Kun Lun (Text-figure 1) show evidence of major Palaeozoic orogenies, although they have all been strongly reactivated during India-Asia collision (Dewey *et al.*, 1988, Searle, 1991).

Decades after the initial geological reconnaissance (De Terra, 1932; Dainelli, 1933; Norin, 1946), the eastern Karakoram was visited by Gergan and Pant (1983), Bagati *et al.*, (1994), and Sinha *et al.*, (1999). However, geological information describing different aspects of the eastern Karakoram region is still in an initial stage. There are major gaps in the stratigraphic column and information is needed to explain the structure and tectonics, tectono-sedimentary evolution, localization of economic deposits, prospecting of petroliferous basins and palaeogeographic reconstruction of the Karakoram. Up to date major information to understand the concept of Karakoram have been arrived from the northwestern sector of Karakoram in Pakistan (Desio, 1974; Searle, 1991; Gaetani, 1997). Based on these studies, the Karakoram has been suspected to be one among the most significant Peri-Gondwanan microcontinents. But it has been always left off from the palaeogeographic reconstruction map of Gondwana and Asian microcontinents (Scotese & McKerrow, 1990; Nie *et al.*, 1990; Scotese & Langford, 1995) mainly because of two reasons: (1). Based on limited traverses scanty geological information available from Pamir, Karakoram and western Tibet,(De Terra, 1932; Dainelli, 1933; Norin, 1946; Desio, 1974; Gergan & Pant, 1983; Bagati *et al.*, 1995; Matte *et al.*, 1996; Gaetani *et al.*, 1997; Sinha *et al.*, 1999); and no Early Permian plant remains and palynomorphs were ever reported from the Karakoram Terrane. Early Permian plant remains have for long been considered as a pointer for Peri-Gondwanan origin of most of the Asian microcontinents (Nie *et al.*, 1990), and (2). Owing to the extreme inaccessibility of the Karakoram and also because of the disputed frontiers of Pakistan, India and China, large areas of the region remain unexplored and unstudied.

Recently, during the summer of 1995, three of us (RU, RC & HR) took a traverse in the eastern Karakoram mountain under the leadership of Professor Anshu K. Sinha, to unravel the intricacies and complex geological history of this inaccessible area bounded by the Nubra-Shyok river valleys to the south and the Karakoram Pass point (5575 m, the end of Indian territory) to the north (Text-figures 1, 2). The geographical limits of this inaccessible region are between the upper Yarkand river in the Chinese territory of the Kun-Lun range of Tibet in the north and the Ladakh Himalayan ranges in the south (Text-figures 1, 2). As a significant breakthrough we here report the first find of the Early Permian plant remains and Late Asselian (~270 Ma) palynomorphs from the Chhongtash Formation of the eastern Karakoram Terrane, India. This paper discusses the palaeogeographical significance of the plant remains and palynomorphs preserved in the sedimentary sequence of the Chhongtash Formation of eastern Karakoram.

## GEOLOGICAL SETTING

On the basis of field evidence across a 150 km long south-north traverse from Sasoma in the Nubra valley to Karakoram Pass in the eastern Karakoram mountain (Text-figures 2d, e). two major tectonic divisions have been recognized (Sinha *et al.*, 1999; Text-figures 2, 3) : (1) the Karakoram Plutonic-Metamorphic Complex, and (2) the Karakoram Tethyan zone. The granites of the Karakoram plutonic complex are two-mica varieties having large xenoliths of metasedimentary and mafic rocks. The most abundant rock types are weakly deformed and relatively well preserved granites, granodiorites and tonalites having both I-and S-type signatures (Sinha *et al.*, 1999). The Karakoram plutonic complex intruded the Carboniferous-Permian sequence of the Karakoram Tethyan zone (Text-figures 2, 3) to the north. The rocks of the Karakoram Tethyan zone are ranging in age from Carboniferous-Permian to Late Cretaceous (Sinha *et al.*, 1999; Text-figures 3). The geological account of the Karakoram Tethyan zone have been provided and discussed elsewhere (Sinha *et al.*, 1999, Bagati *et al.*, 1995 and Gergan & Pant, 1983).




Text-figure 1—Simplified geological sketch map of Central Asia showing present geotectonic position of western Himalaya, Karakoram, Hindukush, Pamirs, Tien Shan and Kun Lun Mountain ranges: their tectonic subdivisions and location of major sutures, microcontinental fragments (modified after Searle, 1991) and location of present findings of the Early Permian plant remains and palynomorphs. SSZ: Shyok Suture Zone, ISZ: Indus Suture Zone, MCT: Main Central Thrust, MBT: Main Boundary Thrust, NP: Nanga Parbat, SG: Siachen Glacier, KK Pass: Karakoram Pass (5575 M), * Location of the Early Permian plant remains and palynomorphs recorded from the Chhongtash Formation near T-Camp nala section in the Chhongtash locality (~70 km south of the Karakoram Pass and ~50-60 km east of Siachen Glacier and 6-7 km west of Chhongtash Camp towards Morgo Formation), eastern Karakoram India.

## PLANT FOSSILS AND PALYNOMORPHS BEARING SEDIMENT INTERVAL IN THE CHHONGTASH FORMATION

Tectono-stratigraphy of the eastern Karakoram reveals that the Chhongtash Formation of Karakoram Tethys is in tectonic contact with the rocks of the Aqtash Formation to the south and overlain by thick carbonate sequence of Morgo Formation (Text-figures 2, 3). Based on the occurrence of *fusulinid* – bearing limestone and siltstone the age of the Chhongtash Formation has been assigned as Permian (Gergan & Pant, 1983), Late Permian (Juyal & Mathur, 1996) and Late Permian to the upper part of the Chhongtash Formation (Sinha *et al.*, 1999). The Chhongtash Formation is a thick (1,500-2,000 m) sedimentary unit consisting mainly of thin to medium bedded black shales, slates, siltstones, dark grey pebbly mudstone and diamictite, calcareous sandstone, dark grey limestone and interbedded pillow lava flow (Text-figure 4). This sedimentary sequence is highly folded and faulted, and is intruded at several places by volcanic sills and dykes (Sinha *et al.*, 1999). The lower and middle parts of the Chhongtash Formation are mostly medium- to fine-grained black shale, siltstone and pebbly mudstone. The interbedded pillow lava in the middle and upper-middle portion of the Chhongtash Formation could be related to the intrabasinal rift volcanism during the Early Permian and may be linked to the Late Carboniferous-Early Permian (~300-250 Myr ago) fragmentation processes of the Pangea and opening of the Tethys ocean. The pillow lava is overlain by a thin succession of thin- to medium-bedded limestone, highly folded and faulted in nature. The middle part of upper portion of the Chhongtash Formation is represented by an important plant fossil bearing horizon (Text-figures 3, 4). The plant fossil bearing outcrop of grey-brown sandstone and shale is located along the T-Camp *nala* upstream section (~6-7 km west of the Chhongtash Camp locality towards Morgo Formation), and is lying few meters above the pillow lava horizon (Text-figures 3, 4) which is followed by a thick succession of grey argillaceous limestone which has yielded Late Permian *fusulinids* (Juyal & Mathur, 1996; Sinha *et al.*, 1999).

The plant megafossils collected from eastern Karakoram are poorly preserved in the form of impressions. The identified impressions are a small leaf of *Noeggerathiopsis* which can not be identified up to specific level, a definite gymnosperm seed probably *Samaropsis* , a portion of *Gangamopteris* leaf, some unidentifiable plants type and a portion of large *Equisetalean* stem (Plate 1). This plant assemblage is similar to the Early Permian Lower Gondwana flora recorded from Talchir assemblages (Feistmantel, 1879, 1882; Surange & Lele, 1956; Lele, 1966) and also from the type locality of the Talchir Coalfield in the Indian subcontinent (Chandra & Singh, 1994). Occurrence of *Equisetalean* – stems and other undentifiable plant types have also been mentioned by Norin (1946) from the Horpatso area (south of the Mawang Kangri mountain in northwestern Tibet). This suggests that the Chhongtash Formation may be a continuation of Horpatso Series of Norin (1946) and extends for a distance of ~ 600 km east-southeast from the Chhongtash locality of eastern Karakoram.

The plant fossil bearing shale was macerated for

**Text-figure 2**—Geological traverse map of the eastern Karakoram showing the location of Chhongtash Formation and Chhongtash locality (simplified after Sinha *et al.*, 1999). →

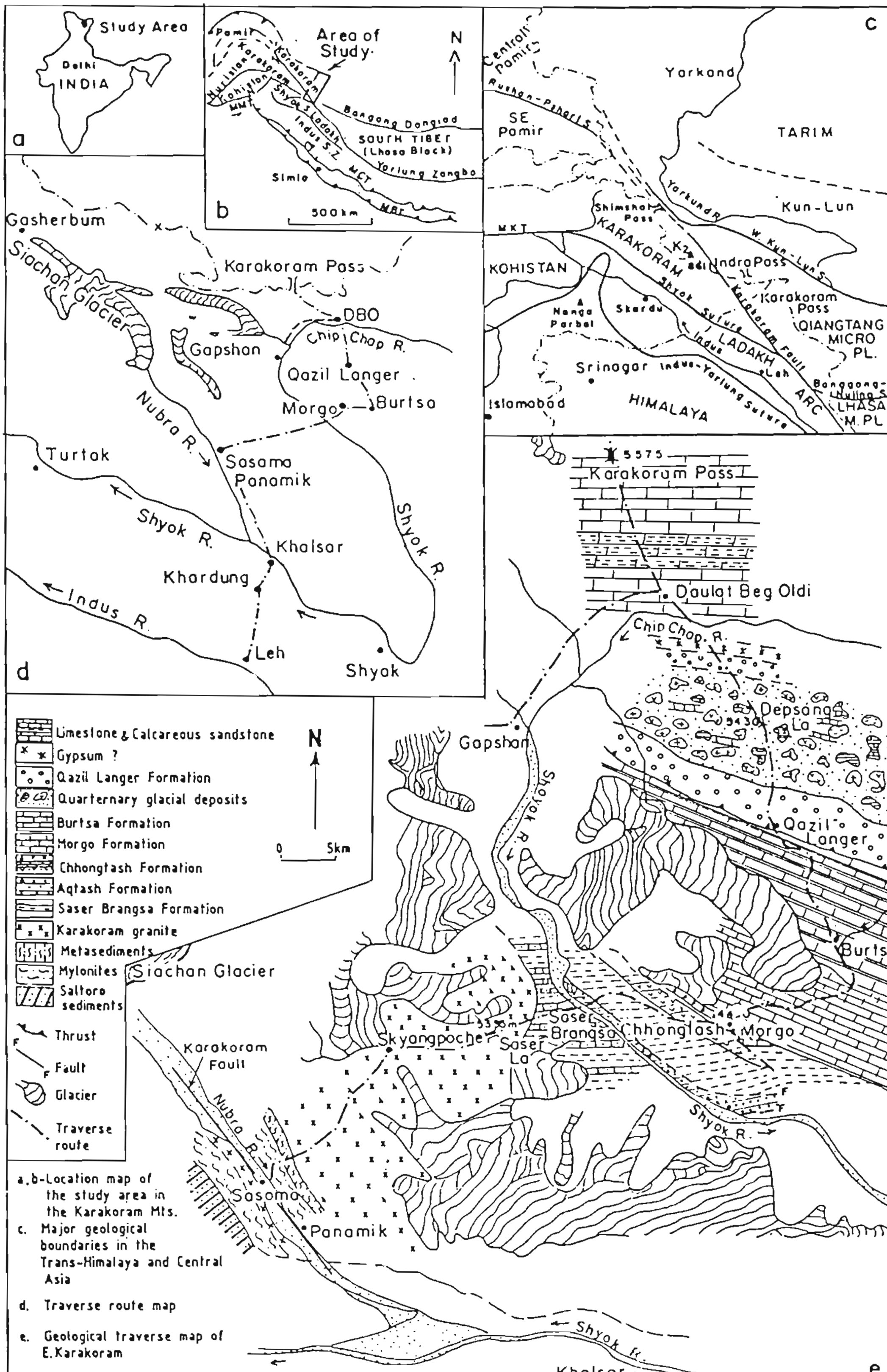
**PLATE 1** →

1. *Noeggerathiopsis* sp. Lower portion of the leaf showing straight, dichotomous veins running parallel to each others X 1.5, B.S.I.P. Specimen No. 35358.
2. Unidentifiable plant type on the left and poorly preserved *Noeggerathiopsis* on the right. X 1.5, B.S.I.P. Specimen No. 35359.
3. Equisetalean stem, poorly preserved ribs. X 1, B.S.I.P. Specimen No. 35360.
4. *Samaropsis* seed, enlarged. X 4, B.S.I.P. Specimen No. 35358.
5. ? *Gangamopteris*, a portion of large leaf. X 1.5, B.S.I.P. Specimen No. 35360.

**PLATE 2** →

(All magnifications X 500)

1. *Plicatipollenites indicus*, B.S.I.P. Slide No. 12391, T44/1
2. *Parasaccites* sp. , B.S.I.P. Slide No. 12392, G27/4.
3. Unidentified, B.S.I.P. Slide No. 12393, E31/3.
4. *Striasulcites tectus*, B.S.I.P. Slide No. 12391, E38.
5. *Callumispora*, B.S.I.P. Slide No. 12396, S21/4.
6. *Caheniasaccites* sp., B.S.I.P. Slide No. 12393, N29/2.
7. *Lunatisporites* sp., B.S.I.P. Slide No. 12391, T18/4.
8. *Parasaccites* sp., B.S.I.P. Slide No. 12395, P57/1
9. *P. diffusus*, B.S.I.P. Slide No. 12391, T45/4.
10. *Virkkipollenites* sp., B.S.I.P. Slide No. 12393, D46/3.
11. *Verticipollenites debilis*, B.S.I.P. Slide No. 12393, V56/4.
12. *Lunatisporites*, B.S.I.P. Slide No. 12392, O54/4.
13. Acritarch, B.S.I.P. Slide No. 12394, N58/1
14. *Lunatisporites* sp. B.S.I.P. Slide No. 12392, G53/3.
15. Microplankton, B.S.I.P. Slide No. 12395, H59/4.
16. *Crescentipollenites*, B.S.I.P. Slide No. 12393, J25/2.
17. *Parasaccites diffusus*, B.S.I.P. Slide No. 12393, M20/4.




Text-figure 2

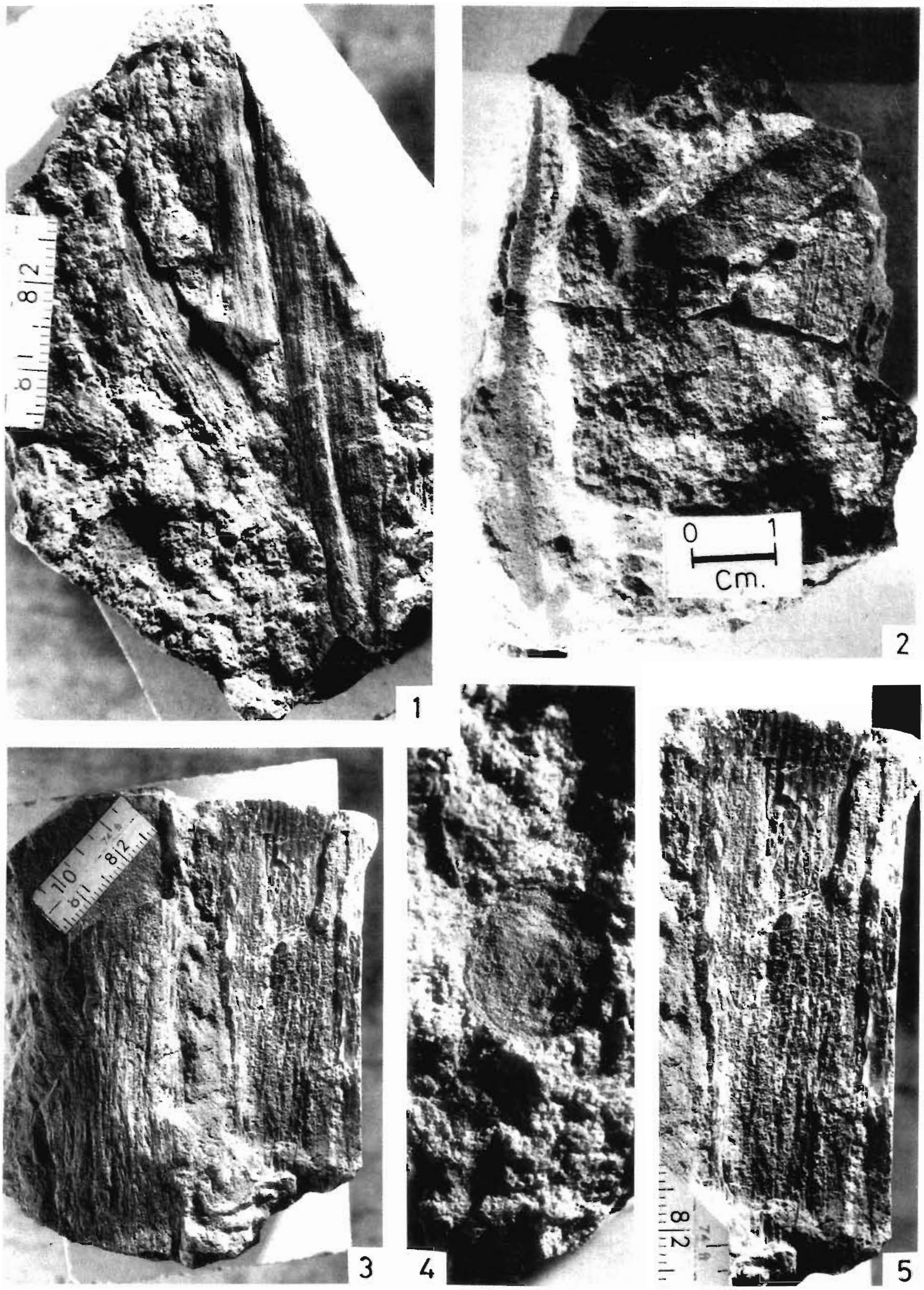



PLATE 1

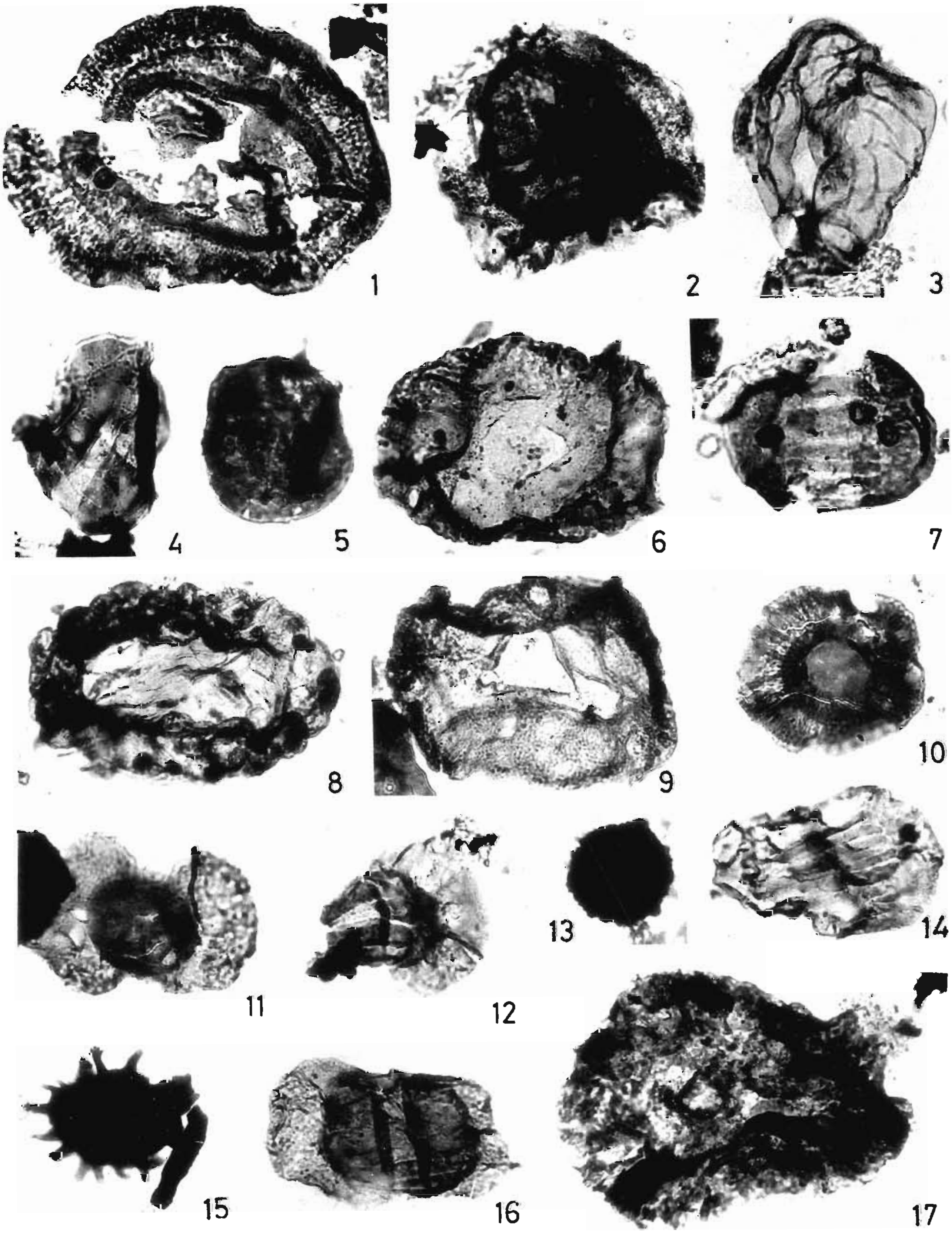



PLATE 2

palynological study and the following 25 genera and 28 species were recorded (Plate 2): *Leiotriletes* sp., *Punctatisporites* sp., *Cyclogranisporites gondwanensis* Bharadwaj & Salujha, 1964, *Cyclobaculisporites minutus* Bharadwaj & Salujha, 1964, *Indotriradites* sp., *Plicatipollenites indicus* Lele, 1964, *Virkkipollenites obscurus* Lele, Bose & Maheshwari, 1968, *Elilasaccites elilaensis* Bose & Kar, 1966, *Elilasaccites ovatus* Bose & Kar 1966, *Parasaccites korbaensis* Bharadwaj & Tiwari, 1964, *Parasaccites diffusus* Tiwari, 1965, *Parasaccites bilateralis* Tiwari, 1965, *Caheniasaccites flavatus* Bose & Kar, 1966, *Caheniasaccites ovatus* Bose & Kar, 1966, *Caheniasaccites elongatus* Bose & Kar, 1966, *Crucisaccites* sp., *Divarisaccus lelei* Venkatachala & Kar, 1966, *Platysaccus papilionis* Potonie & Klaus, 1954, *Cuneatisporites radialis* Leschik, 1955, *Cuneatisporites flavatus* Bose & Kar, 1966, *Scheuringipollenites* sp., *Valiasaccites validus* Bose & Kar, 1966, *Striatites sewardi* (Virkki) Pant, 1954, *Striatopodocarpites antiquus* Leschik, Potonie, 1958, *Striatopodocarpites venustus* Bharadwaj & Salujha, 1965, *Verticipollenites debilis* Venkatachala & Kar, 1968, *Faunipollenites varius* Bharadwaj, 1962, *Rhizomaspora costa* Venkatachala & Kar, 1968, *Trisaccites* sp., *Vittatina subsaccata* Samoilovich, 1953 and *Striasulcites tectus* Venkatachala & Kar, 1968.

The palynological assemblage is dominated by monosaccates (54%) and followed by bisaccates (42%). Amongst the bisaccates the nonstriate (22%) and striate (20%) are more or less equally represented. The triletes are found only in 3% and the monocolpate is very rare (1%). The genera found within the count are – *Cyclobaculisporites* (1%), *Cyclogranisporites* (2%), *Elilasaccites* (10%), *Caheniasaccites* (19%), *Vikkipollenites* (6%), *Parasaccites* (24%), *Divarisaccus* (2%), *Plicatipollenites* (2%), *Crucisaccites* (1%), *Platysaccus* (2%), *Cuneatisporites* (9%), *Striatopodocarpites* (10%), *Valiasaccites* (11%), *Faunipollenites* (9%), *Vittatina* (1%) and *Striasulcites* (1%).

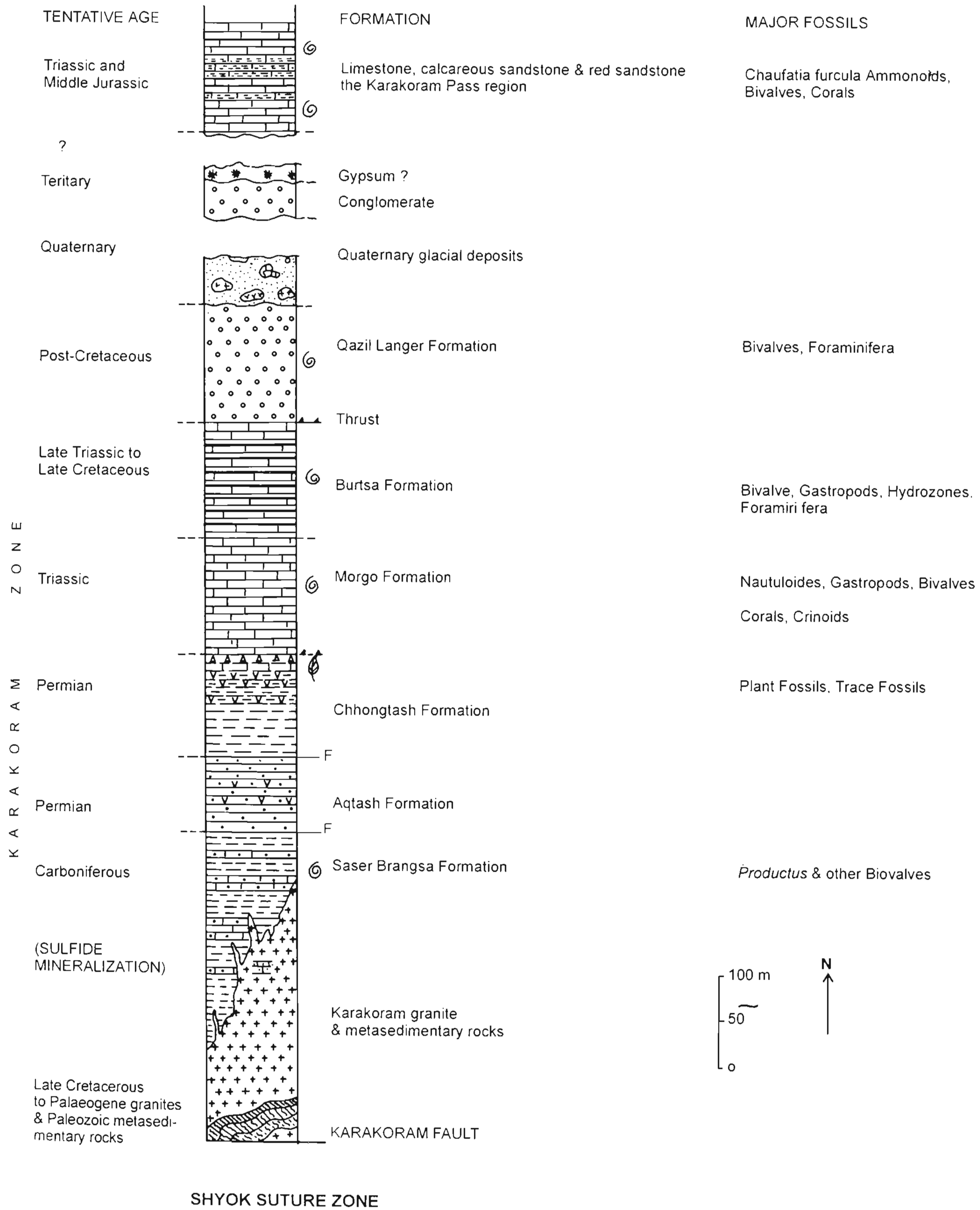
The dominance of monosaccates in the assemblage is once again very much similar to the Talchir or Karharbari (Early Permian) assemblage of India (Potonie & Lele, 1961; Bharadwaj *et al.*, 1976; Kar, 1973; Tiwari & Tripathi, 1992) and Bacchus Marsh Tillite of Australia (Virkki, 1946; Kemp *et al.*, 1977; Segroves, 1970) . However, the presence of striate bisaccate in significant percentage (20%) in the present assemblage favours an Upper Karharbari (Late Asselian, ~ 280–275 Myr ago from present) age. Presence of calcareous microfossils in the thin sections point out that the deposition took place in marine condition. The occurrence of *fusulinid*-bearing limestones (Sinha *et al.*, 1999; Juyal & Mathur, 1996; Gergan & Pant, 1983) is also typical of much of the northern margin of Gondwana (Nakazawa, 1985). Further systematic study is in progress.

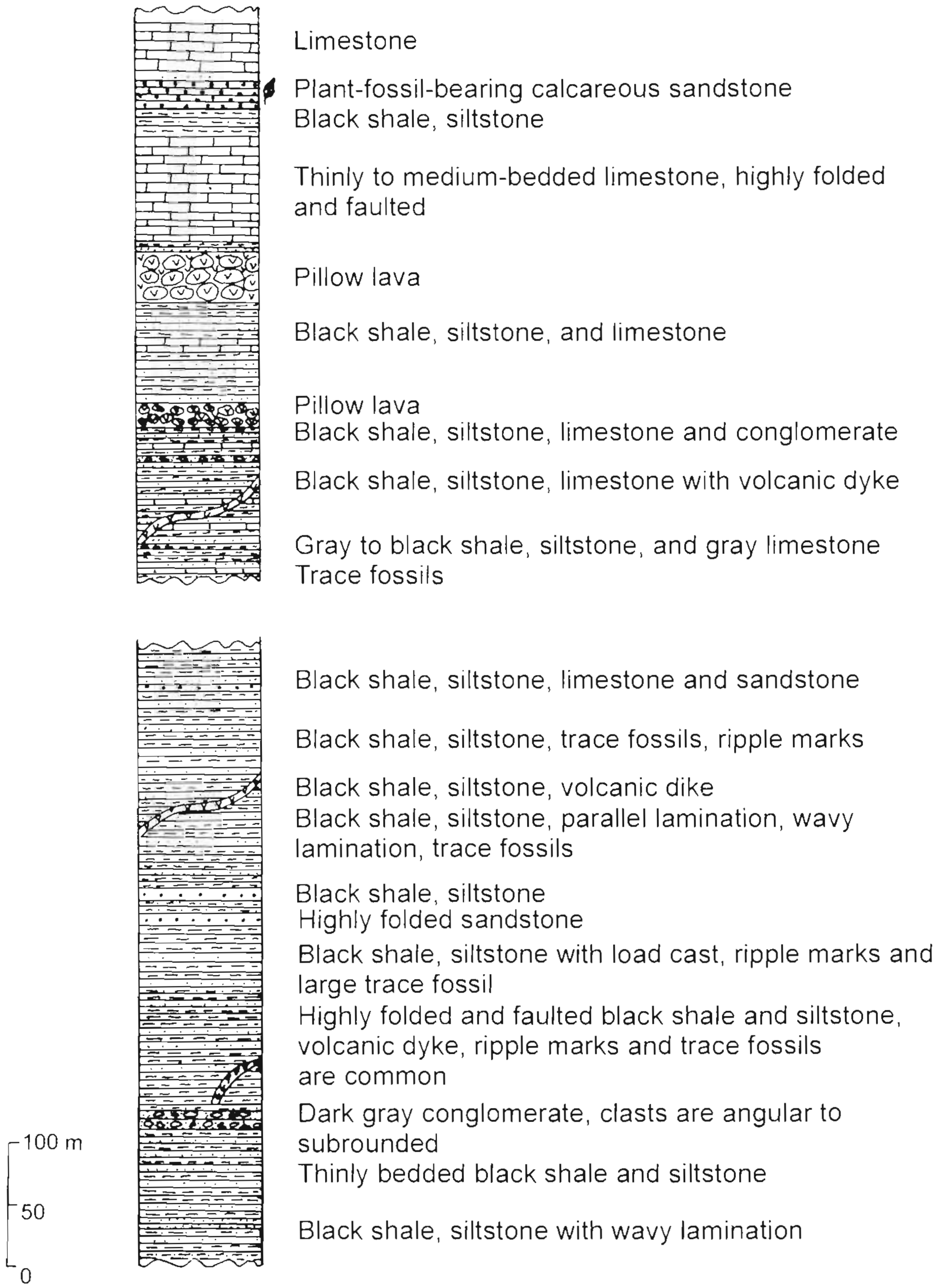
## PALAEOGEOGRAPHIC IMPLICATION

In recent palaeogeographic reconstruction of Pangea during Late Palaeozoic (Scotese & McKerrow, 1990; Nie *et al.*, 1990; Scotese & Langford, 1995), it appears that a southern belt of Asian microcontinents stretching from Iran and Afghanistan, through southern Tibet, to western Thailand, Malaysia and Sumatra comprise several continental blocks and numerous continental fragments that have coalesced since the mid-Palaeozoic by the closure of various branches of Tethys ocean (Sengor, 1987; Nie *et al.*, 1990; Scotese & Langford, 1995; Enos, 1995; Sinha, 1997; Metcalfe,. 1999). Tectonic constraints include the timing of collisions of the microcontinents which have been regarded to proceed from north to south, range in time from Late Palaeozoic to the Tertiary (Sengor, 1984; Dewey *et al.*, 1988). The origin, migration, assembly and timing of accretion of all of these blocks to their present geotectonic position is not well known, because the palaeogeography of the Indian ocean during the initial break up of Gondwana is poorly constrained and there is no Permo–Triassic crust left in the present–day Indian ocean (Searle, 1991). The oldest ocean crust adjacent to the east African and Antarctic margins is of early or middle Cretaceous age (~ 140–100 Myr) (Searle, 1991). However, on the basis of the occurrence of temperate faunas, floras, and even glacial and glacio–marine deposits (tillites or diamictites) from the Permian sequences, the Central Iran, Helmand, Western Qiangtang, Lhasa and Sibumasu blocks are interpreted as to have rifted off the northern margin of Gondwana in post-Early Permian times (Scotese & Mckerrow, 1990; Scotese & Langford, 1995). It is believed that they belong to a loosely associated continent named Peri–Gondwana or Cimmeria (Sengor, 1984; Sinha & Upadhyay, 1997). Plate tectonic reconstruction of Early Permian (~ 277 Myr ago) show that these Peri–Gondwanan microcontinents were situated between ~ $10^0$ - $40^0$ southern latitude from the equator ((Nie *et al.*, 1990; Scotese & Langford, 1995).

The Karakoram – Hindukush microplate in the west and the Qiangtang - Lhasa block in the central and eastern segment of south Asia margin are among those blocks (Text-figure 1) which had already been welded on to Asia probably around 130–120 Myr ago (Dewey *et al.*, 1988; Searle, 1991) before the collision of India (~ 50 Myr) with this collage of plates, and has been suspected to be one among the most significant Peri-Gondwanan microcontinents. But it has been always left off from the palaeogeographic reconstruction map of Gondwana and Asian microcontinents mainly because of

**Text-figure 3**—Schematic tectonostratigraphic traverse column of eastern Karakoram showing the plant fossil bearing Permian Chhongtash Formation (After Sinha *et al.*, 1999).


TENTATIVE AGE
FORMATION
MAJOR FOSSILS
Triassic and Middle Jurassic
Limestone, calcareous sandstone & red sandstone the Karakoram Pass region
Chaufatia furcula Ammonoids, Bivalves, Corals
?
Teritary
Gypsum ?
Conglomerate
Quaternary
Quaternary glacial deposits
Post-Cretaceous
Qazil Langer Formation
Bivalves, Foraminifera
Thrust
Late Triassic to Late Cretaceous
Burtsa Formation
Bivalve, Gastropods, Hydrozones. Foramiri fera
Triassic
Morgo Formation
Nautuloides, Gastropods, Bivalves
Corals, Crinoids
KARAKORAM ZONE
Permian
Plant Fossils, Trace Fossils
Chhongtash Formation
F
Permian
Aqtash Formation
F
Carboniferous
Saser Brangsa Formation
*Productus* & other Biovalves
(SULFIDE MINERALIZATION)
100 m
50
o
N
Karakoram granite & metasedimentary rocks
Late Cretacerous to Palaeogene granites & Paleozoic metasedimentary rocks
KARAKORAM FAULT
SHYOK SUTURE ZONE




**Text-figure 4**—Lithostratigraphic column of a part of the Chhongtash Formation near Chhongtash showing plant fossils and palynomorphs bearing sandstone and shale (After Sinha *et al.*, 1999).

two reasons (1): Scanty geological information available from Pamir, Karakoram and Western Tibet and no Early Permian plant remains and palynomorphs were ever reported from the Karakoram Terrane. Early Permian plant remains have for long been considered as a pointer for Peri–Gondwanan origin of most of the Asian microcontinents, and (2): Owing to the extreme inaccessibility of the Karakoram and also because of the disputed frontiers of Pakistan, India and China, large areas of the region remain unexplored and unstudied.

Our discovery of Early Permian plant remains and Late Asselian (~280-275 Myr ago from present) palynomorphs provides crucial information regarding the palaeogeographic reconstruction of the Karakoram during Permian time. Interestingly, the Early Permian (Artinskian, ~270-265 Myr ago) marine Gondwana sediments with plant remains and palynomorphs have been earlier recorded from the Salt Range in Pakistan (Balme, 1970). Therefore, on the occurrence of Early Permian plant remains and palynomorphs from the eastern Karakoram it could be inferred that during Early Permian time the Karakoram microcontinent was located not far from the Salt Range of Indian subcontinent, and was situated as a Peri–Gondwanan microcontinental fragment around $35^0$ southern latitude from equator, somewhere intermediate between the Indian Plate and the Qiangtang–Lhasa microcontinent. The Karakoram microcontinent can not be a part of the Indian Plate because the present geotectonic position suggest that it lies north of the Shyok–Indus sutures (Desio, 1974; Searle, 1991; Gaetani, 1997; Sinha & Upadhyay, 1997; Sinha *et al.*, 1999) (Text-figure 1), and it is a well known fact that the Indus Suture mark the site of collision between the Indian Plate and accreted fragments of Asian microcontinent during ~50 Myr ago (Dewey *et al.*, 1988; Searle, 1991; Rowley, 1996; Sinha & Upadhyay, 1997, Upadhyay & Sinha, 1998). It has been recently suggested that Karakoram microcontinent was welded to Asia probably around 130–120 Myr ago (earliest Early Cretaceous) (Searle, 1991), therefore it should be a part of Peri–Gondwanan collage of microcontinents accreted with the southern margin of Asia before the 50 Myr old India – Asia collision. Interestingly, the present geotectonic position (Nie *et al.*, 1990; Scotese & Langford, 1995) of Karakoram between $\sim 34^0 - 36^0$ northern latitude (Text-figure 1) from equator further suggest an $\sim 60^0$ latitudinal movement or shift since Early Permian (Late Asselian, ~ 275 Myr ago) to present.

The present discovery of Early Permian plant remains and palynomorphs from the eastern Karakoram is a beginning towards understanding the large scale geological processes and hopefully should trigger the pace of geological exploration programmes to be carried out in near future in the remote regions of eastern Karakoram so that new information would emerge towards understanding the palaeogeography of the Gondwanaland and accretion of Peri-Gondwanan Asian microcontinents vis-a-vis India-Asia collision. Future research programmes are urgently needed to unravel the hidden wealth of information in the Karakoram.

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