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NEW FINDINGS OF PERMIAN FUSULINIDS AND CORALS FROM WESTERN KARAKORUM AND E HINDU KUSH (PAKISTAN)

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Abstract. Additional findings of fusulinids and corals from Permian rocks of Western Karakorum and Eastern Hindu Kush are reported. The Lashkargaz Fm. of Western Karakorum (Sakmarian – Kubergandian in age), is redefined in its uppermost part. A new unit of sucrosic dolostone, the Ini Sar Fm., of early Murgabian age in its basal part, is established for a level previously attributed to the Ailak Fm. The Ailak Fm. is confirmed to be Late Permian in its lower part. A rich fusulinid fauna of early Kubergandian age was found in a carbonate nappe previously unidentified, along the Pakistan-Afghanistan border in the Eastern Hindu Kush.

Riassunto. Vengono segnalati nuovi ritrovamenti di fusulinidi e coralli nelle rocce permiane del Karakorum occidentale e dell'Hindu Kush orientale. In Karakorum si ridefinisce nella sua parte sommitale la Formazione Lashkargaz, di età Sakmariano – Kubergandiano. Viene inoltre proposta una nuova unità di dolomie fortemente ricristallizzate, la Formazione Ini Sar, la cui parte basale è del Murgabiano inferiore. In precedenza queste dolomie erano riferite alla Formazione Ailak. La Formazione Ailak contiene nella sua parte inferiore una fauna a foraminiferi mal conservati del Permiano superiore. Nell'Hindu Kush Orientale, lungo il confine tra Pakistan e Afghanistan, viene segnalata una ricca fauna a fusulinidi riferibile al Kubergandiano, nei carbonati di una falda mai identificata prima.

Introduction

Additional findings of Permian fusulinids and one coral colony from new localities of Western Karakorum and Eastern Hindu Kush are described to update the studies on the Permian of Karakorum carried out by an Italian team (Gaetani et al. 1995; Angiolini 1995, 1996, 2001; Angiolini & Rettori 1994; Angiolini et al. 2005). The findings allow to update the stratigraphic record and a new lithostratigraphic unit are proposed.

Geological setting

The North Karakorum Terrain, as defined in recent papers (Zanchi & Gaetani 1994; Gaetani et al. 1996; Zanchi et al. 2000) consists of a thick and polyphase stack of thrust sheets which lay north of the Karakorum Batholiths (Le Fort & Gaetani 1998) (Fig. 1). In the Chitral region, the Karakorum is separated from the East Hindu Kush - Wakhan by the Tirich Mir Boundary Zone, a left lateral shear zone including deformed ultramafic rocks (Zanchi et al. 1998, 2000). These rocks record pre-mid-Cretaceous accretion of the Karakorum block to the Pamir ranges. East of the Shah Jinali Pass, the Tirich Mir Boundary Zone is tectonically elided by NE-SW left-lateral strike-slip faults and the Palaeozoic Wakhan and Misgar slates of Wakhan are directly stacked against the Karakorum units. We document in this paper the presence in the Eastern Hindu Kush of a sedimentary thrust sheet, mostly cropping out on the Afghan slope, previously unknown, in which Permian fusulinids are abundant.

The North Karakoram Terrain includes several thrust sheets showing complex geometrical relationships (Figs 1, 2). To the northwest, the Tash Kupruk Zone contains alkali basalts, tuffs and dolostones, bounded by shear faults. To the south of the Tash Kupruk, Permian rocks are present in several thrust sheets, namely Siru Gol, Lasht, Lashkargaz/Baroghil, and Kar-

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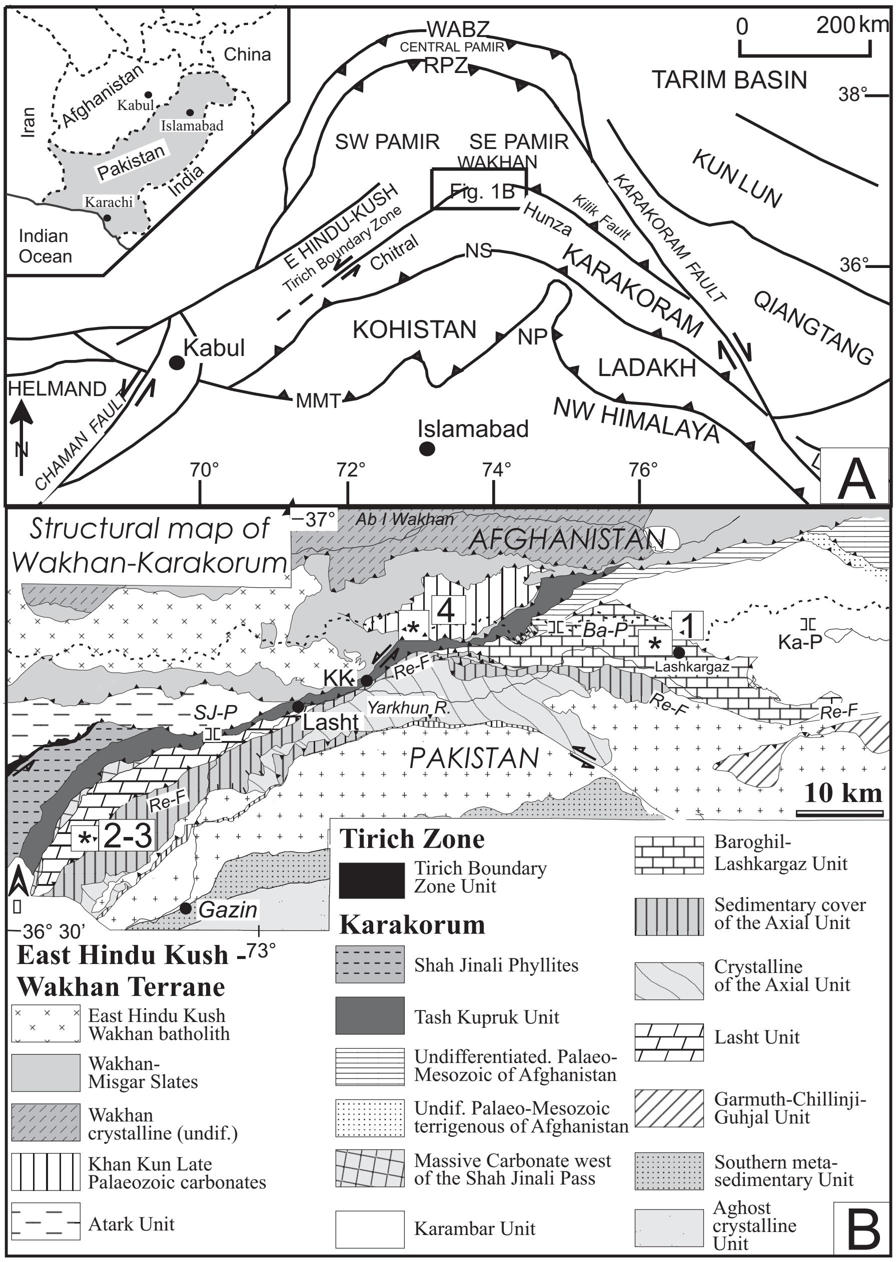


Fig. 1 - A) Index map of the Western Karakorum and Eastern Hindu Kush. B) Structural map of Wakhan-Karakorum - KK = Khan Kun; Ba-P = Baroghil Pass; Re-F = Reshun Fault; Ka-P = Karambar Pass; Ch-P = Chillinji Pass; dotted line = Pakistan-Afghanistan border.
Fossil localities: 1 - Khan Kun Gol; 2 - Lashkargaz - Ini Sar; 3 - Pinin Sar; 4 - Siru An. (From Zanchi in Gaetani et al. 2004, modified).

ambar. We do not consider here the Permian succession of Hunza and its side valleys.

Southwards, a major partition is marked by the Reshun Fault (Pudsey 1985; Zanchi et al. 1998, 2000) (Fig. 1). South of this fault, tectonic units locally include the pre-Ordovician crystalline basement and Palaeozoic/Mesozoic sediments with reduced thickness. The southern margin of the sedimentary units of Northern Karakorum is intruded by the Cretaceous to Paleogene plutons of the Karakorum Batholiths (Debon et al. 1987; Debon 1995; Debon & Khan 1996; Le Fort & Gaetani 1998).

The Permian succession of the Northern Karakorum of the upper Yarkhun valley shows similar trends in the diverse thrust sheets, however with significant variations in thickness. From the bottom the identified units are:

- *Gircha Fm.* – Very thick terrigenous unit (sublitharenites to quartzarenites and siltstones) with few carbonatic interlayers. Thickness up to 1000 m. Age:? Late Carboniferous - Asselian -? early Sakmarian.
- *Lashkargaz Fm.* – Complex unit with five members, partly arenitic, partly carbonatic, rich in brachiopods and fusulinids. Thickness reaching 1000 m. Age: from Sakmarian to Kubergandian.
- *Ini Sar Fm.* – New unit established in this paper, mostly consisting of thick bedded sucrosic dolostones, with few arenitic and conglomeratic layers at the base, eroding the substrate. Present only in the Lashkargaz thrust sheet, it laterally thin out rapidly. Thickness up to 375 m. Age: the base is early Murgabian. The poor conodont content (*Iranognathus* sp. and *Anchignathodus* sp.) from the top of Mb. 4 of the Lashkargaz Fm. (Gaetani et al. 1995, fig. 9) sug-

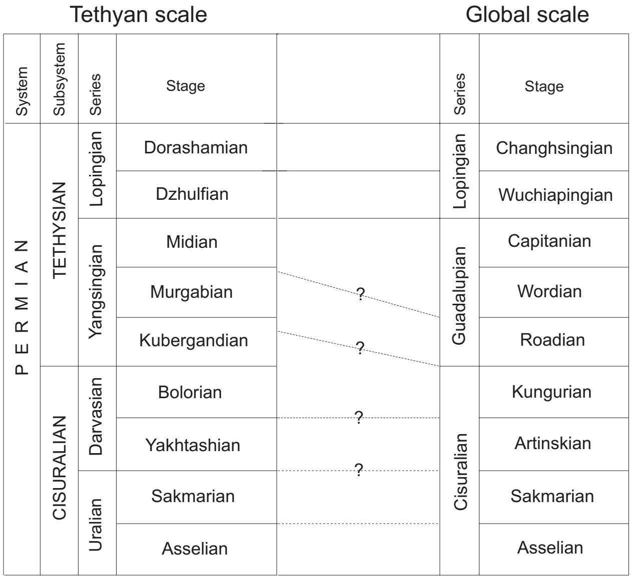


Fig. 2 - The Tethyan scale and its correlation to the Global Standard Scale

gests that the gap at the base of the Ini Sar Fm. should be not very relevant in time.

• *Gharil Fm.* – Thin veneer of alluvial red beds. The base consists of fine conglomerates in red Fe-enriched matrix, containing also reworked fragments of lateritic soils, eroding the substrate. They are overlaid by red siltstone with faint cross-lamination. Total thickness of about 20 m. Age: no direct evidence.

• *Ailak Fm.* – Marine peritidal dolostones in thick beds, often sucrosic and recrystallized. Its upper part should be referred already to the Triassic. The Permian section may exceed 190 m in thickness. Age: Late Permian.

The chrostratigraphic terminology here used is the Tethyan one (Leven 2003). Correlation of the Tethyan and standard scales is still disputable because of the lack of reliable data (see Leven 2001; Leven & Bogoslovskaya 2006). Possible alignments are shown in Fig. 2.

The new findings originate from Lashkargaz, Ini Sar, and Ailak fms. from the following localities.

Western Karakorum

Lashkargaz – Ini Sar

The sampling was done in continuity with the Lashkargaz section, type section of the homonymous formation (Fig. 2, 4). In Gaetani et al. (1995, figs. 8, 9), the mostly terrigenous horizon capping the limestones of the Lashkargaz type section, was erroneously correlated to the Gharil Fm., and the overlying sucrose dolostones were attributed to the Ailak Formation. This terrigenous horizon consists of a lower part with grey siltstones and very fine sandstones (grey sub-arkose passing upwards to quartzarenites) and of an upper part with conglomerates and arenites, up to 4.5 m thick. In a further survey (in 1992 this part was covered by snow), it became clear that the dark red Fe-enriched and lateritic layers that characterize the Gharil Fm. *lie above* the sucrosic dolostones and thus the previous correlation was wrong. We document here the fusulinids found immediately above the conglomeratic level and redefine the Lashkargaz Formation. The siltstone unit is now considered as the 5th member of the Lashkargaz Fm., whilst

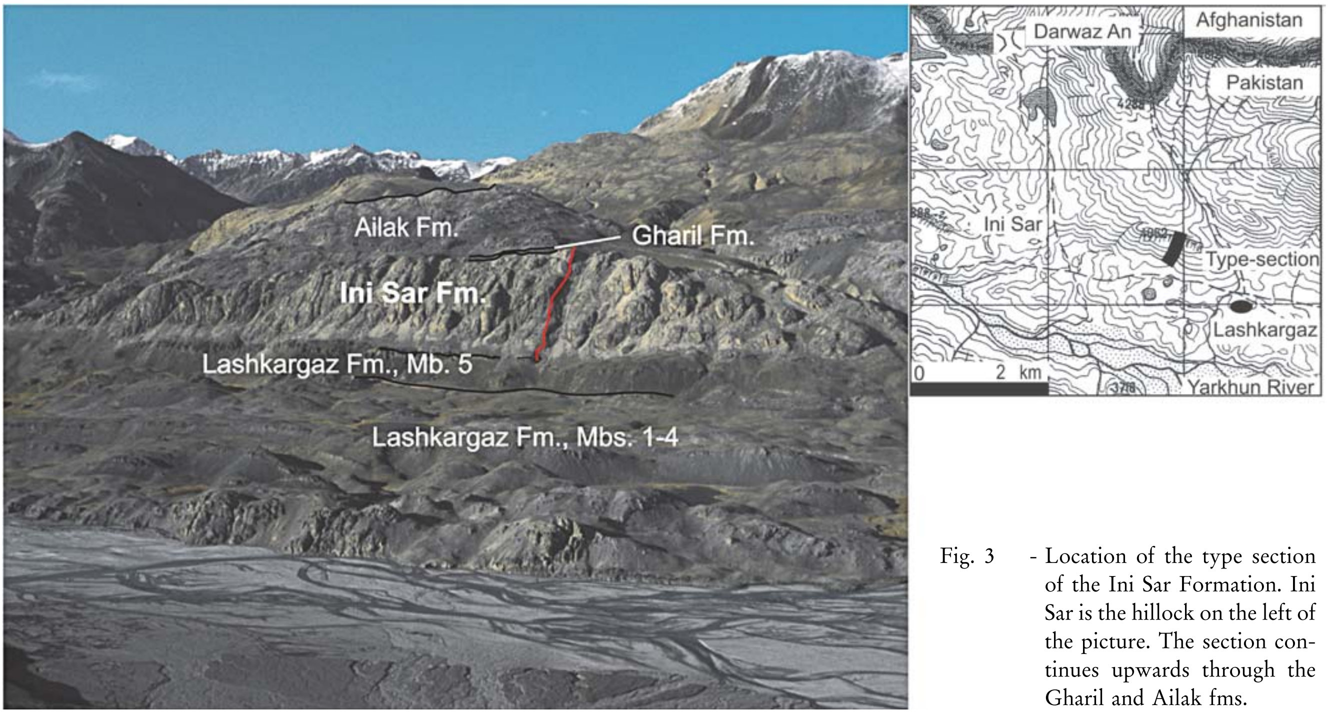


Fig. 3 - Location of the type section of the Ini Sar Formation. Ini Sar is the hillock on the left of the picture. The section continues upwards through the Gharil and Ailak fms.

the erosional surface at the base of the conglomeratic level is considered as the base of the new unit. Sampling and measuring were done by M. Gaetani in 1996.

Bottom to top:

Lashkargaz Mb. 5. It is in continuity with the 4th Member of the formation in the type section. This unit was attributed to the Gharil Fm. in Gaetani et al. (1995). It consists of dark grey calcareous siltstones, extensively burrowed and with rare brachiopod fragments. About 50 m thick.

Ini Sar Fm. (New name). Total thickness: about 370 m.

1) Polymictic conglomerate with prevailing carbonate clasts up to 15 cm at the base, progressively smaller upwards. Carbonate matrix and cement. Parallel laminations in the upper part. Thickness 4.70 m.

2) Coarse grey calcarenites, in beds 20-50 cm thick. Siltstone intercalations in the upper part. The microfacies consists of coarse grainstone with sparitic cement; the well-rounded bioclasts are represented by fusulinids, brachiopods, crinoids, bryozoans, and sphinctozoans. Occasional fine well-rounded quartz grains. Fusulinid content: CK603 - *Schubertella* sp., *Yangchienia* sp., *Chusenella* sp., *Neoschwagerina* cf. *simplex* Ozawa, 1927, *N.* cf. *schuberti* K.-Devide, 1958; CK604 - *Neoschwagerina* aff. *schuberti* K.-Devide; CK606 - *Neoschwagerina deprati* Leven, 1993, *N. verae* Toumanskaya, 1953, *Yangchienia* sp. Age: early Murgabian (*N. simplex* Zone). 9.40 m-thick.

3) Not exposed, 12 m.

4) Light grey sucrosic dolostones in massive beds. Rare ghosts of thin-shelled bioclasts. About 345 m thick.

– Not exposed, 5 m.

Gharil Fm. Total thickness of the formation: 20.60 m

5) Conglomerate with poorly rounded pebbles, often angular, supported by red Fe-enriched matrix, coarse arenites and thin conglomerates, with well-rounded quartzitic clasts and opaque grains interbedded with poorly laminated dark red siltstones. Alluvial fan with reworked fragments of lateritic soil and altered grains, CK619-CK 621. 5.6 m thick.

6) Finely laminated dark red siltstones Fe-enriched with reworked grains of lateritic soil. CK 622-CK 624. 15 m thick.

Ailak Formation. Total thickness 512 m (here only the Permian part is described)

7) Light-grey calcareous dolostone to dolostone with stromatolitic laminae, in 20-50 cm thick beds. When not totally transformed in a sucrosic dolostone, it consists of a bioclastic packstone, with *Tubiphytes* sp., ostracodes, rare sphinctozoans and ghost of foraminifers, including *Agathammina* sp., *Glomospira* sp., *Dagmarit*a sp., *Kamurana*? sp., *Ichtiolaria*? sp., *Globivalvulina* sp., *Multidiscus* sp., and the fusulinid *Sphaerulina* sp. Thickness 140 m.

8) Grey calcareous dolostone in 20-40 cm thick beds. It consists of fine to coarse packstone with micritic matrix, occasionally with gastropods, fragments of bivalves and coated grains. Small foraminifers may be fairly abundant, but very poorly preserved. They are: *Agathammina* ex gr. *pusilla* (Geinitz), *Geinitzina* sp., *Globivalvulina* sp., *Glomospira* sp., *Nodosaria*? sp., *Kamurana*? sp., *Permodiscus* cf. *padangensis* (Lange, 1925), *Pachyphloia* sp., *Hemigordius* sp., *Dagmarita chanakchiensis* Reitlinger, 1965, *D. sharezaensis* Mohtadt-Aghai?, *Dagmarita* sp., *Paradagmarita monodi* Lys, 1978, and the fusulinids *Nankinella* sp. and *Sphaerulina* sp. Dasycladacean algae (*Permocalculus* sp.) are also present. Thickness 6.70 m.

9) Light sucrosic dolostone to calcareous dolostone, in 30-70 cm thick beds. Poorly preserved fragments of bivalves and gastropods. Thickness 37 m.

The foraminifer assemblage of the first two levels of the Ailak Fm., even if poorly preserved, is sufficient to prove the Late Permian age of the lower part of the formation, without further details.

Pinin Sar

In 1999 M. Gaetani measured and cursorily sampled a short section in front of the alpine meadows of Pinin Sar (Pauer Gol). Base of the outcrop at 4120 m a. s. l. (Fig. 5).

Bottom to top:

"Gircha Fm."

1) Light quarzarenites in beds 10-50 cm thick, amalgamated to form layers of 3-5 m, with parallel laminations, intercalated to blackish siltstones and slates. About 70 m.

Lashkargaz Fm.

2) Blackish slates and marls with concoid fracture, with poorly preserved brachiopods, mainly productids. About 20 m.

3) Two beds of arenites separated by a layer of blackish marls, 3 m-thick. Thickness 21 m.

4) Dark slates and siltstones with occasional thin arenitic intercalations. 10 m.

5) Grey limestones forming small coarsening-upwards cycles, 0.3-0.6 m-thick. 2.5 m. CK 1146. Packstone with poorly preserved fusulinids, dasycladaceans, fragments of gastropods and brachiopods, few algal coatings and sparse angular quartz grains. Fusulinids: *Reitlingerina* sp., *Staffella* aff. *powwowensis* Thompson, 1948, *Nankinella minor* Sheng, 1955, *Schubertella* sp., *Misellina* cf. *termieri* (Deprat, 1915); small foraminifers: *Glomospira* sp., *Nodosaria* sp. Age: Bolorian.

6) Hybrid arenites with parallel lamination, partly dolomitized. 6 m.

7) Dark grey bioclastic packstone with algae, sphinctozoans, bryozoan and brachiopod fragments, small foraminifera *Glomospira* sp., *Tuberitina* sp. A few poorly rounded quartz grains. 5 m.

8) Grey limestones in beds 20-50 cm thick, alternating with dark grey marls. 10 m.

9) Light dolostones with a thick alteration surface. A coral colony of *Pseudohuangia chitralica* (Smith, 1935), collected in the debris, perhaps originates from this horizon. About 20 m.

Unconformity

Gharil Fm.

10) Dark red Fe- enriched siltstone. Not sampled because the slope is too unstable and dangerous. 4-5 m.

Ailak Fm.

11) Thick-bedded yellowish sucrosic dolostones.

According to this sampling, the calcareous part of the sequence should correlate with the upper part of Member 2 of the Lashkargaz Fm. (Gaetani et al. 1995). The basal arenites could be correlated to the top of the Gircha Fm. or to Member 1 of the Lashkargaz Fm. We prefer the first option, because the arenites are rather homogeneous and with limited shaly intercalations, even if a coastal marine environment is suggested by isolated brachiopod fragments.

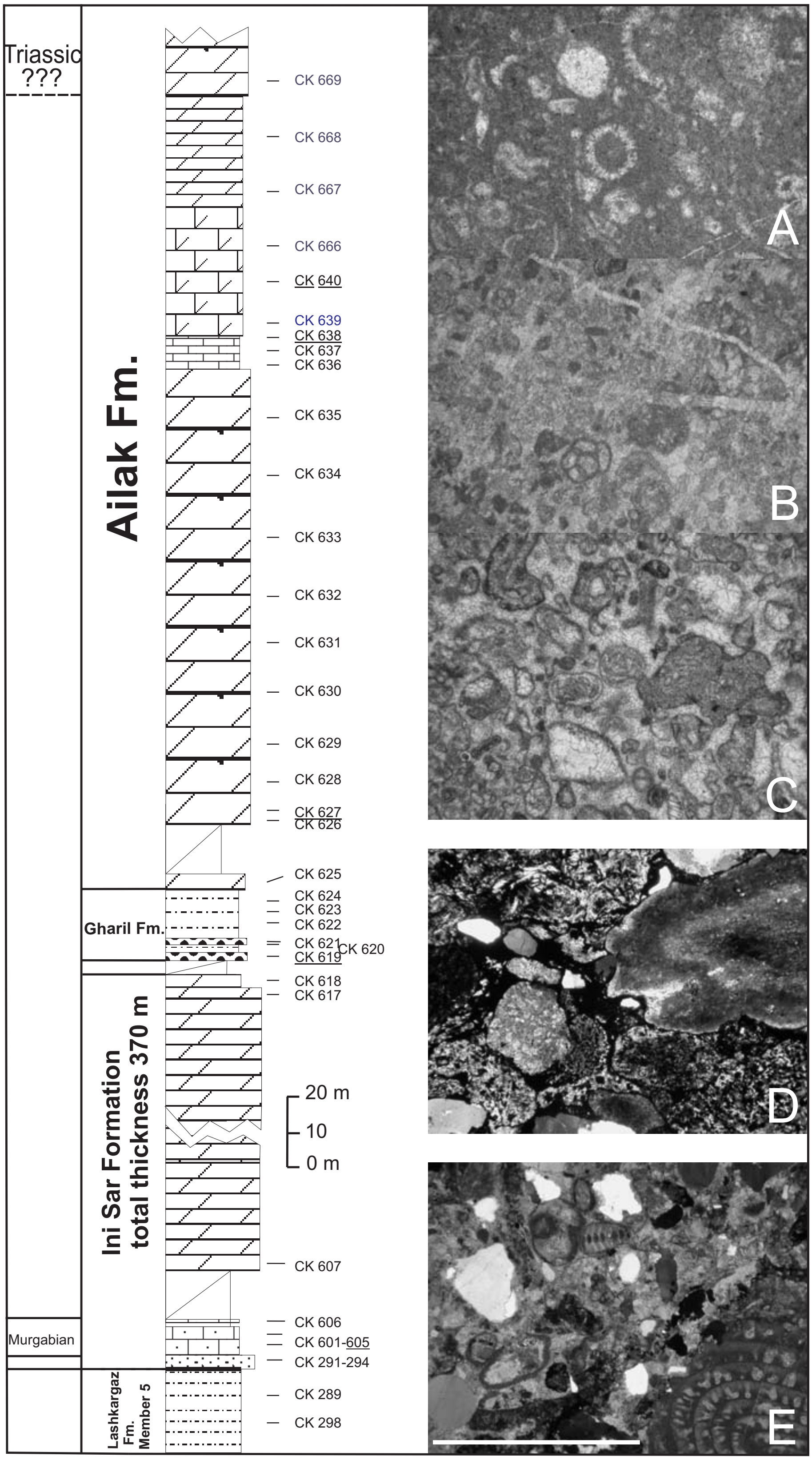


Fig. 4 - The log of the type section of the Ini Sar Fm. and overlying permian units. Significant microfacies: A) CK 640 - Packstone with dasycladacean fragments (*Permocalculus* sp.); B) CK 638 - Packstone with rare small foraminifera in partly recrystallized matrix, *Paradagmarita monodi* Lys, *Dagmarita sharezaensis* Mohtadt-Aghai, *D. chanakchiensis* Reitlinger Endothyridae; C) CK 627 – Packstone with small foraminifera and small bioclasts in partly recrystallized matrix, *Multidiscus* sp., *Globivalvulina* sp., Hemigordiopsidae; D) CK 619 – Coarse arenite with rounded qurtz grains, opaque grains and altered reworked lateritic fragments; E) CK 605 – Arenitic packstone with fusulinids (*Leeina* sp.). Magnification the same for all pictures. Scale bar = 2 mm.

Loose samples in the debris on the west side of the Siru An

On the west side of the Siru An, approximately at 4500 m a.s.l., loose blocks in debris, originating from the dark grey limestone cropping out in a saddle to the NE, contain fusulinids. They are:

Sample CK1143a – Hybrid arenite with well-rounded and sorted quartz grains, and bioclasts including fragments of fusulinids: *Leeina* cf. *kraffti* (Schellwien & Dyhrenfurth, 1909) and corals. Age: Bolorian.

Sample CK1143b – Coarse sandstone with larger carbonate clasts, mostly bioclasts; matrix with well-rounded and sorted quartz grains. Well-preserved fusulinids: *Chalaroschwagerina (Cuniculina) vulgarisiformis* (Morikawa, 1952), *Pseudofusulina* (?) sp., *Praeskinnerella* (?) sp. and fragments of crinoids, brachiopods and algal lumps. Reworked carbonate crusts in high-energy environment. Age: Bolorian.

They might be correlatable to the upper part of the Mb. 2 of the Lashkargaz Fm. because of the fusulinid content.

It is to be noted the huge thickness of the Lashkargaz Fm. in the Lashkargaz area. This unit is already reduced westwards in the Baroghil area, where the Member 5 is thinned and the Ini Sar Fm. is reduced to merely 30 m (the topmost dolostones of Mb. 4 – fig. 10 in Gaetani et al. 1995). The area of Siru An – Pinin Sar is

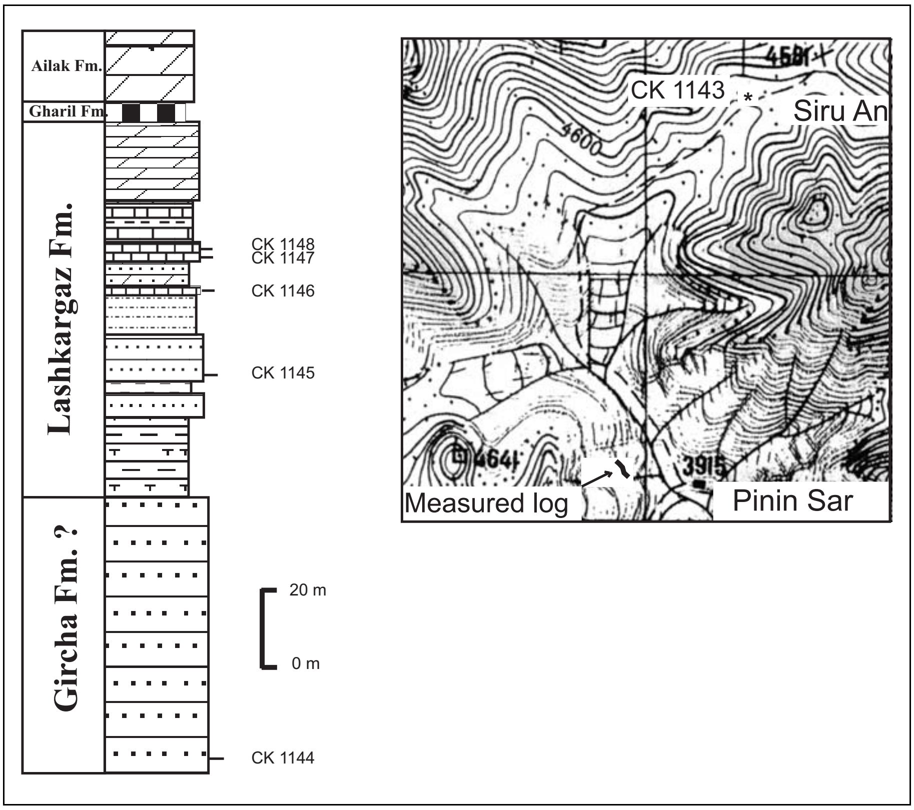


Fig. 5 - Location and log of the Pinin Sar section and the Siru An loose blocks.

severely deformed, but this trend seems to continue also westwards.

Eastern Hindu Kush

Khan Kun Gol

The upper reaches of the Khan Kun Gol open in a number of small circuses. Climbing to the north from 4560 m upwards, a succession of grey splintery slates, overlain by grey arenites, folded and partly covered by scree, was observed. On the small plateau at 4800 m a.s.l. grey thin-bedded packstones with very abundant fusulinids, and subordinate gastropods and fragments of brachiopods crop out. They belong to a succession of alternating massive and well-bedded limestones that are repeatedly folded and stacked by reverse faults (Fig. 6). The fossil content, collected by M. Gaetani in 1999, is as follows: Fusulinids: *Misellina parvicostata* (Deprat, 1915), *M.* cf. *termieri* (Deprat, 1915), *M. ovalis* (Deprat, 1915), *M.* cf. *confragaspira* Leven, 1967, *M. megalocula* Wang & Sun, 1973, *Armenina salgirica* A. M.-Maclay, 1957, *Chalaroschwagerina* (?) sp., *Leeina fusiformis* (Schellwien & Dyhrenfurth, 1909), *L.* ex gr. *fusiformis* (Schellwien & Dyhrenfurth, 1909), *L. exiqua* (Schellwien & Dyhrenfurth, 1909), *L.* (?) cf. *postkraffti* (Leven, 1967), *L.* (?) cf. *exornata* (Leven, 1967), *L.* (?) *dzhamantalensis* (Leven, 1967), *L.* (?) aff. *minoensis* Igo, 1996, *Skinnerella yabei asiatica* (Leven, 1967). *S.* ex gr. *yabei* (Hanzawa, 1942); small foraminifers: *Globivalvulina* sp., *Climacammina* sp., *Tetrataxis* sp.

Age: early Kubergandian (*Misellina ovalis-Armenina* Zone).

As previously noted, the presence of a carbonate

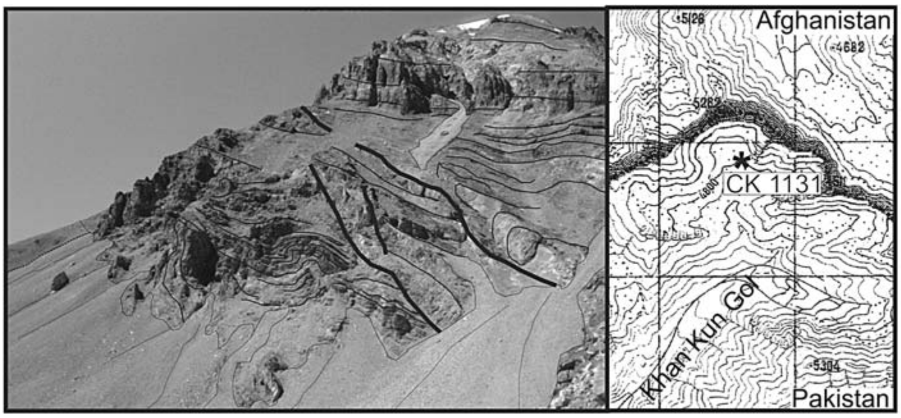


Fig. 6 - The Permian limestones forming reverse faulted folds on the western side of the upper circus in the Khan Kun Gol. Sample CK 1131 originates from the recessive succession cropping out in the middle of the wall.

thrust sheet in this part of the Eastern Hindu Kush was never reported previously. The map published by Kafarskyi in Abdullah & Chmyriov (1980), at the scale 1:500.000, is too sketchy, and it is difficult to link it to the outcrops observed on the Pakistan side of the range, where there is no trace of the granitoid body, of supposed Triassic age, reported on that map.

Stratigraphic conclusions

These new findings improve the knowledge on the Permian rocks of Western Karakorum and East Hindu Kush.

1. The major marine interval with deposition of grey well bedded mudstone, wackestone and packstone, with spells of arenitic material is confirmed to occur in the Lower Permian, from Sakmarian to Kubergandian (~ Kungurian), both in Karakorum and Hindu Kush.

2. An erosional surface cuts the top of the Lashkargaz Fm. and in the lowermost beds of the overlying Ini Sar Fm. a fusulinid fauna of the early Murgabian was recovered. It is overlaid by a thick peritidal carbonate flat, largely dolomitized.

3. The top of the carbonate flat emerged and an alluvial fan was established, fed by terrigenous older rocks and with lateritic soils partly reworked, developed on the alluvian plain.

4. The carbonate peritidal flat recovered by the Late Permian and continued up to the end of the Period. Due to the poor paleontological evidence and preservation, no further details are possible.

Palaeontology

Repository of the material. Fusulinids: GIN Moscow Catalogue Number GIN4783. Corals: Palaeontological Museum of the University of Milan, Catalogue No. MPUM 8456.

The fusulinids and their assemblages

In the regions under consideration fusulinids were first found by Hayden (1915) at the upper courses of the Yarkhun (the Baroghil Pass) and Yasin rivers. Tipper in Fermor (1922) reported them from the Rosh Gol river valley of Eastern Hindu Kush. Later Italian (De Filippi 1932; Desio & Cita 1955, 1962; Gaetani et al. 1990, 1995) and Dutch – Swiss (Visser 1935; Reichel 1940) researchers, as well as Russian-Chinese (Beljaevskyi 1947), Russian-Afghan (Kafarskyi & Abdullah 1976), and Australian (Talent et al. 1981) expeditions discovered fusulinids in the Shaksgam, Hunza, and Chapursan river valleys of Karakorum, and to the north of the Baroghil Pass and in the Mastuj River valley of eastern Hindu Kush.

The largest collection of fusulinids was derived from the Shaksgam River valley and was described by Reichel (1940). It should be noted that the Permian outcrops in Shaksgam belong geographically to the Karakorum, but they should be linked geologically to the SE Pamir (Gaetani et al. 1990, 1991). Some individual species were described by Reed (1925), Merla (1934), Dunbar (1940), Premoli Silva (1965), Ciry & Amiot (1965). A number of publications (Silvestri 1935; Gaetani & Leven 1993; Gaetani et al. 1995) contain pictures of specimens, their location and stratigraphic position, but no descriptions.

From our study and taxonomic review of the fusulinids listed in these publications and of those mentioned herein we can infer the occurrence of the following genera in Karakokum, Shaksgam, and Eastern Hindu Kush: *Pamirina, Pseudoendothyra, Staffella, Nankinella, Boultonia, Minojapanella, Schubertella, Neofusulinella, Yangchienia, Darvasites, Chusenella, Rugosochusenella, Chalaroschwagerina, Kubergandella, Pseudofusulina, Leeina, Skinnerella, Eoparafusulina, Monodiexodina, Misellina, Armenina, Cancellina, Neoschwagerina.* Their age ranges from the Sakmarian through early Murgabian. No pre-Sakmarian fusulinids have been found, and only poorly preserved Staffellids occur in post-Murgabian Ailak Formation.

In general, the fusulinids of the region are similar to those present throughout the Tethys. The exception is a Sakmarian assemblage constituted of numerous species of a single genus, *Pseudofusulina*. The assemblage was called Kalaktash (Leven 1993a) and characterizes the southern peri-Gondwanan part of the Tethys. It was recorded also in the Central Pamirs and Southern Afghanistan (Leven 1993a, 1997), and lately in Oman (Angiolini et al. 2006). The absence of Asselian fusulinids and the endemism of the Sakmarian specimens can be explained by the Gondwana maximum glaciation. Fusulinids could not survive in such cold waters. More temperature-resistant *Pseudofusulina* species appeared during the Sakmarian warming. Due to the progressive warming, later warm-water genera and species penetrated into the region under consideration and from the late Yakhtashian the fusulinid assemblage lost its distinctive features and regional peculiarities, as evidenced by the new collection of fusulinids.

In addition to wide stratigraphic ranged staffellids from Ailak Formation, the collection contains forms from three stratigraphic levels, i.e. Bolorian, lower Kubergandian, and lower Murgabian.

The **Bolorian assemblage**, which was detected in samples CK1143 and CK1146, comprises *Millerella (?)* sp., *Schubertella* sp., *Staffella* aff. *powwowensis* Thompson, *Nankinella minor* Sheng, *Misellina* cf. *termieri*

(Deprat), *Chalaroschwagerina (Cuniculina) vulgarisiformis* (Morikawa), *Pseudofusulina* sp., *Leeina* cf. *kraffti* (Schellwien & Dyhrenfurth), *Praeskinnerella* sp.

The genus *Millerella* (Pl. 1, fig. 5) characteristic of the Visean, Bashkirian and Moscovian stages of the Carboniferous was not found previously in Permian deposits (Rauser-Chernousova et al. 1996). Therefore its identification is inconclusive. The form identified is slightly larger than the typical *Millerella* and has, probably, a different wall structure, which is difficult to determine because of poor preservation.

The genus *Schubertella* is widespread from the Bashkirian through the Permian (Rauser-Chernousova et al. 1996). In our collection it is represented by specimens unidentifiable at species level.

The genus *Staffella* spread widely in the Upper Permian. Its relatively primitive forms resembling *S. powwowensis* Thompson (Pl. 1b, figs. 1-3) are known from the Lower Permian of North America and South China.

Similarly to *Staffella,* the genus *Nankinella* is common (it means common, but not only) in the Upper Permian. *N. minor* Sheng (Pl. 1, fig. 4) is referred to the most primitive representatives of the genus.

The genus *Misellina* is represented by a single specimen with destroyed outer whorls (Pl. 1, fig. 10). It resembles *Misellina (Misellina) parvicostata* (Deprat). The species spread through the Tethys in the second half of the Bolorian-early Kubergandian (Deprat 1915; Leven 1967, 1997, 1980; Leven et al. 1992; Leven & Vaziri 2004; Xiao et al. 1986 a. o.).

The genus *Chalaroschwagerina* occurs in the Yakhtashian and Bolorian deposits of the Tethys and their age equivalents of western North America (Skinner & Wilde 1965). The collection includes the subgenus *Cuniculina,* distinguishable for the presence of cuniculi and confined to the Bolorian. *Ch. (C.) vulgarisiformis* (Morikawa) (Pl. 2, fig. 1) is known from Japan, China, the Pamirs, Darvaz, Afghanistan, and Iran (Morikawa 1952; Leven 1967, 1997; Leven et al. 1992; Leven & Vaziri 2004; Zhang 1982). It occurs always in Bolorian deposits dated also by conodonts (Leven et al. 2007).

The genera *Pseudofusulina, Praeskinnerella,* and *Leeina* are represented by single poorly preserved specimens. A form of the latter genus is very similar to *Leeina kraffti* (Schellwien & Dyhrenfurth), characteristic of the Yakhtashian and, to a lesser extent, of the Bolorian.

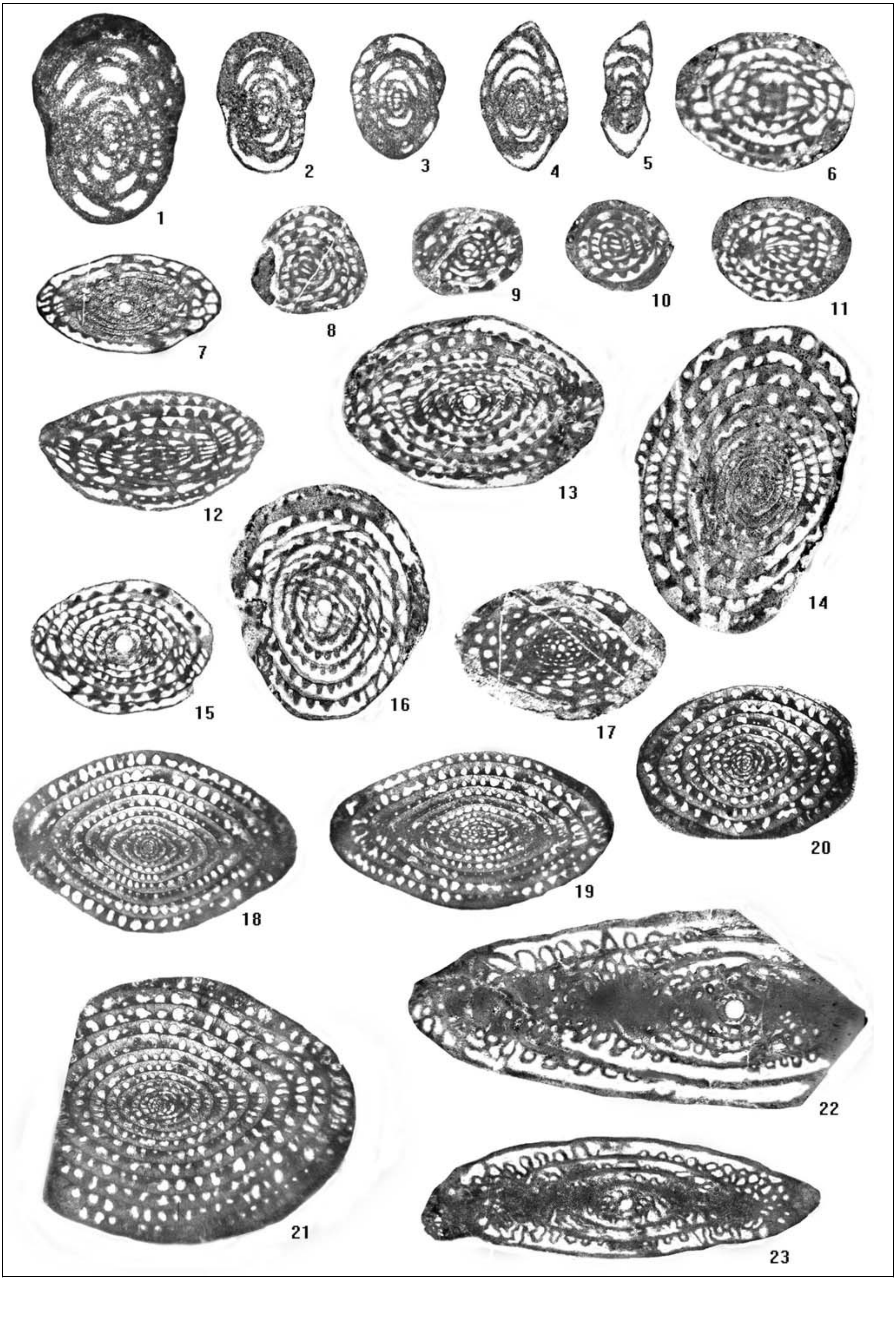
Even if the assemblage is not diverse, the co-occurrence of *Misellina parvicostata, Chalaroschwagerina vulgarisiformis,* and *Leena* cf. *kraffti* indicates its Bolorian age unambiguously.

The **Kubergandian assemblage** found in sample CK1131 is more representative. Fusulinids occur in abundance, but most of them are strongly deformed and poorly preserved. The following genera and species can be identified with different degrees of confidence: *Misellina parvicostata* (Deprat), *M.* cf. *termieri* (Deprat), *M. ovalis* (Deprat), *M.* cf. *confragaspira* Leven, *M. megalocula* Wang et Sun, *Armenina salgirica* A. M.-Maclay, *Chalaroschwagerina* (?) sp., *Leeina fusiformis* (Schellwien & Dyhrenfurth), *L.* ex gr. *fusiformis* (Schellwien & Dyhrenfurth), *L. exiqua* (Schellwien & Dyhrenfurth), *L.* (?) cf. *postkraffti* (Leven), *L.* (?) cf. *exornata* (Leven), *L.* (?) *dzhamantalensis* (Leven), *L.* (?) aff. *minoensis* Igo, *Skinnerella yabei asiatica* (Leven). *S.* ex gr. *yabei* (Hanzawa).

The genus *Misellina* appeared in the Bolorian and became extinct in the Kubergandian (Leven 1967; Leven et al. 1992; Ueno 1996). *M. parvicostata* (Deprat) (Pl. 1, figs 8, 9, 11) is common in the upper half of the Bolorian and the lowermost part of the Kubergandian of many Tethyan sections (Deprat 1915; Leven 1997, 1998; Leven et al. 1992; Xiao et al. 1986). *M. ovalis* (Deprat) (Pl. 1, fig. 12) is the index-species of the lower Kuberganian zone of *Misellina ovalis, Armenina.* It spreads from Japan and Indo-China to the east, and to the Transcaucasia and Iran to the west (Deprat 1915; Leven 1967, 1997, 1998; Toriyama 1975; Gaetani & Leven 1993). *M. confragaspira* Leven (Pl. 1, fig. 7) was described from the lower Kubergandian of the south-eastern Pamirs and recorded from the equivalent deposits of Indochina (Leven 1967; Toriyama 1975). *M. megalocula* Wang & Sun (Pl. 1, figs. 13, 15) was described first from the "*Misellina*" Zone of North China (the Chinling Range) (Wang & Sun 1973). Due to subse-

PLATE 1

Fig. 1-3 - *Staffella* aff. *powwowensis* Thompson. x20. Axial and subaxial sections. Sample CK 1146; 1, 3 - GIN4783/1; 2 - GIN4783/2. Fig. 4 - *Nankinella minor* Sheng. x20. Subaxial section. Sample CK 1146; GIN4783/3. Fig. 5 - *Millerella* (?) sp. x20. Subaxial section. Sample CK 1146; GIN47833. Fig. 6 - *Misellina* cf. *termieri* (Deprat). x15. Tangential section. Sample CK 1131; GIN4783/4. Fig. 7 - *Misellina* cf. *confragaspira* Leven. x15. Axial section. Sample CK 1131; GIN4783/5. Fig. 8 -11 - *Misellina parvicostata* (Deprat). x15. Oblique sections. 8, 9, 11 - sample CK 1131; GIN4783/4; 10 - sample CK 1146; GIN4783/3. Fig. 12 - *Misellina ovalis* (Deprat). x15. Tangential section. Sample CK 1131; GIN4783/4. Fig. 13, 15 - *Misellina megalocula* Wang et Sun. x15. Subaxial sections. Sample CK 1131; 13 - GIN4783/6; 15 - GIN4783/9. Fig. 14, 16 - *Armenina salgirica* A. Miklulho-Maclay. x15. Subaxial and axial sections. Sample CK 1131; 14 - GIN4783/7; 16 - GIN4783/10. Fig. 17 - *Misellina* sp. x15. Oblique section. Sample CK 1131; GIN4783/8. Fig. 18, 19 - *Neoschwagerina deprati* Leven. x15. Axial sections. Sample CK 606; 18 - GIN4783/11; 19 - GIN4783/12. Fig. 20 - *Neoschwagerina* cf. *schuberti* Kokansky-Devidé. Sample CK 604; GIN4783/13. Fig. 21 - *Neoschwagerina verae* (Toumanskaya). x15. Subaxial section. Sample CK 606; GIN4783/14. Fig. 22 - *Leeina* (?) *dzhamantalensis* (Leven). x10. Axial section. Sample CK 1131; GIN4783/15. Fig. 23 - *Leeina fusiformis* (Schellwien et Dyhrenfurth). x10. Axial section. Sample CK 1131; GIN4783/16.



quent findings of this species in the Transcaucasia, Iran, and Afghanistan (Leven 1997, 1998), its stratigraphic position was determined more precisely: it is confined everywhere to the lower Kubergandian deposits.

The genus *Armenina* including *A. salgirica* A. M.-Maclay (Pl. 1, figs. 14, 16) occurs from the lower Kubergandian to the Murgabian.

The genus *Leeina* was established by Galloway (1933), but was not recognized worldwide. Recently it was reviewed by Rauzer-Chernousova et al. (1996). *Fusulina vulgaris* var. *fusiformis* (Schellwien & Dyhrenfurth, 1909) was chosen as the type species. The genus comprises forms with tests of middle and large size, fusiform to subcylindrical, with thick wall, intensively folded septa and usually well-developed axial fillings. Such forms, as well as the type species, are characteristic of the Yakhtashian and Bolorian deposits (Leven et al. 1992). They occur also higher in the section up to the Murgabian, where, however, they have cuniculi, which are not diagnostic features of the genus. Similar forms are attributed usually to *Parafusulina,* but they have little in common with the true American *Parafusulina.* More likely, they are advanced forms of *Leeina* and after a more thorough study they might be united into a subgenus of this genus. The collection includes both typical *Leeina* and forms with distinct cuniculi, which are usually larger. Therefore they are described with uncertainty.

Leeina fusiformis (Schellwien & Dyhrenfurth) (Pl. 1, fig. 23) was described first from the Yakhtashian and Bolorian beds of Darvaz. It was reported also from Japan, Indo-China, China, Afghanistan, and Iran (Suyari 1962; Sheng 1963; Kalmykova 1967; Leven 1997; Leven et al. 1992; Leven & Vaziri 2004; Igo 1996). *Leeina exiqua* (Schellwien et Dyhrenfurth) (Pl. 2, fig. 2) occurs together with the prevoius species in Darvaz and other regions of the Tethys**.** *Leeina* (?) (cf. delete) *postkraffti* (Leven) (Pl. 2, fig. 4) was described from the Bolorian of the southeastern Pamirs, Iran and from the Bolorian-Kubergandian deposits of Afghanistan (Leven 1967 1997; Leven & Vaziri 2004). A form in the collection is poorly preserved, and axial fillings are less developed than those of the typical representatives of the species. Therefore the form is left in open nomenclature. *Leeina* (?) cf. *exornata* (Leven) (Pl. 2, fig. 8) is large, similar in septal folding to the typical form of the species from the Bolorian of the northern Pamirs (Leven 1967). *Leeina* (?) *dzhamantalensis* (Leven) (Pl. 1, fig. 22) was found in the Kubergandian of the southeastern Pamirs, Darvaz and Iran (Leven 1967; Leven et al. 1992; Leven & Vaziri 2004). *Leeina* (?) aff. *minoensis* (Igo) (Pl. 2, fig. 9) is very large, similar to Japanese representatives of the species. It is distinguished by a larger size and well-advanced cuniculi which are absent in the Japanese type forms. The age of the latter can be approximately defined as Yakhtashian (Igo 1996).

The genus *Skinnerella,* including *S. yabei* (Hanzawa) (Pl. 2, figs. 6, 7), is characteristic of the Kubergandian and Murgabian of Japan, South China, and the Pamirs. In the northern Pamirs it is represented by *S. yabei asiatica* (Leven) found in the Kubergandian deposits (Leven 1967).

The taxonomic composition of the assemblage, particularly the occurrence of advanced *Misellina* together with *Armenina* and *Skinnerella,* indicates reliably its Kubergandian age. At first sight, this contradicts the Bolorian and even Yakhtashian-Bolorian ages of most of the mentioned *Leeina* species. However, as noted above, many forms referred conventionally to this genus have such progressive features as cuniculi, which are absent in their typical Yakhtashian and Bolorian representatives. The assemblage includes no forms of *Cancellina,* characteristic of the upper zone of the Kubergandian. This enables the assemblage to be dated as early Kubergandian.

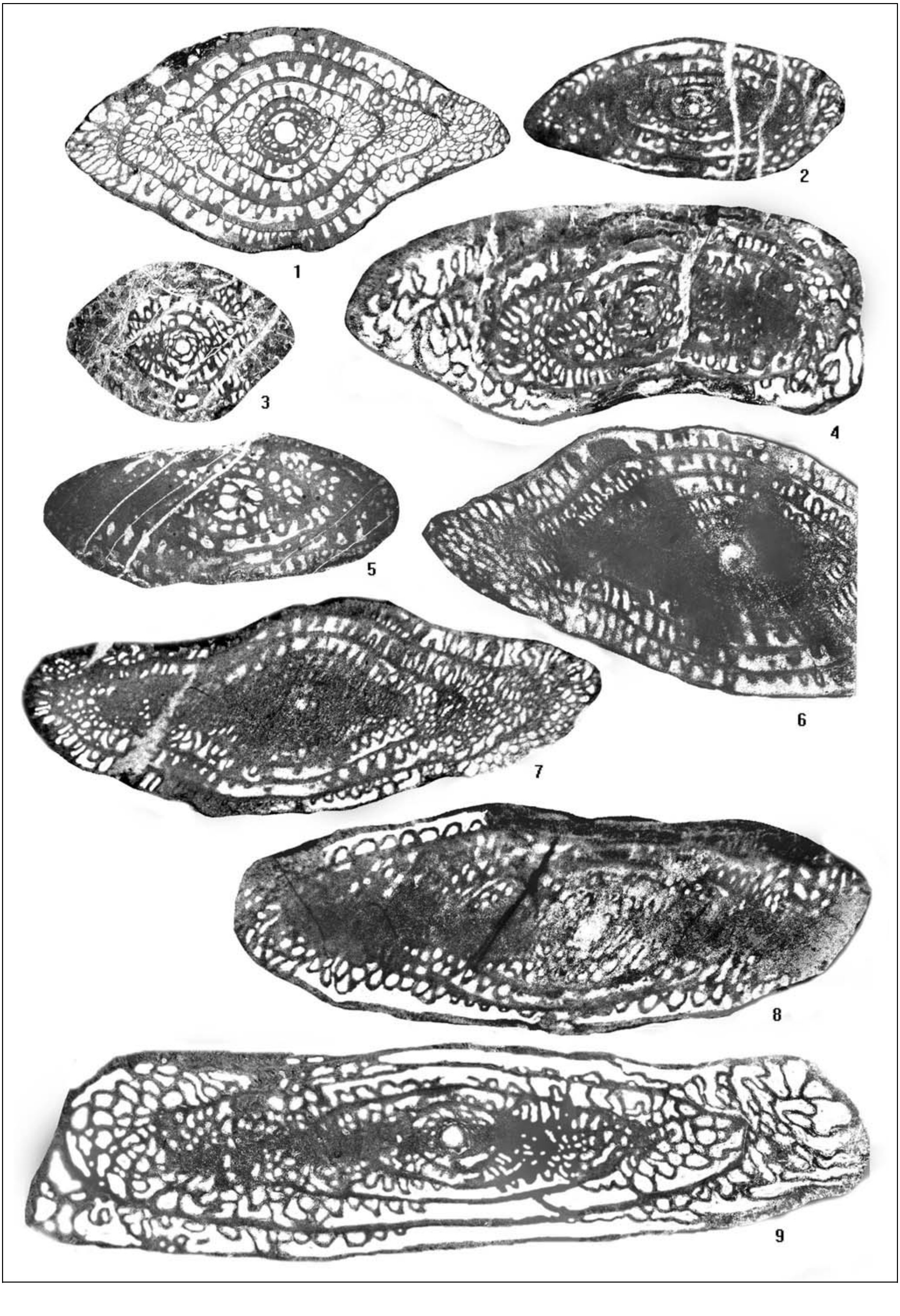
The **Murgabian assemblage** was discovered in samples CK 603, CK 604, and CK 606. It is the first time that Murgabian fusulinids are found in Karakorum. The assemblage consists of several *Neoschwagerina* species and unidentified *Schubertella* and *Yangchienia* species.

The genus *Neoschwagerina* is represented by three species as advanced as *N. simplex* Ozawa, the index-species of the lower zone of the Murgabian. *Neoschwagerina verae* (Toumanskaya) (Pl. 1, fig. 21; sample CK 606) was described first from the well-known Marta River locality of the Crimea (Toumanskaya 1953), where it was associated with the species characteristic of the lower zone of the Murgabian, such as *Presumatrina neoschwagerinoides* (Deprat), *Cancellina sphaerica* A. M.-Maclay, and some others. *Neoschwagerina* cf. *schuberti* Kochansky-Devide (Pl. 1, fig. 20; sample CK 604) is a primitive representative of the genus. It is known from the Murgabian deposits of Montenegro, the Southeastern Pamirs, and some se-

PLATE 2

Magnification x10 for all pictures

Fig. 1 - *Chalaroschwagerina (Cuniculina) vulgarisiformis* (Morikawa). Axial section. Sample CK 1143; GIN4783/17. Fig. 2 - *Leeina exiqua* (Schellwien et Dyhrenfurth). Axial section. Sample CK 1131; GIN4781/18. Fig. 3 - *Chalaroschwagerina* (?) sp. Subaxial section. Sample CK 1131; GIN4783/8. Fig. 4 - *Leeina* (?) cf. *postkraffti* (Leven). Subaxial section. Sample CK 1131; GIN4783/19. Fig. 5 - *Leeina* ex gr. *fusiformis* (Schellwien et Dyhranfurth). Axial section. Sample CK 1131; GIN4783/4. Fig. 6 - *Skinnerella yabei asiatica* (Leven). Axial section. Sample CK 1131; GIN4783/20. Fig. 7 - *Skinnerella* ex gr. *yabei* (Hanzawa). Axial section. Sample CK 1131; GIN4783/21. Fig. 8 - *Leeina* (?) cf. *exornata* (Leven). Axial section. Sample CK 1131; GIN4783/22. Fig. 9 - *Leeina* (?) aff. *minoensis* (Igo). Axial section. Sample CK 1131; GIN4783/23.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quences of South China and Indochina (Kochansky-Devidé 1958; Leven 1967; Toriyama 1975).

The forms illustrated in Pl. 1, figs. 18, 19 spread widely through the Tethys. Usually, they are attributed to *Neoschwagerina craticulifera* (Schwager). They are more primitive than the holotype, as evidenced by fewer spiral whorls and, correspondingly, smaller dimensions, as well as less slender and straight septula, which are partially united with parachomata. These features are similar to those of a specimen referred to *N. craticulifera* by Deprat (1914, pl. 7, fig. 4). Leven (1993b) proposed to attribute such *Neoschwagerina* forms to an independent species, *N. deprati* Leven. This species would include the specimens of our collection. It may be an ancestor of true *N. craticulifera* and occur lower in a section, i.e., not higher than the lower half of the Murgabian.

The genera *Schubertella* and *Yangchienia* found together with *Neoschwagerina* are not identified at species level. As noted above, the former has very wide stratigraphic range, whereas the latter appeared in the Bolorian time, but spread widely in the Kubergandian.

The rugose coral genus *Pseudohuangia* Minato & Kato, 1965

A small fragment of the waagenophyllid species *Pseudohuangia chitralica* (Smith, 1935) was identified in the collections from the Lashkargaz Fm. at Pauer Gol. This coral, which was subsequently designated as type species of *Psudohuangia* - was described first from the "right bank of the Yarkhun River, in Chitral, about 2 ½ mi. N of Baroghil, Ailak, Pakistan". Its type stratum was originally cited as "Upper Carboniferous, Uralian", but according to Minato & Kato (1965) it belongs now to the *Parafusulina* zone (Guadalupian). Apparently, the specimen was collected by Hayden (1915) and should originate from the slope to the North of Gharil.

Although *Pseudohuangia* is widely distributed along the margin of the Permian Tethys, ranging from Turkey in the west to Vietnam in the east, most of the species assigned to this genus are rare and not well documented. This is particularly the case concerning the monotypic type species "*Waagenophyllum chitralicum*". Subsequently, the species was recorded from Iran (Douglas 1936, 1950), the Bükk Mountains in Hungary (Heritsch 1944; Kolosvary 1951), Turkey (Flügel 1955), Armenia (Iljina 1974) and Montenegro (Kostic-Podgorska 1965), but all these records need critical revision, which is beyond the scope of this note. As no recent data concerning records from the type area in Pakistan are available, and a detailed description is also missing from Minato & Kato (1965: 90) it is desirable to gather additional information.

Recently *Pseudohuangia* was regarded as a synonym of *Liangshanophyllum* Tseng, 1949 by Lin et al. (1995: 583), from which it differs in having less steeply inclined clinotabulae, a generally larger corallite diameter and almost no elongate dissepiments.

Pseudohuangia chitralica (Smith, 1935)

Fig. 7

Description. The fragment of a loosely dendroid colony consists of only a few adult corallites with a diameter of 7-10 mm. Corallite wall is relatively thin, but may be dilated by wedge shaped septal bases, without forming a peripheral stereozone. The 24-27 major septa reach about 1/2 to 2/3 of the radius and thus never enter the axial structure. They are only a little longer than the minor septa. Generally, septa are thin or only slightly dilated within the tabularium, but sometimes there is a compact zone of dilation where they enter the tabularium. The stereome of the thickened dissepiments may spread onto septa and some corallites develop a complete stereozone, which is however more common in juvenile corallites. Septa are generally smooth, but may show some knot-like structures (no carinae) or are slightly wavy close to the epitheca. Axially there is a wide columella, reaching about 1/4 of the corallite diameter and showing a distinct median plate, commonly

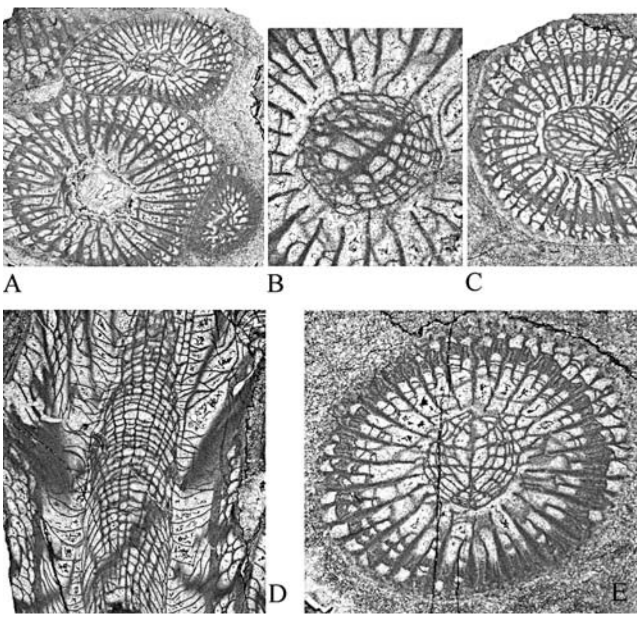

Fig. 7 - *Pseudohuangia chitralica* (Smith, 1935); sample CK1151. A) Transverse section of a budding corallite. Axial space of mother corallite infilled by sparite, x 2.7. B) Detail of columella, clearly showing the median plate, x 7.5. C) Transverse section of a typically developed corallite, x 3. D) Obliquely cut longitudinal section, showing the wide axial column. Clinotabulae and elongate dissepiments are missing, x 3.5. E) Transverse section of a juvenile corallite with a peripheral stereozone, x 5.

bisecting the axial structure. The columella is irregularly constructed by axial tabellae and septal lamellae, and if more regularly developed it takes the shape of a spider-web. The dissepimentarium is very narrow, consisting of only 1-3 rows of mostly globose dissepiments. It is sharply bound from the tabularium which consists of steeply inclined clinotabulae and transverse tabulae. The lamellae of the axial column are strongly convex, with a median plate.

Remarks. Even if the type material consists of a single fragmentary colony, and even though the knowledge of the morphological range of this taxon is rather limited, the specimen described is remarkably similar to the holotype. Corallite diameter, number of sepata and general morphology correspond very well. Only the axial column is more consistently developed and shows a better developed median plate in some corallites, reminding of the specimens described from Iran. It was observed correctly by Minato & Kato (1965) that the characteristic stereozone commonly developed in the juvenile stage at the boundary of the dissepimentarium loosens up and may be completely absent in adult corallites (compare Smith in Reed 1925: pl. 1, fig. 25). The longitudinal section of a juvenile specimen figured by Flügel (1995: fig. 3b) differs in having a very narrow columella and steeply inclined clinotabulae.

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