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PERMIAN RUGOSA FROM NORTHERN KARAKORUM AND AGHIL RANGES

HELMUT W. FLUEGEL* & MAURIZIO GAETANI **

Key-words: Rugosa, Permian, Artinskian, Kubergandian, Murgabian, Palaeobiogeography, Central Asia.

Riassunto. Nelle unità calcarenitico-arenacee del Karakorum settentrionale (Formazione Panjshah in valle Hunza) e della catena dell'Aghil (Formazione Shaksgam in valle Shaksgam) sono state raccolte faune a Coralli di età Artinskiano/Kubergandiana. La maggior parte delle specie non era stata sinora descritta, ma è possibile definire abbastanza bene la loro età mediante i Fusulinidi e i Conodonti. Da un punto di vista paleobiogeografico essi appartengono alla provincia a *Lytvolasma*, con alcune affinità con la microplacca di Lhasa, la catena Himalayana e la falda alloctona di Timor.

Abstract. A Coral fauna has been collected in the calcareous/arenitic shallow-water units of Artinskian/Kubergandian ages in Northern Karakorum (Hunza valley) and Aghil Ranges (Shaksgam valley). Most of the species collected were undescribed, but their age is fairly well constrained through fusulinids and conodonts. From the biogeographic point of view they belongs to the *Lytvolasma* province, with some affinities to Lhasa microplate, Himalaya Range and allochthonous Nappe in Timor.

Introduction.

During two geological expeditions, in the 1986 to the Hunza valley (Northern Karakorum) and in the 1988 to the Shaksgam valley between Aghil and Karakorum Ranges, Rugosa were collected from Permian rocks (Fig. 1). The taxonomy of these findings has been described in Flügel (1990). Their list is the following:

	HUNZA	SHAKSGAM
Yatsengia hangchowensis (Huang)	x	
Paracaninia similis (Schindewolf)	x	
Paracaninia sp. A	x	

*Institut für Geologie und Paläontologie, Heinrichstrasse 26, A-8010 Graz, Austria.

** Dipartimento di Scienze della Terra dell'Università degli Studi di Milano, Via Mangiagalli 34, I-20133 Milano and Ev-K2 CNR, Via Ampère 56, Milano, Italy.

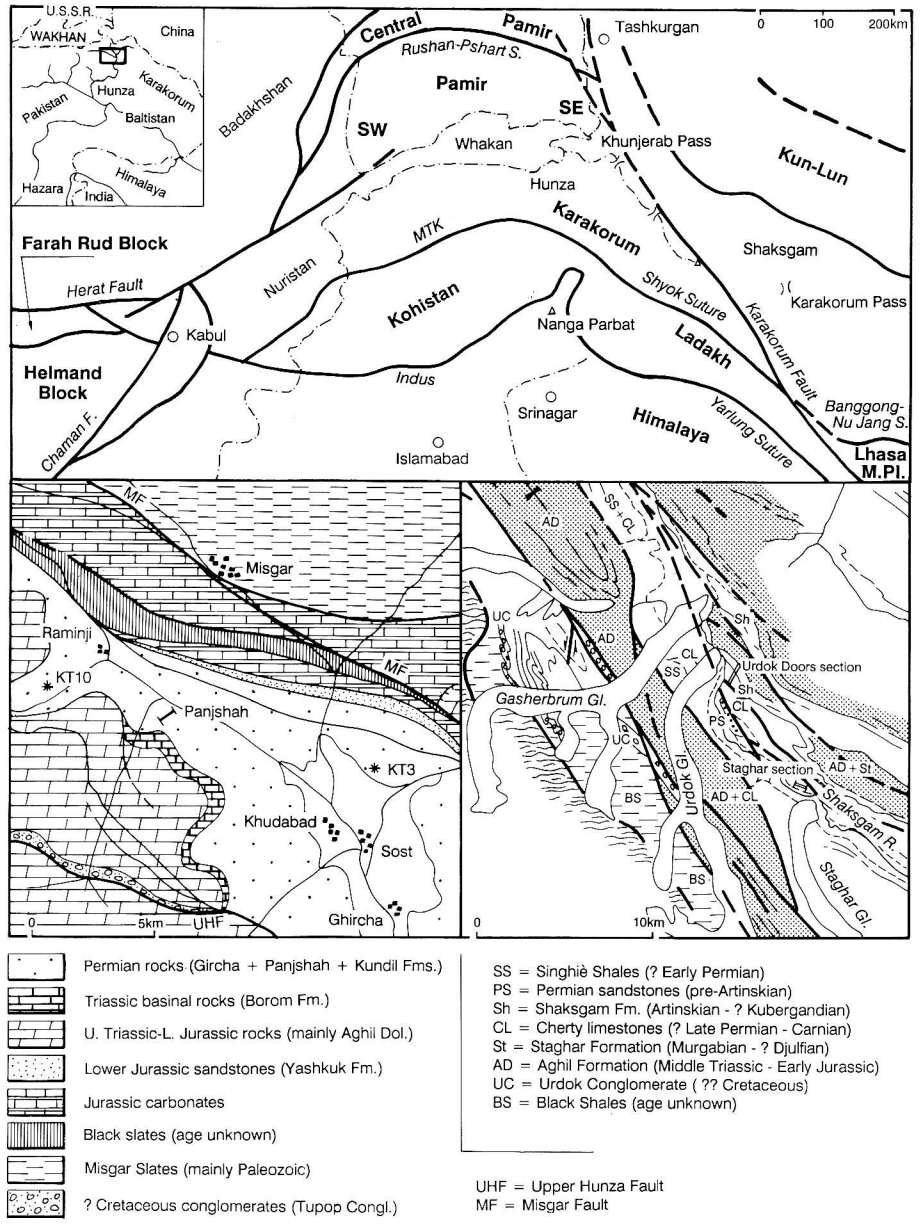

Fig. 1 - Index-map of the fossiliferous localities (top) and geological sketch in Hunza (bottom left) and Shaksgam valleys (bottom right).

Paracaninia sp. B		x
Paracaninia sp.	x	
Petraphyllum hunzaianum Flügel	x	
Petraphyllum columnum Flügel		x
Duplocarinia sp.	x	
Ufimia hunzensis Flügel	x	
Lophophyllidium (Lophbillidium) martini (Schouppé & Stacul)		x
Verbeekiella australis (Beyrich)		x
Allotropiochisma (Allotropiochisma) biseptata Flügel		x
Amandophyllum (?) sp.		x
Euryphyllum sp.		x
Chaetetes sp.	x	

Previously, only one form of Permian Rugosa, *Amplexocarinia* sp. (= *Barrandeophyllum* Merla, 1935) was shortly described from the Shaksgam valley by Fantini Sestini (1965). Consequently, the faunas are mostly new for the studied areas. Only at the easternmost end of Karakorum, near the Rimu Glacier, Merla (1934) described several solitary Rugosa, which consist of species belonging to the genera *Lophophyllidium, Ufimia* and *Paracaninia* of the *Lytvolasma* province. They still need a revision.

Geological Setting.

Hunza Valley.

The general pattern of the geology of this area has been described in Gaetani et al. (1990a). The Permian sequence consists of the following units, bottom to top (Fig. 2):

1) *Gircha Formation.* Gray coarse to fine litharenites, in festooned m-thick bodies, channeling dark-gray siltites and slates. Sparse calcareous sand lenses contain brachiopod fragments, especially towards the top of the unit, testifying to the incipient marine ingression. Thickness: more than 1000 m. Age: Artinskian in the upper part.

2) *Panjshah Formation.* Three-fold carbonatic-arenitic unit. The first member is made up by hybrid arenites and siltstones containing reworked phosphatic nodules, interbedded by crinoidal calcarenites, very rich in the spiriferid brachiopod *Elivina* ex gr. *tibetana* (Diener). Total thickness exceeding 250 m.

The second member starts with calcarenites with bryozoans and then by an interval packed with fusulinids (*Monodiexodina wanneri, Pseudofusulina quasigruperensis, Schwagerina nipponica*). Slightly higher also *Nankinella* and *Reichelina* appear. The member continues with shallowing upwards cycles capped by oolite bars, followed by laminated aphanitic dolomites. The thickness may reach 250 m.

The third member starts with a fairly consistent arenitic interval, grading laterally in marly siltstones. In the lower part of this member several Productids (*Marginifera* - like) have been collected. Then the succession continues with thin bedded packstones with shaly partings, bearing a rich brachiopod fauna in the middle and upper part (*Enteletes, Hemiptychina, Stenoscisma, Uncinunellina, Cancrinella, Eliva, Neospirifer, Spiriferella, Permophrycodothyris, Dielasma*). Most of the brachiopod fauna

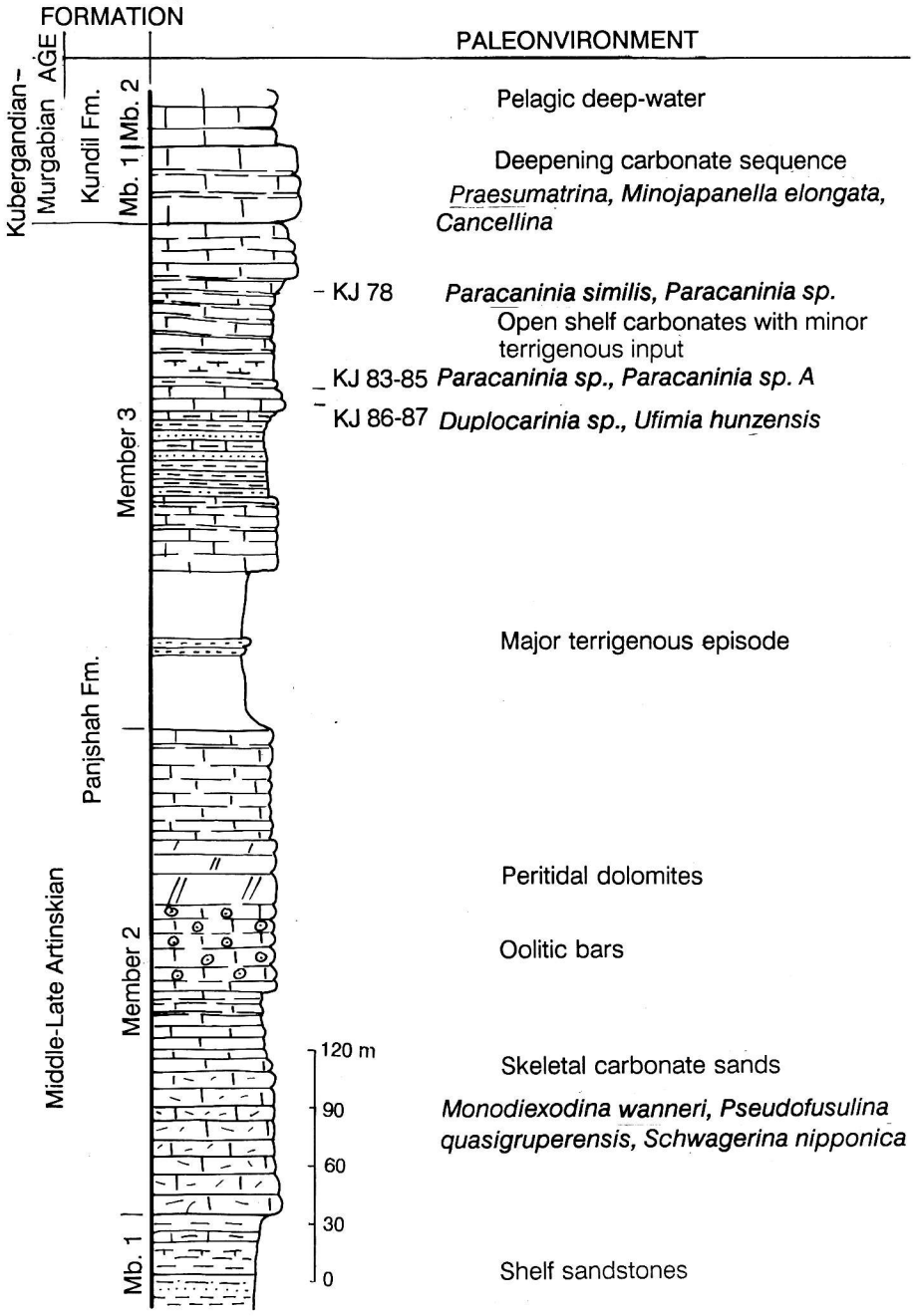

Fig. 2 - The stratigraphic section of Panjshah, type-section for the Panjshah Formation (Hunza valley). The whole development of the first member is not reported.

described by Fantini Sestini (1965) should derive from this member. The thickness of the carbonate part may reach 200 m. Since the Rugosa here dealt with derive from this formation, its age will be fully discussed in the next chapter.

3) *Kundil Formation.* At the base thick bedded cherty limestones intercalated to calcarenites, then thinly bedded light gray cherty limestones. A few fusulinids (*Minojapanella elongata, ? Cancellina* sp., *Praesumatrina* sp.) and the conodont *Gondolella idahoensis* have been collected in the lower part. Huge megabreccia bodies may occur in the middle and upper part of the unit. Thickness 250-400 m. Age: Kubergandian-Murgabian and Midian ages were ascertained in this unit (Gaetani et al., 1990a).

The stratigraphic succession has been interpreted as representing a passive margin sequence, with a marine transgression on an alluvial wedge (Gircha Fm.), followed by shallow-water carbonate/arenite shelf (Panjshah Fm.), subsequently sunked to deep-water through (Kundil Fm.).

Collecting localities. Rugosa have been collected from the third member of the Panjshah Fm. in its type-section above the Panjshah Shrine in the Chapursan valley, Rishipjerab area. (Fig. 2, name spelling after Bolinder, 1990) (samples KJ78, 83, 84, 85, 86, 87). The sample KT 8, collected in loose rocks on the surface along the type-section, also probably derives from the same horizon. Instead samples KT10 and KT3 were collected in the scree, south of Raminji and along the SW slopes of the Sost-i-Sar, near Sost, respectively, and no reference to stratigraphic position can be made.

Shaksgam Valley.

The main features of the geology of the Shaksgam Sedimentary Belt has been preliminarily described in Gaetani et al. (1990b), and a general account may be found in Gaetani et al. (1991). The Permian sequence, bottom to top, is as follow (Fig. 3).

1) *Permian sandstones.* Quarzarenitic to litharenitic m-thick, parallel to slightly lenticular beds, alternating with dark grey mottled siltites and slates. Towards the top the arenitic lenses are more carbonatic and contain brachiopod and bryozoan fragments. Thickness exceeding the 120 m measured. Age: no data. Assigned to the Permian because of general stratigraphic interpretation.

2) *Shaksgam Formation.* Three-fold carbonatic-arenitic unit, with significant lateral changes. It starts with a thick to thin bedded skeletal crinoidal limestone, rarely interbedded by marls. It is more terrigenous to northwest, whilst the calcarenitic facies seems to be more extended at southeast. The Rugosa here discussed originate from the base of the member, in the Urdok Doors section (sample KM51) (Fig. 3), where only crinoidal fragments were collected with. In the Staghar section (Fig. 4), Rugosa derive from an higher level and they are together with a rich brachiopod (*Enteletes*) and bryozoan (*Sulcoretepora*) fauna (samples KM86, KM89). Also the conodont *Merillina* aff. *oertli* has been recognized. The fusulinid content is poor, and only at the Staghar section *Minojapanella wutuensis* and *Monodiexodina* sp. have been found.

The middle member is characterized by an alternance of thin bedded arenaceous limestones and festooned cross-bedded litharenites and quartzarenites. It is the richest

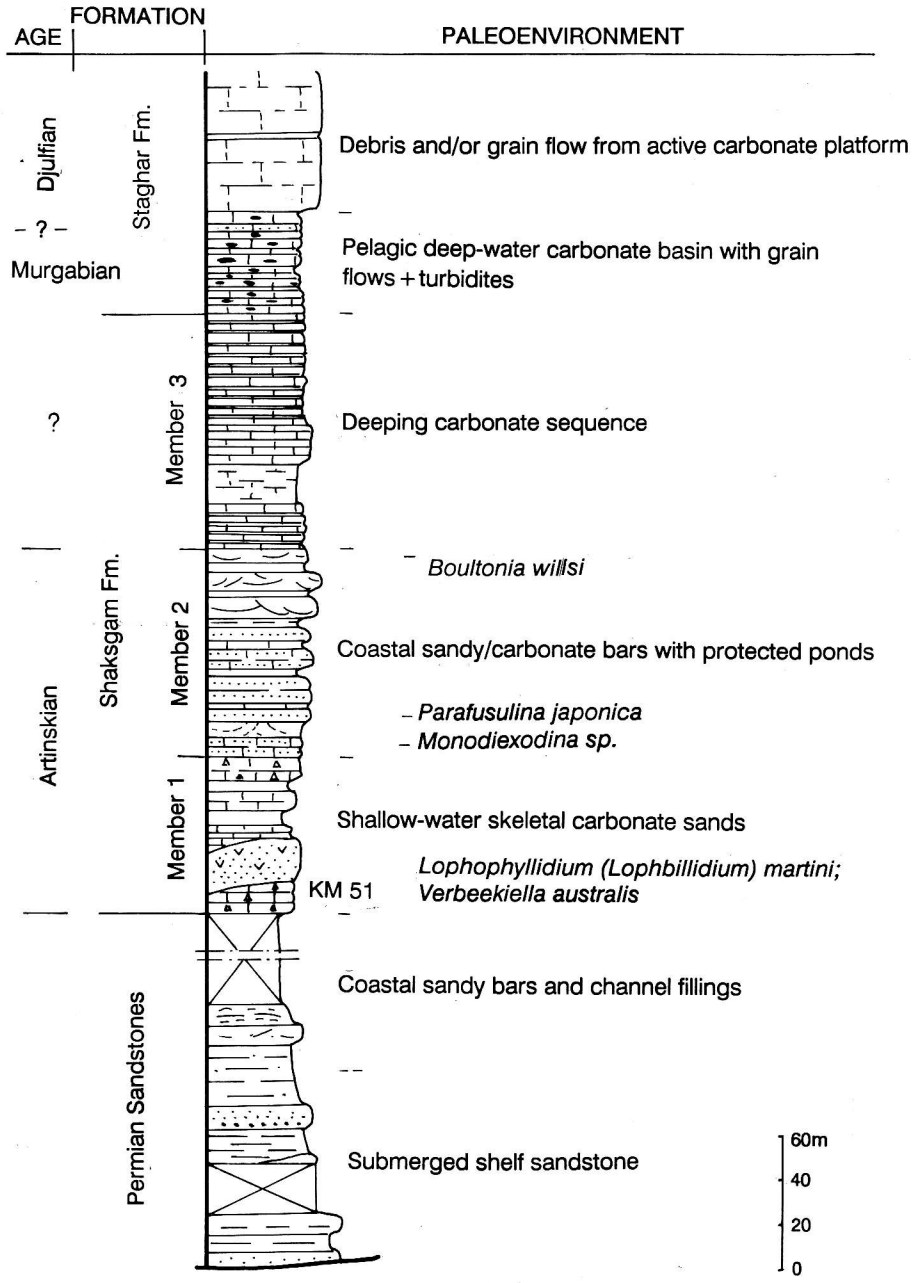

Fig. 3 - The stratigraphic section of the Urdok Doors, reference section in Shaksgam valley for the Shaksgam Formation.

in fusulinids, dominated by *Parafusulina japonica* and *Monodiexodina caracorumensis* and other species like *Pseudofusulina shaksgamensis, Chalaroschwagerina* sp., *Triticites* sp. At the top of this member *Boultonia willsi* was also found.

The third member consists of well bedded packstone to wackestone/packstone, with shaly intercalations and sparse brachiopods. No fusulinids have been found.

The entire formation has a thickness exceeding 200 m. Its age will be discussed in the next chapter.

3) *Staghar Formation.* At the base dark-grey cherty limestones, increasingly polluted by calcarenites and then with huge megabreccia bodies from nearby living carbonate platforms. The fusulinids are fairly spread within the resedimented calcarenites, calcirudites and megabreccias. *Neoschwagerina simplex* and *Dunbarula nana*, together with the genera *Misellina, Schubertella, Khalerina, Cancellina* and *Conodofusiella* points to a Murgabian-Djulfian age for the Staghar Fm. Thickness from 100 to 200 m, very depending on the megabreccia bodies.

Also in the Shaksgam valley, the succession records the passive margin history of transgression on a clastic wedge, with shallow-water carbonate/arenite stage and then drowing to deeper water with huge resedimentation episodes from carbonate platform.

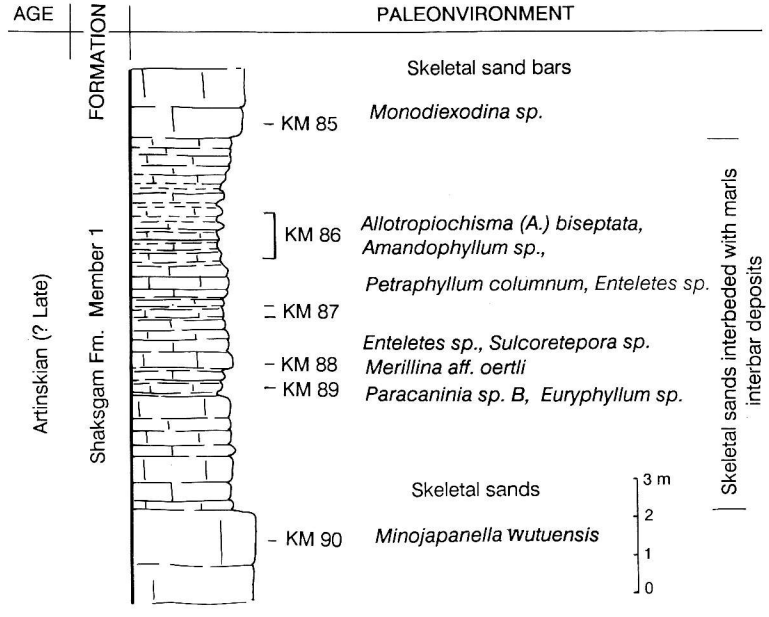

Fig. 4 - The short Staghar section was measured within a very thick development of the first member of the Shaksgam Formation.

Comparisons between Hunza and Shaksgam.

Both the stratigraphic sequences are cropping out either at the core of an anticline either of have a thrusted base. Consequently we have no data on their basement.

The Hunza succession at present may be assumed as paradigmatic for the Northern Karakorum. The Sost Unit (Gaetani et al., 1990a) was followed on the field till the Shimshal valley and further east on the satellite imagery till the Sarpo Laggo valley (Fig. 5). There it is included in the Sarpo Laggo-K2 Metamorphics. Beds full with *Monodiexodina* may still be recognized at the Sarpo Laggo-Skamri confluence.

The paleogeographic position of the Shaksgam Sedimentary Belt is more doubtful (Fig. 5). It may further subdivided in three parts (Gaetani et al., 1990b, 1991). Very

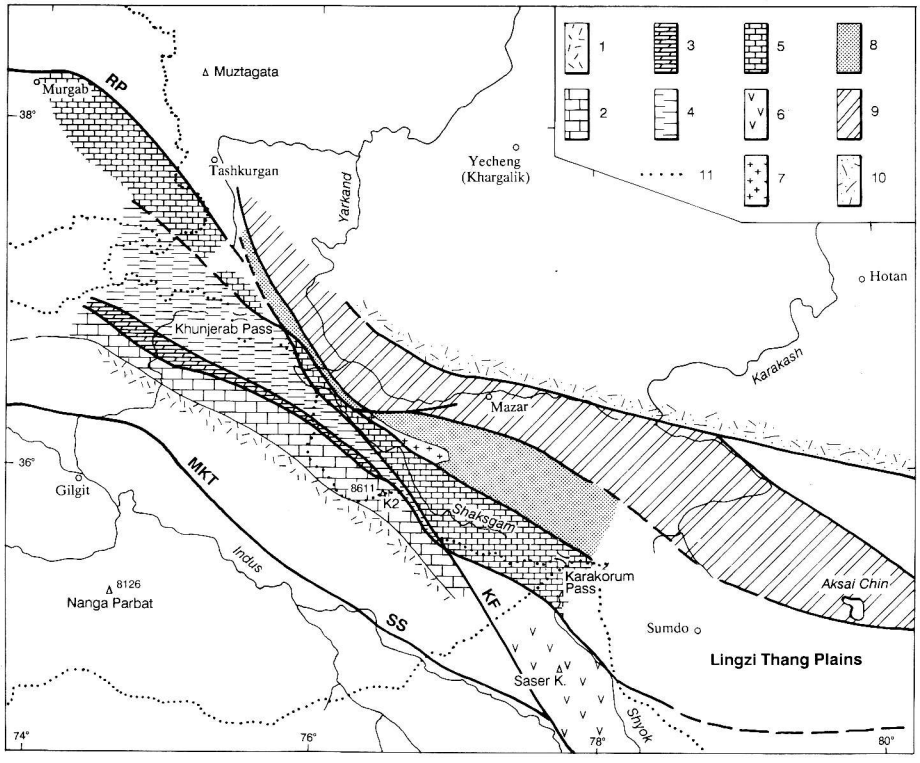

Fig. 5 - Tectonostratigraphic correlations in the area between Karakorum and Kun Lun (from Gaetani et al., 1991). The Hunza fauna derives from the Sost Unit and the Shaksgam fauna was collected in the Shaksgam Sedimentary Belt. 1) Karakorum Axial Batholith; 2) metasediments of the Guhjal Unit; 3) sediments of the Sost Unit; 4) Misgar Slates and equivalent black slates; 5) SE Pamir sediments and Shaksgam Sedimentary Belt; 6) magmatic and metamorphic rocks of Saser Kangri Unit; 7) Aghil Dara Granodiorite; 8) Surukwat Thrust Sheets, mostly metamorphics; 9) Bazar Dara Slates; 10) Kun Lun Crystalline and associated sediments. MKT) Main Karakorum Thrust; SS) Shyok Suture; KF) Karakorum Fault; RP) Rushan Pshart Suture.

tentatively, the southernmost part may be correlated with the Misgar Unit of Hunza. The other two, lying north of it, are tentatively correlated with SE Pamir. It should be also noted that Jurassic sequence of the Shaksgam Sedimentary Belt has a red sandstone unit similar to that which characterizes the Qiantang microplate (Leeder et al., 1988). The Sedimentary Belt is also dismembered by the Karakorum Fault Zone, making further difficulties to the correlations.

In conclusion, the two areas have a similar evolutionary pattern: i.e. the marine transgression on a alluvial wedge, the shallow-water stage with a carbonate sequence partitioned by a clastic reappraisal, and eventually a deepening with carbonate and siliceous sediments in which huge resedimentation episodes may occur. However, the timing of the events is not exactly equivalent.

As far as the Rugosa are concerned, they were both found in the intermediate unit. However, in Hunza they lie above the clastic member, whilst in Shaksgam below the clastic member.

Chronostratigraphy.

Bio- and chronostratigraphic evidence may derive from the Rugosa itself, from fusulinids and conodonts found in the Panjshah and Shaksgam Formations. Instead, brachiopods and other small foraminifers are not yet fully studied and their constrain is too large.

The fusulinids (identified by M. Pasini, Siena) collected in the Panjshah Formation, some 300 m below the Rugosa, are dominated by *Monodiexodina wanneri* and point to a Middle/Late Artinskian age. The fusulinids lying 30-70 m above the Rugosa indicate a Kubergandian age, whilst the conodonts which follows (*G. idahoensis*) should point to a Murgabian age.

In the Shaksgam Formation, the Rugosa were collected some 60 m below the first fusulinids of Artinskian age, in the Urdok Doors section. At the very to of the Member 2, 160 m above the Rugosa level, a *Boultonia* species, thought not trespass the topmost Artinskian, was collected. In the Staghar section, a possibly higher level, within the Artinskian, is recorded.

The Rugosa may be assigned to the so-called *Lytvolasma* fauna, which spans from the Sakmarian to the Kubergandian, being always older than the *Neoschwagerina* fusulinid assemblage.

In the present stage of Permian bio- and chronostratigraphy we cannot go further in the age assignement. However, the following points may be established:

1) The solitary Rugosa fauna described in Flügel (1990) is older than the appearance of the *Neoschwagerina* fauna and hence it is older than the Murgabian.

2) All the Shaksgam, and possibly the Hunza findings are older than the *Misellina-Cancellina* assemblages, hence older than the Kubergandian.

3) Due to different position in the stratigraphic sequence, the Rugosa doesn't belong to a single level, but at the present it is not possible to better constrain their age within the Artinskian.

Palaeobiogeography.

The coral fauna of Hunza and Shaksgam is characterized by small, solitary Rugosa, typical for the Early Permian *Lytvolasma* province, sensu Wu (1975). Instead, massive Rugosa of the contemporaneous *Polythecalis-Stylidophyllum* province are totally missing. Corals of the *Lytvolasma* have been recorded from Central Iran (Lower Jamal Fm.; Flügel, 1972), Lhasa microplate (Ria Fm.; Lin Baoyu, 1984; Smith & Xu, 1988, p. 709; Jialeshan Kou Fm.; Lin Baoyou, 1984), NW Tibet, Ali Mountains (Yangweishan Fm.; He & Weng, 1983), Himalaya Range (Dolpo; Flügel, 1966; Smith & Xu, 1988), Allochthonous Nappe of Timor (Schouppé & Stacul, 1955, 1959; Audley Charles, 1965) and the Lower Permian of Kunlun Plate (Zhao Jia-Ming & Zhou Guang-di, 1987). The *Lytvolasma* fauna is interpreted as belonging to a cold- or temperated water realm. During the Maokou stage (sensu Khaler, 1974, roughly corresponding to the Murgabian), this fauna was replaced in Eastern Iran (Shotori Range; Flügel, 1972) and Tibet (Lhasa microplate; Smith & Xu, 1988; Xiala Fm. of Xainza; Lin Baoyu, 1984) by different elements of the *Waagenophyllum* fauna sensu Minato & Kato (1965), like *Iranophyllum, Wentzelloides, Lonsdaleiastraea* etc. Whereas south of the Indus-Yarlung Suture, in the Himalaya Range (Langco Fm., Selong Fm.; Lin Baoyu, 1984) and in Timor (Fedorowski, 1986; Schouppé & Stacul, 1955, 1959) the *Lytvolasma* fauna persisted during the Middle Permian. Like the *Polythecalis* fauna, the *Waagenophyllum* fauna was a warm-water fauna. It is possible that the significant change of the faunal character coincides with the a widespread Middle Permian facies changing, producing the carbonate platforms in Oman (Al Jil Fm.; Blendinger & Flügel, 1990), in Iran (Ruteh Lmst.; Assereto, 1963 and Upper Jamal Fm.; Flügel, 1972; *Neoschwagerina* Lmst.; Flügel, 1991), in Afghanistan (Kotal-e-Tera; Flügel, 1965), in Turkey (? Ala Dag Lmst.; Flügel, 1955) and the southern part of the North Pamir (Pyzhanov, 1965). For most of the Karakorum and Shaksgam instead, the Middle Permian coincides with the drowning to deep-waters.

The character of the Early Permian (Artinskian) *Lytvolasma* fauna was controlled either by the water-depth either by the primary latitude and temperated water. The diversity of the fauna should exclude the first possibility, and an higher primary latitude should better explain the occurrences (Wang Yu-Wing & Mu Xi-Nan, 1981) of this province. This is also in accordance with palaeomagnetic data of the Carboniferous of the Kun Lun Terrane (Jinlu & Watts, 1988; Dewey et al., 1988). Therefore, the present findings could point to a Peri-Gondwanian fringe palaeoposition of this coral-Province during the Early Permian.

Whereas Smith & Xu (1988) pointed out that along the Himalaya-Kunlun section (Lhasa-Golmud), the different distribution pattern of the coral, fusulinid- and brachiopod fauna during the Artinskian could be explained as a product of the latitudinal gradient, Jin Yu-Gan (1981) suggested that the Permian lithological and faunistic change from south to north was the result of ecological factors in connection with an environmental change from an onshore- to an offshore-facies. From the point of view

of the coral provinces, both explanations seems to be possible only for the Early Permian (Artinskian) time, not for the Murgabian. During this latter time, two different coral provinces existed, separated by the sea-way presently squeezed in the Indus-Yarlung suture. To the north, the warm-water *Waagenophyllum-Iranophyllum* province occurred, whilst to the south laid the temperate-water *Lytvolasma* province (Lin Baoyu, 1984). Consequently the coral fauna cannot help for correlating the Karakorum and Shaksgam area to a single terrane or microplate of the Lhasa-Golmud transect.

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Repository of the coral fauna described in Flügel (1990).

The fauna is stored in the Museum of Palaeontology, Milan University, with the following registration numbers.

Yatsengia hangchowensis Huang	No. 6584
Paracaninia similis (Schindewolf)	No. 6585, 6586
Paracaninia sp. *A.*	No. 6587, 6588
Chaetetes sp. ind.	No. 6589
Duplocarinia sp. ind.	No. 6590
Ufimia hunzensis Flügel	No. 6591
Lophophyllidium (Lophbillidium) martini (Schouppé & Stacul)	No. 6592
Verbeekiella australis (Beyrich)	No. 6593
Allotropiochisma (? Allotropiochisma) biseptata Flügel	No. 6594
Amandophyllum (?) sp. ind.	No. 6595
Petraphyllum columnum Flügel	No. 6596
Paracaninia sp. B	No. 6597
Euryphyllum sp. ind.	No. 6598
Petraphyllum hunzaianum Flügel	No. 6599
Paracaninia sp. ind.	No. 6600

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