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The Sefid Kuh Limestone – A Late Lower Triassic Carbonate Ramp (Aghdarband, NE-Iran)

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With 3 Text-Figures and 2 Plates

NE-Iran
Aghdarband
Triassic
Scythian
Anisian
Eustatic Sea Level
Geodynamics

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Zusammenfassung

Nach dem weltweit einschneidenden Perm-Trias-Ereignis bildete sich mit der Sefid Kuh Formation erst in der oberen Untertrias wieder eine mächtigere Karbonatsequenz. Zusammen mit typischen Untertrias-Foraminiferen konnten hier zum ersten Mal auch Dasycladaceen (*Acicularia* sp.) gefunden werden.

Oolithische und peloidale grainstones und packstones, stark bioturbate mudstones (= „Wurstelkalke"), Crinoiden („*Holocrinus* sp."), packstone Tempestite und algal boundstones bauen in mehreren shallowing upward Parasequenzen eine Karbonatrampe auf.

Die Sefid Kuh Formation insgesamt ist das Produkt eines Transgressions-Regressionszyklus. Nach conodonten-stratigraphischen Untersuchungen setzt der Zyklus mit dem Spathian ein und endet mit dem ?Aegean/Bithynian. Vergleiche mit zeitlichen Sequenzen im westlichen Tethysraum zeigen, daß dieser T-R-Zyklus wahrscheinlich eustatischer Natur ist.

Geodynamische Überlegungen von R. BRANDNER führen zum Schluß, daß zur Zeit der Permotrias der nördliche paläozoische Tethysozean im untersuchten Raum zur Gänze subduziert war.

Abstract

After the worldwide drastic Permo-Triassic event, a thick sequence of shallow-water carbonates, i.e. the Sefid Kuh Formation, was formed before the late Early Triassic. For the first time dasycladacean algae (*Acicularia* sp.) were found there, together with foraminifera which are typical of the Lower Triassic.

A carbonate ramp is formed by several parasequences, each of them shallowing upwards and consisting of grainstones and packstones, being oolithic and/or pelletoidal, mudstones being strongly affected by bioturbation ("Wurstelkalk", "vermicular limestone"), crinoids ("*Holocrinus* sp."), packstone-tempestites, and algal boundstones.

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The Sefid Kuh Limestone Formation as a whole is the product of a transgressison-regression cycle. According to conodont-stratigraphical studies, this cycle set in at Spathian times and came to an end in ?Aegean/Bithynian times. This T-R-cycle is probably of eustatic nature, as comparisons with coeval sequences of the western Tethys realm show.
Geodynamic considerations of R. BRANDNER result in the conclusion that in the area studied the northern Paleozoic Tethys ocean was entirely subducted already in Permo-Triassic times.

1. Introduction

The Sefid Kuh Limestone Formation is part of the first of three depositional sequences (in the sense of HAQ et al., 1987), which are separated from each other by distinct unconformities in the Lower Anisian as well as in the Carnian.

Differing from all other Triassic sequences of Iran, the marine sedimentation starts in the Aghdarband area not before the Late Scythian with the Sefid Kuh Limestone. These shallow water limestones overlie unconformably extremely thick Permo-Triassic alluvial plain and marginal marine siliciclastic sediments (Qara Gheitan Formation). The base of this lowermost sequence of clastic rocks is the Hercynian metamorphic basement (cf. RUTTNER, this vol.).

Comparisons with other well dated Permo-Triassic sequences of the western Tethys realm suggest that sea evel fluctuations occurred at that time.

With the Sefid Kuh Limestone, shallow-water carbonates of some thickness accumulated in the form of a "ramp" for the first time after the Permo-Triassic event. In view of the worldwide disappearance of many carbonate-producing organisms – especially that of reef organisms – in the Early Triassic, a detailed analysis of this carbonate sequence, which is well dated by conodonts, seems to be of special interest.

The most complete succession of the Formation is exposed at the NW-slope of the Sefid Kuh mountain (cf. Fig. 1), about seven kilometers to the west of the Aghdarband village. Because of the general plunge of the Aghdarband Syncline towards ENE, the basal parts of the Formation outcrop there at the surface. Towards the east the Sefid Kuh Limestone occurs only at the tectonically disturbed northern strike-slip margin of the syncline (Slice II) and – also tectonically amputated – east of the Aghdarband village at the northern border of another syncline (Slice III), cf. RUTTNER (this vol.) and BAUD et al. (this vol.).

Two of the present authors (A. B. and R. B.) measured sections at Sefid Kuh independently from each other in 1972 and 1977 respectively; these sections are combined here to a joint type section. A short section, measured by A. RUTTNER at the base of the Formation, is included in this type section.

Text-Fig. 1.
NW-slope of the Sefid Kuh. A, B, C, D refer to subunits in the type section (Text-Fig. 2).
T = volcanic litharenit. The thick line indicates the location of the detailed section shown in Fig. 3 at the base of the Sefid Kuh Fm. C = conglomerate of the Qara Gheitan Fm.
Photo by A. RUTTNER.

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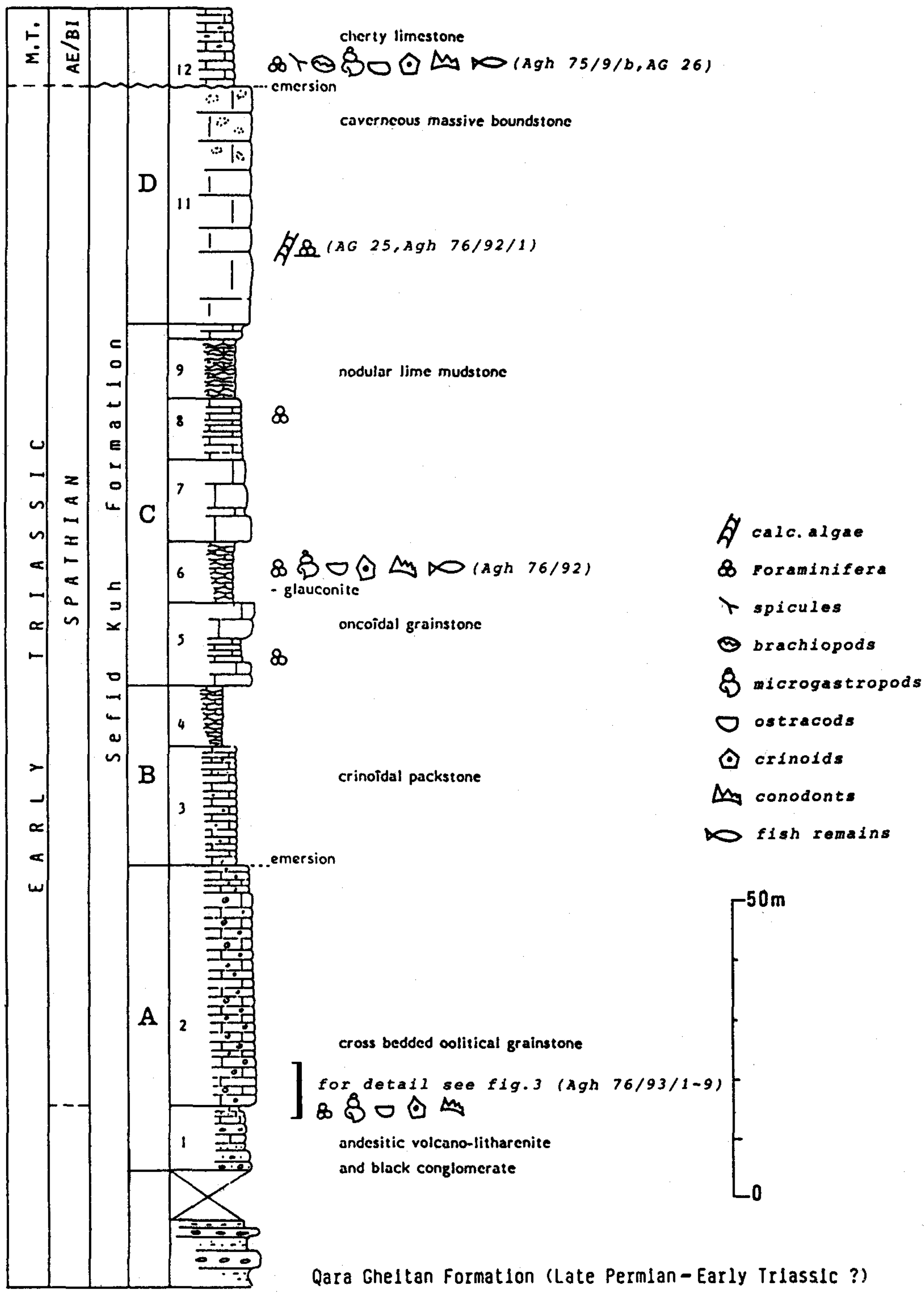
2. Description of the Sefid Kuh Limestone

The general aspect of the Sefid Kuh Limestone is described by RUTTNER (this vol.). This Formation, about 200 meters thick in the Sefid Kuh area, is subdivided into 4 subunits (A–D) and represents one main transgressive-regressive cycle (Fig. 1). It lies unconformably (sequence boundary) on the Qara Gheitan Formation, but in the Sefid Kuh area, the contact between the two formations is mostly obscured by overlying scree.

2.1. Subunit A

The basal part (1) is illustrated in Fig. 1. It consists of dark green to black coarse-grained volcanic litharenite, andesitic in composition (BAUD et al., this vol.) and black conglomerate, about 15 m in thickness (RUTTNER, this vol.).

There is a transition to the overlying oolitic limestone. The main part (2) of subunit A consists of thick-bedded, cliff-forming (about 40 m), cross-bedded oolitic grainstone (Plate 2, Fig. 5; see also A. RUTTNER, this



Text-Fig. 2.
Type section of the Sefid Kuh Fm., NW-slope of the Sefid Kuh.
Remarks on fossil remains are based on investigations on thin sections and insoluble residue.

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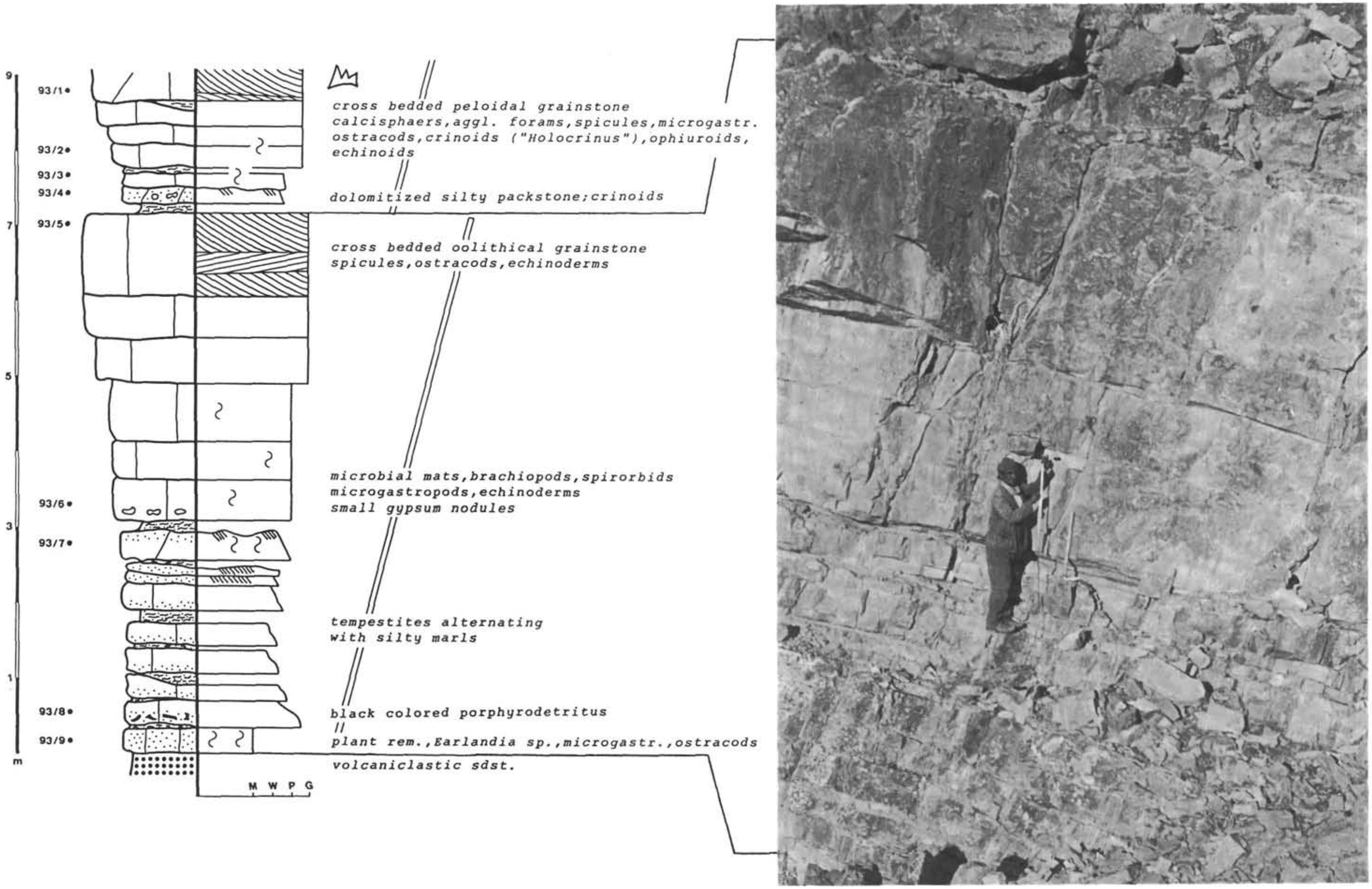

Text-Fig. 3.
Retrogradational parasequences at the base of the Sefid Kuh Fm..
Location of the section in Text-Fig. 1. Mr. Jadollah as scale is about 1.6 m.
Photo by A. RUTTNER.

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vol., Fig. 8). The washed and well sorted, high energy calcarenite is partly recrystallized, with pervasive dolomitization. The diagenetic change suggests a fresh water influx. The poor biota is represented by microgastropods, crinoids, bivalves, ?algal spores and echinoid spines. At the top, solution-cementation suggests emersive conditions.

Particulars of the incipient transgression are shown in Section Fig. 3. A quick rise of the sea-level occurred contemporaneaously with the deposition of volcaniclastic sand, possibly accelerated by tectonic subsidence. The siliciclastic sedimentation changes to a pure carbonatic sedimenation within three meters. This transition is marked by an interbedding of tempestites with thin-bedded silty marls. Fossil-content and microfacies are shown in Fig. 3.

Retrograde parasequences showing cyclic decreasing siliciclastic sedimentation are clearly discernible. Small nodules of gypsum point to a temporary fluctuation in salinity. It was possible to time the beginnig of the transgression by means of conodonts obtained through an extensive investigation of the insoluble residue of limestone samples.

2.2. Subunit B

The dark, thin-bedded limestone, showing a thickness of 25 meters, contrasts with the light yellow massive underlying subunit A. Level (3) consists of platy peloidal and crinoidal packstone. It is overlain by nodular, highly bioturbated calcilutite, i.e. ostracods- and brachiopods-bearing crinoidal mudstone to wackestone, interrupted by thin rhythmites of graded crinoidal packstone (distal tempestite).

The depositional environment is deepening and represents a more distal part of a shallow ramp.

2.3. Subunit C

This subunit is about 70 meters thick. At the base, Level (5) consists of thin-bedded limestone and yellow marl, with brachiopods, and is intercalated between two layers of peloidal-oncoidal thick-bedded packstone to grainstone. Foraminifera, including *Earlandia* sp., *Nodosaria* sp., sponge-spicules, and *Spirorbis* sp., appear there. It is overlain by vermicular limestone (6) interbedded with proximal coarse grained rhythmites, i.e. mainly crinoidal peloidal packstone with ostracods, foraminifera and glauconite. The foraminiferal assemblage consists of *Meandrospira pusilla* (HO, *Cyclogyra mahajeri* BRÖNNIMANN, ZANINETTI & BOZORGNIA, *Glomospira* sp. and *Nodosaria* sp.. *Spirorbis phlyctaena* DAUDIN is also frequent.

The upper part of the subunit, the Levels (7), (8), (9), form a thinning and deepening upward sequence. Level (9) is a highly bioturbated nodular calcilutite.

The depositional environment fluctuates between central and distal parts of the shallow ramp.

2.4. Subunit D

This subunit is a very thick-bedded to massive, cliff-forming, light-coloured limestone. In its upper part appear large solution cavities, 0.5 to 2 m in cross-section, which seem to be of paleokarstic origin. These massive limestones have some analogies with older carbonate mounds. The carbonate producing organisms are calcareous algae (e. g. *Acicularia* sp.) and encrusting foraminifera.

Acicularia sp. is rather frequently found in subunit D. Its proof is one of the most interesting results of the present study in so far as this occurrence of dasycladean algae is world-wide the earliest known after the Permo-Triassic event.

The main facies of the subunit consists of algal boundstone; oncoidal grainstone is also frequent. Emersion at the top is indicated by solution cavities and partial dolomitization. This carbonate mound represents the first Triassic carbonate "buildup". The facies model is changing from shallow carbonate ramp to a carbonate platform. This change occurs close to the Early – Middle Triassic (Spathian – Anisian) boundary.

The Sefid Kuh Limestones are unconformably (= sequence boundary) overlain by thin-bedded calcilutite with chert, and by volcanic sandstone, belonging to the Nazarkardeh Formation. A conglomerate is locally the base of the overlying Sina Formation.

3. Biostratigraphy

Faunas useful for biostratigraphic purposes yielded the samples Agh 76/93/1, 76/92, 75/9/b and AG 26. The samples are collected at the base of the Sefid Kuh Limestone as well as in its middle section and from a horizon that is situated shortly above the top of the limestone, but still below RUTTNER's Fossil Horizon 1 (cf. Figs. 2, 3)

Generally, the fauna is rather scarce and partly also badly preserved. A poor preservation is shown particularly by skeletal material which is less resistant to acids, e.g. Echinoderms. The scarcity of microfossils may be related to the generally small amount of sample material collected.

Conodonts

Neospathodus triangularis (BENDER) 1967
Ellisonia torta SWEET 1970
Ellisonia triassica MÜLLER 1956
Ellisonia cf. *delicatula* SWEET 1970
Gondolella bulgarica (BUDUROV & STEFANOV) 1975.

The joint occurrence of the species *N. triangularis*, *E. torta* and *E.* cf. *delicatula* in sample 76/93/1 is a reliable proof of Late Scythian (Spathian) age. In addition, the combination of the respective stratigraphic ranges of *N. triangularis* and *E. torta* point, according to SWEET (1970b: 313), to a position in the basal segment of the Spathian (Zone 8 [SWEET, 1970]). Sample No. 76/92, containing *E. triassica* can still clearly be ascribed to the Spathian. *G. bulgarica* of the samples Nos. 75/9/b and AG 26, however, point to the boundary range Aegean/Bithynian. Indications for this are the sporadic occurrence of this species in the Upper Aegean of the Asiatic faunal province on the one hand, and its immediate superpositions by Fossil Horizon 1 (*Osmani* Zone of the Bithynian [cf. KRYSTYN & TATZREITER, this vol.]) on the other. However, an exact zonal delimitation is not possible, because of the scattered point-by-point collection of the samples.

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Sample No. Agh 76/82 is collected in the "Schuppen-zone" of the Southern Frame (cf. RUTTNER, this vol.). It yielded two conodonts, i.e.: a damaged specimen of *Neospathodus* which is possibly identical with, or closely related to *N. triangularis* (BENDER), and an indeterminable fragment of a ramiform conodont element. The presence of *Neospathodus* cf. *triangularis* (BENDER; pl. 2, fig. 5) proves, in the first place, Triassic and is, in all probability of late Scythian age.

All conodonts were tested according to the "Color alteration index" of EPSTEIN, EPSTEIN & HARRIS (1977). This test resulted in a classification into order 2 of the color scale, i.e. index 1–½, showing extremely pale-brown colour, which is caused by temperatures between 50° and 90°C.

Here follows a description of two species which is made despite of the small numbers of specimen (2–3 specimen each). The remaining species are represented only by one specimen each and damaged to a degree that only some of the most important characteristics are discernible.

4. Systematic Paleontology

4.1. Conodonts

Order: Conodontophorida EICHENBERG 1930
Genus: *Neospathodus* MOSHER 1968

Neospathodus triangularis (BENDER 1970)

(Plate 1; Figs. 1, 2)

1963 *Spathognathodus triangularis* BENDER – BENDER & KOCKEL, Pl. 54 (1).
1964 *Spathognathodus* sp. A. STAESCHE – p. 289, Pl. 31, Fig. 1.
*1967 *Spathognathodus triangularis* n. sp. BENDER – p. 530, Pl. 5, Figs. 22a,22b,23.
1968 *Neospathodus cristagalli* (HUCKRIEDE) – MOSHER, p. 930, Pl. 115, Fig. 2.
1970 *Neospathodus triangularis* (BENDER) – SWEET, p. 253–254, Pl. 1, Figs. 7,8.
1976 *Neospathodus triangularis* (BENDER) – BUDUROV, p. 99, Pl. 1, Figs. 1–15,17–20.
1979 *Neospathodus triangularis* (BENDER) – SOLIEN, p. 304, Pl. 3.
1979 *Neospathodus triangularis* (BENDER) – PERRY & CHATTERTON, Pl. 2, Figs. 35,36.
1980 *Neospathodus triangularis* (BENDER) – CHHABRA & SAHNI, Pl. 1, Figs. 23,26,29,31a–b,32a–b,34a–b.
1981 *Neospathodus triangularis* (BENDER) – WANG & DAI, Pl. 1, Figs. 10–11.
1983 *Neospathodus triangularis* (BENDER) – GUPTA, Pl. 1, Fig. 6.
1983 *Neospathodus triangularis* (BENDER) – MATSUDA, p. 93–94, Pl. 3, Figs. 5–9.
1984 *Neospathodus triangularis* (BENDER) – MOSTLER & ROSSNER, p. 115, Pl. 18, Figs. 9–10.
1984 *Neospathodus triangularis* (BENDER) – HATLENBERG & CLARK, p. 112, Pl. 3, Fig. 15.
1985 *Neospathodus triangularis* (BENDER) – MATSUDA, Pl. 1, Fig. 11.
1986 *Neospathodus triangularis* (BENDER) – PERRI, p. 25, Pl. 1, Figs. 1a–c.
1987 *Neospathodus triangularis* (BENDER) – PERRI & ANDRAGHETTI, p. 311–312, Pl. 33, Figs. 1–5.

Remarks: Both specimen represented on Plate I show the morphology being specific for this species, i.e. a short blade, particularly in relation to the entire heigth of the conodont. The posterior denticles are inclined to such a degree that the blade projects over the boundary of the base (side-view and view from below). The denticles are of the same height, with exception of both the first and the last elements which are slightly shorter than the rest. The number of denticles, being very variable in general (4–14), is small, as far as the material in question is concerned. This number is 8 in case of the holotype, and 9 in case of the paratype; the average number of denticles is 8, as far as the whole of specimens hitherto described is concerned. PERRI (1987) published specimens derived from the Werfen Formation of the Southern Alps (plate 33) which are in particular rich in denticles (10–14).

○ The medio-lateral rib described by SWEET (1970: 253) as a well developed bladed element can not be regarded to be a constant characteristic feature of this species (according to an analysis of the author's own material as well as of that represented in publications – cf. also A. MATSUDA, 1983:94).

○ The basal cavity occupies the posterior half of the conodont resembling in its whole morphology an isosceles triangle. The concentric lamellar conodont elements extend from a small cavity which is excentrically situated rather close to the posterior end and passes over to a deep groove in the direction of the anterior end.

Occurrence: Aghdarband (NE–Iran), Sefid Kuh Section, Sample No. Agh 76/93/1.

Age: Early Triassic (Spathian).

Material: 3 specimens.

Repository: collection of Aghdarband samples (Agh, AG) and REM1 – Department of Geology and Paleontology, University of Innsbruck (Austria).

Gondolella bulgarica (BUDUROV & STEFANOV 1975)

(Plate 2; Figs. 1–3)

1958 *Gondolella navicula* – HUCKRIEDE, p. 174, Pl. 11, Figs. 1,14.
1970 *Neogondolella regale* – MOSHER, Pl. 110, Fig. 2.
*1975 *Paragondolella bulgarica* n. sp. – BUDUROV & STEFANOV, p. 794, Pl. 1, Figs. 1–23.
1976 *Neogondolella bulgarica* (BUDUROV & STEFANOV) – NICORA, p. 639, Pl. 84, Figs. 11,13–16.
1979 *Paragondolella bulgarica* BUDUROV & STEFANOV – BUDUROV & GANEV, Pl. 1, Figs. 1–7.
1980 *Gondolella bulgarica* (BUDUROV & STEFANOV) – SZABO et al., p. 804, Pl. 59, Figs. 7.
1980 *Neogondolella bulgarica* (BUDUROV & STEFANOV) – PISA et al., p. 817–818, Pl. 61, Figs. 1,2,5,10–12, non 3,4,6–9; Pl. 61 on Fig. 1.
1980 *Gondolella bulgarica* (BUDUROV & STEFANOV) – KOVÁCS & KOZUR, Pl. 2, Figs. 1,2.
1983 *Neogondolella bulgarica* (BUDUROV & STEFANOV) – KOLAR-JURKOVSEK, p. 337–338, Pl. 8, Figs. 3a,b,c.
1984 *Gondolella bulgarica* (BUDUROV & STEFANOV) – FARABEGOLI et al., p. 37, Figs. 4a,b.
1968 *Gondolella bulgarica* (BUDUROV & STEFANOV) – KOVÁCS & PAPSOVA, p. 66, Pl. 1, Fig. 6; Pl. 2, Fig. 5; Pl. 3, Figs. 2,3.

Remarks: A rather broad platform, its ledges being slightly bent upwards and only rarely showing a lobate to rounded form. The extent to which the platform narrows forward and backward, is dependent on the specimen, but it always ends with a point at both poles. The platform encloses the carina entirely at the anterior side; at the posterior side the last

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denticle mostly protrudes, but it may also be enclosed by the slightly rising platform.

At the second half of the conodont, the denticles of the carina are always rearward inclined. The keel is high showing a rather deep basal groove. The basal cavity is terminally situated, slightly rounded, deep. The posterior basal plane has the form of a triangle.

Occurrence: Aghdarband (NE-Iran), Sefid Kuh Section – Samples Agh75/9/b, AG26.

Age: Early Middle Triassic (Late Aegean).

Material: 3 specimens.

Repository: Collection of Aghdarband samples (Agh, AG and REM), Department of Geology and Paleontology, University, Innsbruck (Austria).

4.2. Remaining fauna

The fauna obtained from the insoluble residue shows the following composition:

- Foraminifera
  Agglutinated tests are present in all samples.
- Spicules of Poriferans
  Found solely at the base of the Formation (within the first 8 meters): they are of the hexactine, oxyhexactine and pentactine type, partly pyritized.
- Microgastropodes
  They represent the only group of molluscs found in the samples; predominantly trochiform conchs.
- Ostracods
  They are present generally as internal casts, and rarely only as isolated valves.
- Echinoderms
  Preserved are spines of Cidaris-type, frequently ambulacral plates, and rarely also elements of the Aristotele's lantern (denticles, bows).
  Stem-fragments of crinoids are no rarity; they show partly well preserved articular facets. Of special interest is the discovery of columnalia showing pentamerous articular facets in the shape of a particular star-like feature (Pl. 1, Fig. 3). MOSTLER & ROSSNER (1984: 115) described similar columnalia derived from the Spathian of the Northern Calcareous Alps. The material was handed over by the authors for further studies to Dr. SIEVERTS-DORECK; according to preliminary results, it is a question of a new species of the genus "*Holocrinus*" (oral communication). Mass occurrences of these columnalia are reported also from the Cencenighe Member, Werfen Formation, of the Southern Alps (BROGLIO-LORIGA et al., 1983).
  Laterals of Ophiurides are abundant, mostly derived from proximal and median arm-sections. All of them show well visible tentacle pores. One specimen belongs probably to a taxon which is not yet established.
  Sclerites of Holothurians were not found in the Sefid Kuh Section.
- Fish-remnants
  In all samples are to be found well preserved fish-teeth and toothplates, scales and fin-spines.
- Megafossils
  Sample Agh 76/52 collected in the scree at the base of Sefid Kuh Limestone yielded a poorly preserved valve of *Eumorphotis* sp.; it is the only determinable megafossil collected in the Sefid Kuh Formation. The possible species are either *E. kittli* (BITTNER or *E. telleri* (BITTNER). The absence of radial ribs as well as the elongated shape of the valve favours *E. telleri*. This species is associated with *Dinarites* in the Upper Werfen Formation (Cencenighe Member) of the Southern Alps (BROGLIO LORIGA & MIRABELLA, 1986).

5. Comparisons and Conclusions

The Sefid Kuh Limestone Formation is lying on top of a partly extremely thick stratigraphical sequence which is called "Hercynian Molasse" in the area to the north of the Northern Iranian oceanic Suture-Zone. This sequence, being partly shallow marine, partly continental, reaches – according to STÖCKLIN (1984) – a thickness of several thousand meters in places. Base and top of the sequence are formed by unconformities.

An unconformable superposition of this sequence on a metamorphical and folded Hercynian basement is recorded by MAJIDI (1978) from the Binalud mountain range. There, the basement is composed of fossil-bearing limestones of Permo-Carboniferous age. An uplifting of large areas in the north (e. g. of the South Caspian region [DAVOUDZADEH & WEBER-DIEFENBACH, 1987]) results in a removal of large quantities of debris and in the accumulation of the latter (Qara Gheitan Formation) in foreland basins to the south of the Hercynian orogenic belt.

Unlike BAUD & STAMPFLI (1989), one of us (R. B.) is of the opinion that already in the Permian, the Iranian Plate must be positioned close to the Hercynian Turan Plate, i. e. that in this area the Northern Paleozoic Tethys ocean was entirely subducted in Permo-Scythian times. Just in the Lower Permian, shallow-water carbonate detritus (crinoidal grainstone with fusulinaceans) was transported by gravity flows from continental areas in the closin oceanic realm (see KOZUR & MOSTLER, this vol.) This view is also favoured by the fact that a geodynamic-stratigraphic sequence, comparable to that as described above, was also deposited on the Iranian Plate. According to the compilation made by DAVOUDZADEH & WEBER-DIEFENBACH (1987), the Permo-Triassic sedimentary cycle commenced there also by a widely-spread basal unconformity. Only a northern provenance comes into question there for the red, clastic sediments (Dorud Formation) at the base of this cycle. It is true that a shallow marine carbonate facies predominates further on; but this can be simply explained by the existence of a northerly foreland basin which accumulated the terrigenous debris material. In fact, the thickness of the clastic sediments, and the clastic influx respectively, increase towards the north at the northern margin of the Iranian Plate in the Upper Paleozoic, as, e. g. STEPANOV et al. stated already in 1969.

The conspicuous structural uplift of Permian age in the South fits in well with the concept of a flexur-like ("epirogenetic") deformation of the crust in foreland-zones (see, e. g. TANKARD, 1986). Basin subsidence and peripherical upwarping of the lithosphere are a response to the Hercynian thrust-belt loading. The wide-spread paraconformities in the Permian, accompanied partly with the deposition of bauxite (ALTINER et al., 1979; BRANDNER et al., 1981) are the result of these

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tectonic movements. A very important uplifting of this kind occurred at the Permian-Triassic boundary. Tectonic folding of Middle- to Late Permian age was proved by THIELE (1973). Extensive tectonic deformations in zones of subsidence are accompanied locally by volcanism: e. g. in the Alborz Mountains in the Middle Permian (STEPANOV et al., 1969: 45), or at the base of the Qara Gheitan Formation at Aghdarband.

However, such a type of foreland-tectonics as described above is conceivable only in close contact with the Hercynian belt. If this is acceptable, there would be invalid all those reconstructions which assume a more or less wide ocean still existing in Permo-Triassic times, separating the Turan Plate from the Iranian Plate. In this view, the Triassic basin of Aghdarband is not a remainder of the northern, Paleozoic Tethys but a new intracontinental basin, most probably developed in a strike-slip regime. A detailed other point of view (back arc geodynamic model) is given in BAUD & STAMPFLI (this vol.).

A reasonable facies-relationship can also be shown with respect to the Lower Triassic. The red calcareous shales of the Sorkh Shale Formation in Central Iran (RUTTNER et al., 1968), as well as the red sandstones and conglomerates at the base of the Alam Formation at Nakhlak (DAVOUDZADEH & SEYED-EMAMI, 1972) can be well correlated with the Qara Gheitan Formation of the North, after a retrograde rotation of the Central East-Iran Microplate (DAVOUDZADEH, SOFFEL & SCHMIDT, 1981). With that, the typical Werfen-facies of the Lower Elikah Formation of the Alborz Mountains would have to be positioned at a distal foreshore-position. This suggests a comparison with the Lower Triassic of the Northern and Southern Alps, and with the facies-association "Alpiner Buntsandstein" – Werfen Beds (BRANDNER et al., 1984).

The reason of this similarity is obviously due to a comparable tectogenetic development, and to the effect of eustatic changes of the sea level. Stratigraphical studies based on conodonts at the type section of the Elikah Formation (MOSTLER, in LESSANI, 1979) resulted in an amazingly exact correlation of at least two events of transgression, followed by a regression in each case:

1) The Siusi (Seis) transgression
   and
2) the Val Badia transgression.

The Val Badia transgression event was the cause of the built up of the Sefid Kuh Limestone ramp of Aghdarband. Equally, the facies change of Member 1 to Member 2 of the Alam Formation, exposed far away at Nakhlak, can be correlated with this transgression event. Typical Spathian ammonites, as *Tirolites cassianus* (TOZER, 1972) permit the correlation with the conodont association in the Elikah section (*N. triangularis*, LESSANI, 1979). Using sequence-stratigraphic comparisons, this transgression-event can also be found in the eastern Alborz Section ("Ghosnavi") of STAMPFLI et al. (1976). There, the facies change of "calcaires colores" Member to "Calcaire gris" Member seems to correspond to the Badia transgression.

The sequence boundary at top of the Sefid Kuh Formation – indicating a considerable regression in Late Scythian–?Early Anisian time – seems to be also of eustatic nature. As equivalents can be regarded a distinct shallowing in the Elikah Formation (ALTINER et al., 1979), as well as thick evaporites at top of the Sorkh Sahle Formation in Central Iran (STÖCKLIN, 1961). Widespread occurrences of evaporites are known also in the Alps at top of the Cencenighe Member of the Werfen Formation and at the base of the Reichenhall Beds ("Haselgebirge", p. p.) respectively.

This shows that coeval sea level fluctuations are traceable independently of the local development in a specific basin, through which the eustatic nature of these sea level fluctuations is emphasized. However, the conodont-stratigraphic classification as disclosed above requires a few corrections of the Eustatic sea level curve established by HAQ et al. (1987).

Finally, it may be pointed out that only the basal Triassic sequence of Aghdarband is comparable with greatly similar sequences exposed in the Alps; the overlying Middle and Upper Triassic differs strongly from the contemporary development at Aghdarband. Quick subsidence and volcanic activity at Aghdarband prevented the building up of thick carbonate platforms there, being so typical of the Alps.

Formation of basins, geodynamically similar to that of Aghdarband, are found in the area of the Hercynian oceanic suture from Afghanistan (BOULIN, 1988), via Aghdarband, the Great Caucasus and northern Anatolia (Kocaeli peninsula [GÖRÜR & SENGÖR, 1986]) to the Pienninic Zone (KOZUR & MOCK, 1987), i. e.: a typical late transgression in the Scythian, partly a volcanism in the Early Triassic, followed by a short-lived but intensive subsidence in the Middle Triassic and, finally, by an orogenesis in the Upper Triassic – Lower Jurassic.

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Plate 1

Sefid Kuh section, sample Agh 76/93/1.
Sefid Kuh Formation, Aghdarband Group.

Fig. 1: ***Neospathodus triangularis* (BENDER, 1970).**
a) Lateral view.
b) Lateral/oblique view.
c) Lower view.
× 200.

Fig. 2: ***Neospathodus triangularis* (BENDER, 1970).**
a) Lateral/oblique view.
b) Lateral view.
c) Basal/oblique view.
× 200.

Fig. 3: ***"Holocrinus"* n. sp.**
Columnal with crenularium, probably of the proxistele.
× 50.

Fig. 4: ***Ellisonia* cf. *delicatula* SWEET 1970.** Lateral view.
× 180.

Fig. 5: ***Ellisonia torta* SWEET, 1970.**
Lateral/oblique view.
× 200.

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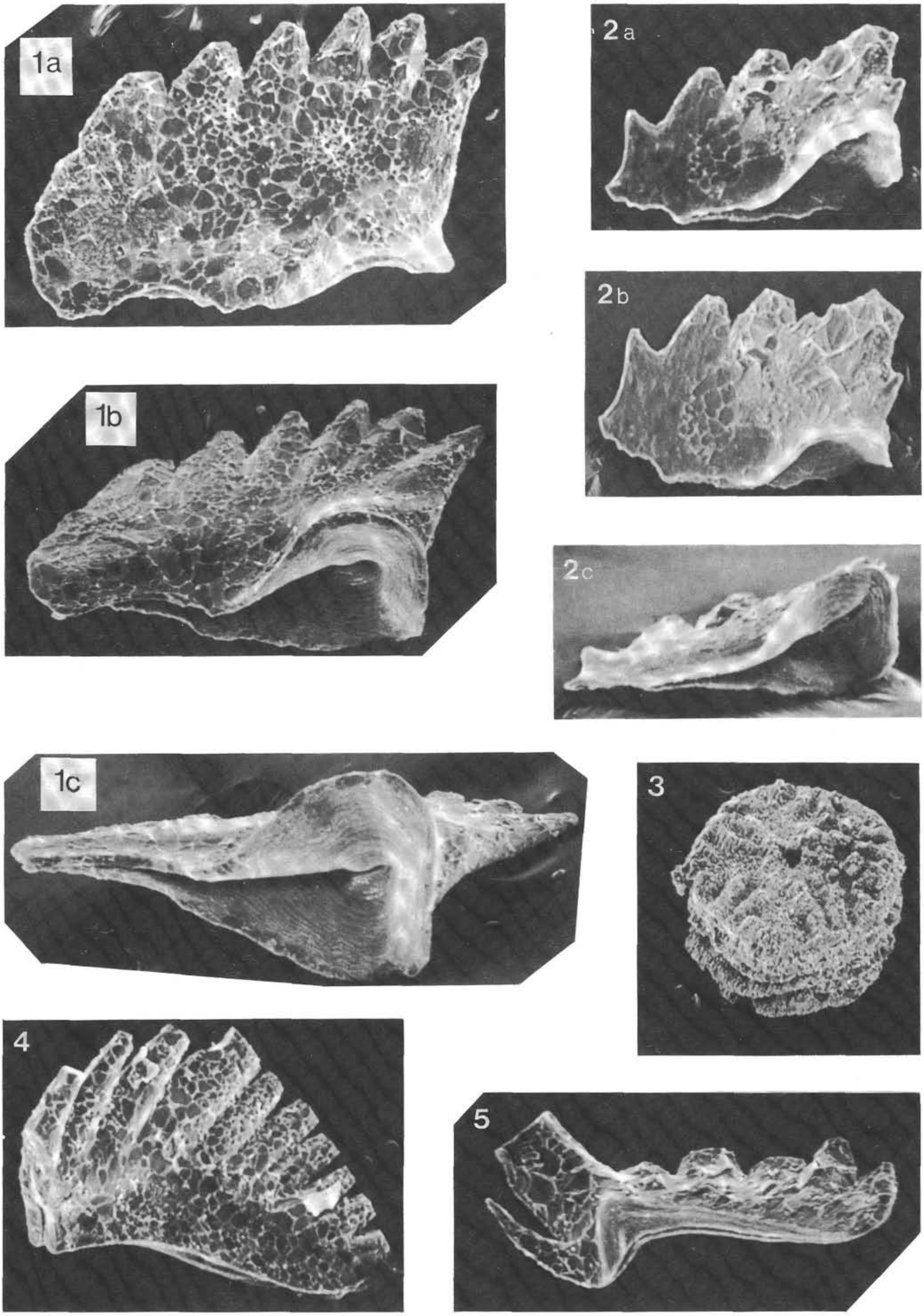

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Plate 2

Fig. 1: ***Gondolella bulgarica*** **(Budurov & Stefanov, 1975).**
Sample Agh 75/9/b.
× 300.

Fig. 2: ***G. bulgarica.***
Sample AG 26.
× 200.

Fig. 3: ***G. bulgarica.***
Sample AG 26.
× 350.

Fig. 4: ***Neospathodus* cf. *triangularis*** **(Bender, 1970).**
a) Lateral view.
b) Lateral/oblique view.
Sample Agh 76/82.
× 200.

Fig. 5: **Partly dolomitized poorly washed grainstone with reworked pisolithes.**
Dasycladacean algae *Aciculella* sp. in the centre.
Sample Agh 76/92/1.
× 12.

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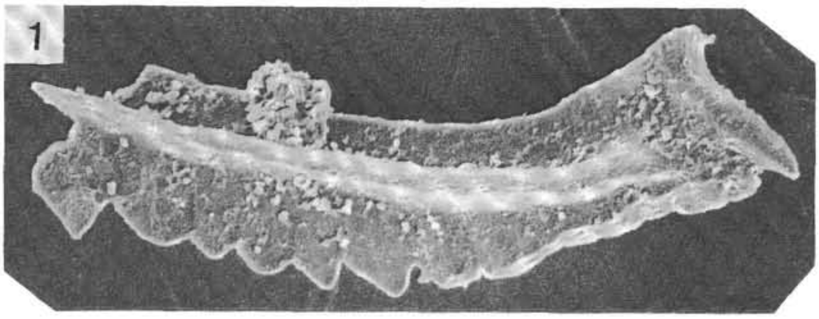

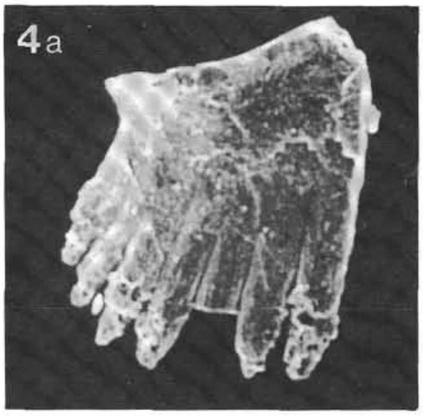

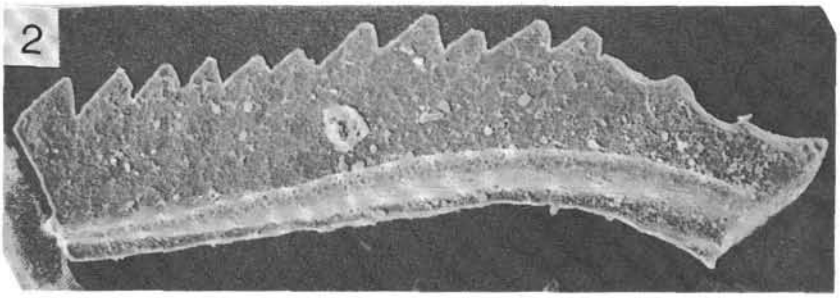

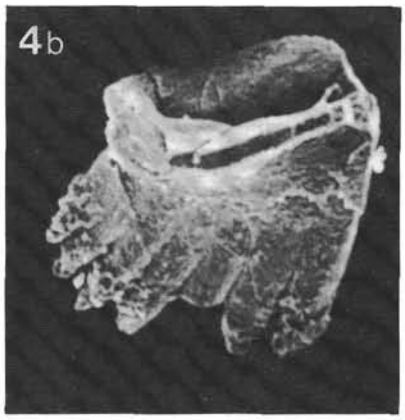

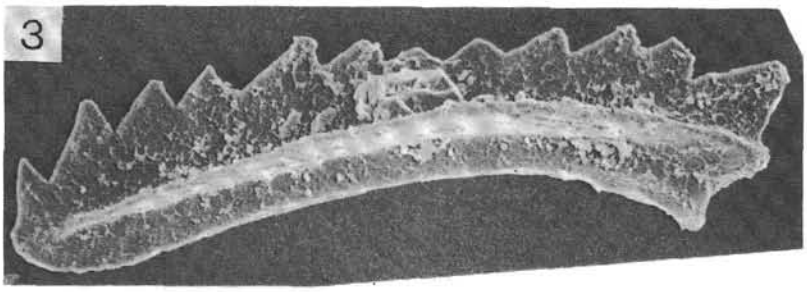

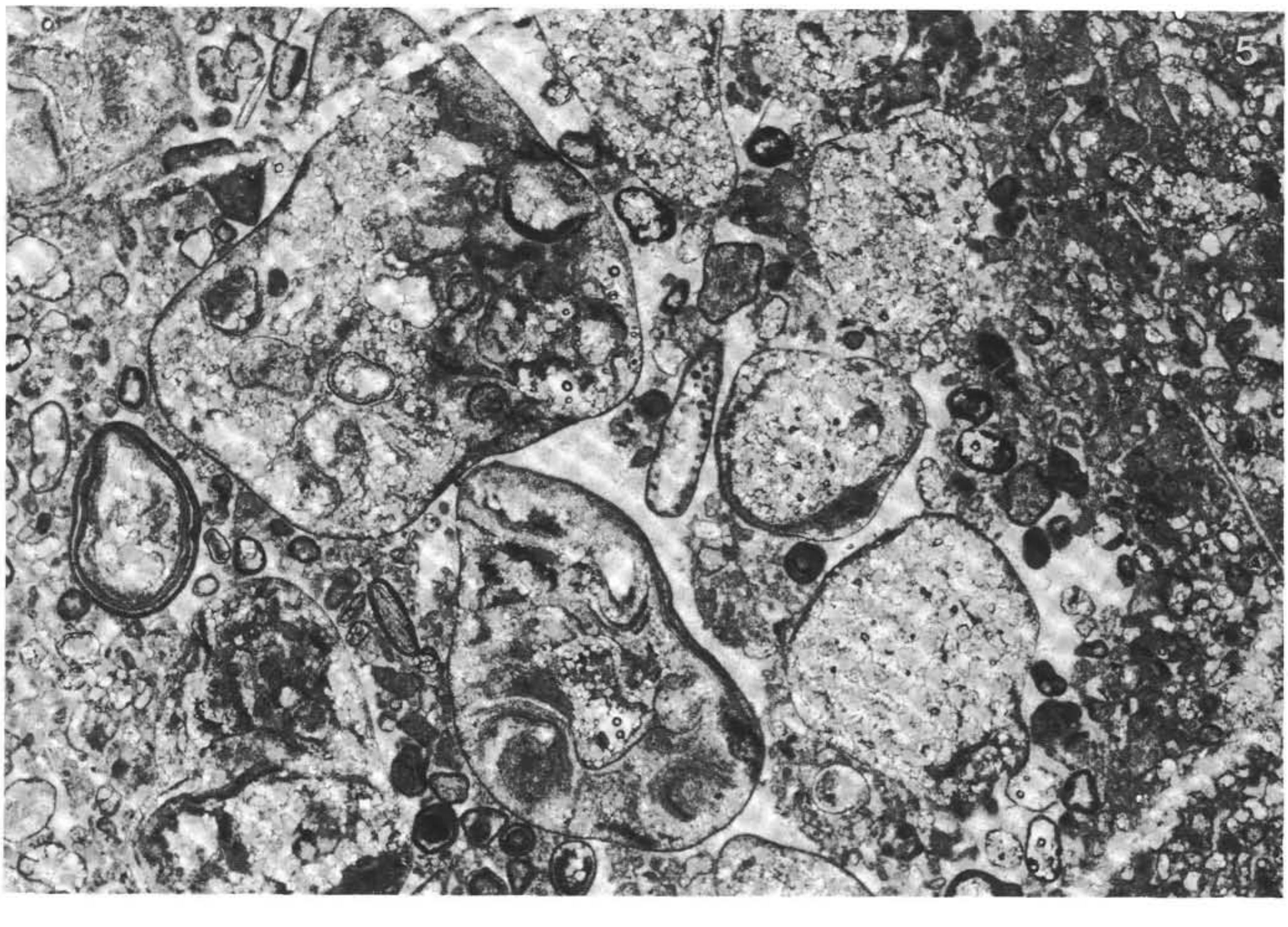

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