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Dating the Horta da Torre Formation, a New Lithostratigraphic Unit of the Ferreira-Ficalho Group, South Portuguese Zone: geological consequences

By

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Key-words: Ferreira-Ficalho Group; Pyrite Belt; spores; acritarchs; ophiolite; collision; strike-slip orogene.

Abstract: The Horta da Torre Formation is a new lithostratigraphic unit in the upper part of the Ferreira-Ficalho Group, a major sequence that crops out in the north limb of the Pulo do Lobo Antiform. Stratigraphical inferences and geochemical affinities suggest that oceanic metabasalts interbedded in the Pulo do Lobo Fm, are lateral equivalents of the Beja-Acebuches ophiolite. This crops out at the South Portuguese-Ossa Morena Zones boundary.

The discovery of lower to middle Famennian palynomorphs in black shales of the Horta da Torre Fm indicates that:

1 — The Ferreira-Ficalho Group is older than upper Famennian, and the underlying Beja-Acebuches ophiolite is possibly of lower to middle Devonian age. The geological setting of this ophiolite may be indicative of a pre-Famennian collision between the South Portuguese and the Ossa Morena Zones.

2 — The stratigraphic sequence of the Pyrite Belt seems to be younger than the South Portuguese-Ossa Morena collisional event. It is suggested that the tectonic deformation of the Pyrite Belt is probably of a strike-slip orogene type.

Resumo: A Formação da Horta da Torre é uma nova unidade litostratigráfica que ocorre no topo do Grupo de Ferreira-Ficalho. Correlações estratigráficas e geoquímicas sugerem que os metabasaltos intercalados na Formação do Pulo do Lobo, a unidade subjacente ao Grupo Ferreira-Ficalho, são equivalentes laterais de Ofiolito de Beja-Acebuches, o qual aflora no contacto ente as Zonas Sul Portuguesa e Ossa Morena.

A descoberta de palinomorfos, do Fameniano inferior a médio, em xistos negros da Formação de Horta da Torre indica que:

1 — Toda a sequência estratigráfica do Grupo de Ferreira-Ficalho é mais antiga que o Fameniano superior, e o Ofiolito de Beja-Acebuches é, possivelmente, do Devónico inferior a médio. A posição geológica deste ofiolito é indicadora de colisão entre a Zona Sul Portuguesa e a Zona de Ossa Morena, antes do Fameniano;

2 — A sequência estratigráfica da Faixa Piritosa parece, portanto, ser mais recente do que a colisão antes referida. Sugere-se que a deformação tectónica da Faixa Piritosa é, provavelmente, do tipo "strike-slip".

INTRODUCTION

The Ferreira-Ficalho Group is a terrigenous sequence that occurs in the north limb of the Pulo do Lobo Antiform, at the boundary between the Ossa Morena and South Portuguese Zones.

The age of this sequence has been a subject of controversy owing to the scarcity of fossils (poorly preserved crinoid ossicles and plant remains). For a long time the rock succession of the Ferreira-Ficalho Group has been considered a single lithostratigraphic unit to which various stratigraphic ages were ascribed, namely: lower Devonian (CARVALHOSA, 1965; TEIXEIRA & THADEU, 1967); upper Devonian (geological map of Portugal, scale 1/500000, 1972); Tournaisian (CARVALHO *et al.*, 1971) and Visean (PFEFFERKORN, 1968; SCHERMERHORN, 1971). More recently D. CARVALHO *et al.*, (1976) divided the sequence into a lower unit, the Ribeira de Limas Formation of upper Devonian to Tournaisian age, and a upper unit, the Santa Iria Formation of Visean age.

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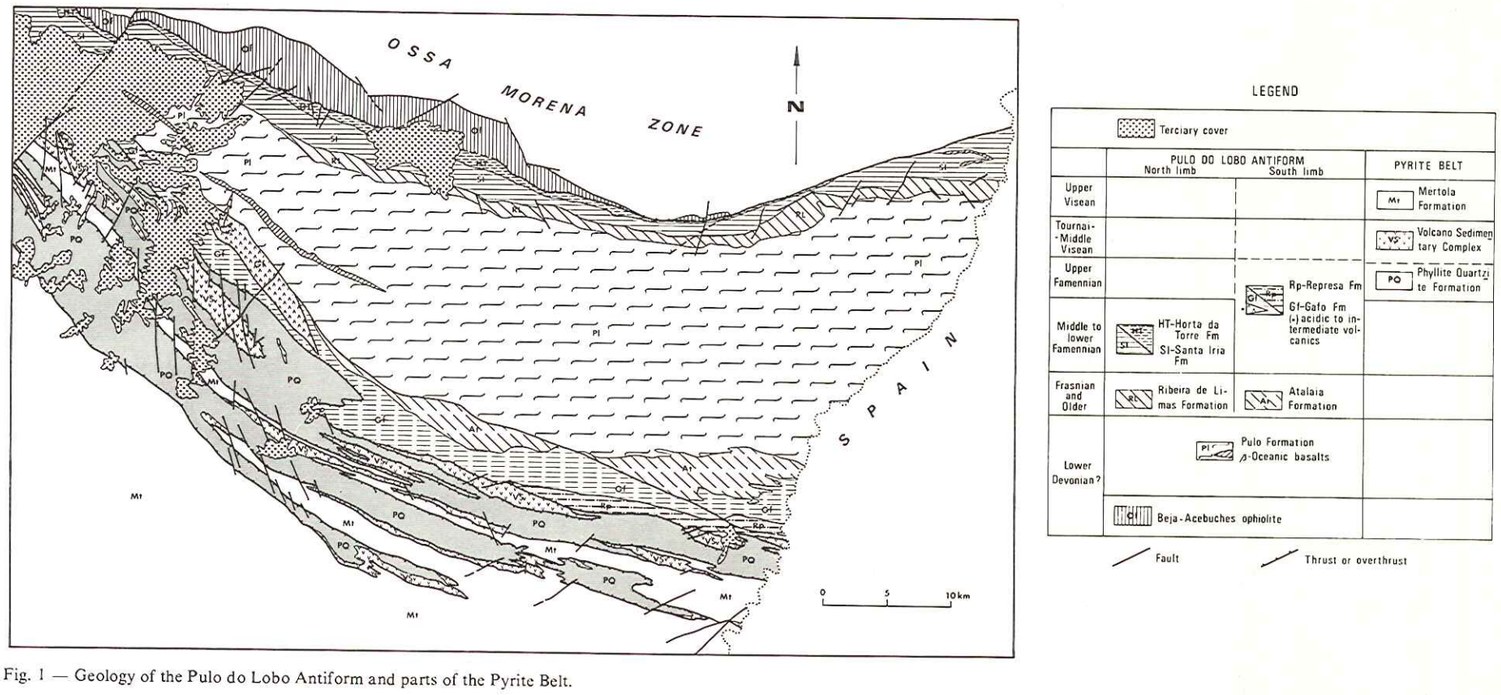

Fig. 1 — Geology of the Pulo do Lobo Antiform and parts of the Pyrite Belt.

A recent revision of the Ferreira-Ficalho Group (Geological Map of Portugal, scale 1/200 000, sheet 8, in press) led to the recognition of a third lithostratigraphic unit, the Horta da Torre Formation, which constitutes the top of that group.

The discovery of lower Famennian palynomorphs in black siliceous shales of the Horta da Torre Fm has important geological consequences and may contribute to a better understanding of the Ferreira-Ficalho Group stratigraphy and its significance within the context of South Portuguese Zone geology.

GEOLOGICAL SETTING

The Ferreira-Ficalho Group is composed, from base to top, of three lithostratigraphic units: the Ribeira de Limas, Santa Iria and Horta da Torre Formations (fig. 1). The first two units were already described by D. CARVALHO *et al.* (1976) and we will refer to their main characteristics only. The Horta da Torre Fm is for the first time described.

— Ribeira de Limas Formation: this unit is made up of thick and thin bedded quartzwackes and shales, with minor tuffitic lenses interbedded. Tectonic deformation consists of three coaxial and NW trending episodes of folding each of which with associated axial plane cleavage. This formation grades downward to the Pulo do Lobo Formation and, according to D. CARVALHO *et al.* (1976), is conformably overlain by the Santa Iria Formation.

— Santa Iria Formation: greywackes, siltstones and shales are the dominant lithologies, forming a flysch-like succession. The greywackes yielded poorly preserved crinoid ossicles and plant remains. The unit is affected by one main NW trending episode of folding with generation of axial plane cleavage. Locally, this cleavage is weakly refolded to open folds.

Tectonism precludes the definition of the Ribeira de Limas and Santa Iria Fms stratotypes and their thicknesses (a figure around 150 m for each is only estimated).

— Horta da Torre Formation: it comprises small scale cross laminated siltstones, fine greywackes and impure quartzites, which are interbedded in dark shales and black siliceous shales. The sandstones maturity becomes higher northward and locally the quartzites are true orthoquartzites. Bioturbation is common.

The unit crops out along the north limb of the Pulo de Lobo Antiform (except where it is truncated by faults) both in Portugal and Spain. The Horta da Torre Formation grades downward and laterally into the Santa Iria Formation and is affected by the same type of tectonic deformation. Again, this tectonism does not allow the characterization of the unit stratotype. A good, although incomplete, reference section is found in a quarry behind the Horta da Torre farm, 3 km SW of Quintos village. Field observations suggest that the thickness of the unit may vary between 50 and 100 m.

The Horta da Torre Fm is bounded to the north by the Beja-Acebuches ophiolitic suite (MUNHÁ *et al.*, 1986), which is now disrupted by left lateral thrusts and late Hercynian faults.

PALYNOLOGY

In spite of a thorough search only samples from three localities (fig. 2) provided rich and well preserved assemblages of spores and acritarchs. The palynomorphs were collected from very fine black siliceous shales interbedded in thin cross laminated siltstones and fine quartzites (locs. A8a, A8c, quarry behind the farm), or from dark siliceous shales (locally weathered to pink or reddish colours) which are interbedded in immature sandstones (locs. A2 and All).

The following specimens were identified (fig. 3 and Plates I, II).

The spore assemblage deserves some comments. The species collected from loc. A2, clearly indicate an upper Frasnian to middle Famennian age range (LOBOZIAK & STREEL, 1981). The spore species from locs. A8a, A8c show an age range from the upper Frasnian to lower Tournaisian. In these localities note however the absence of important upper Famennian guide species, as for instance *Rugospora flexuosa* (Jushko), STREEL (*in* Becker *et al.*, 1974) or *Retispora lepidophyta* (Kedo) Playford 1976. It appears so that all the spore assemblage is of upper Frasnian to middle Famennian age.

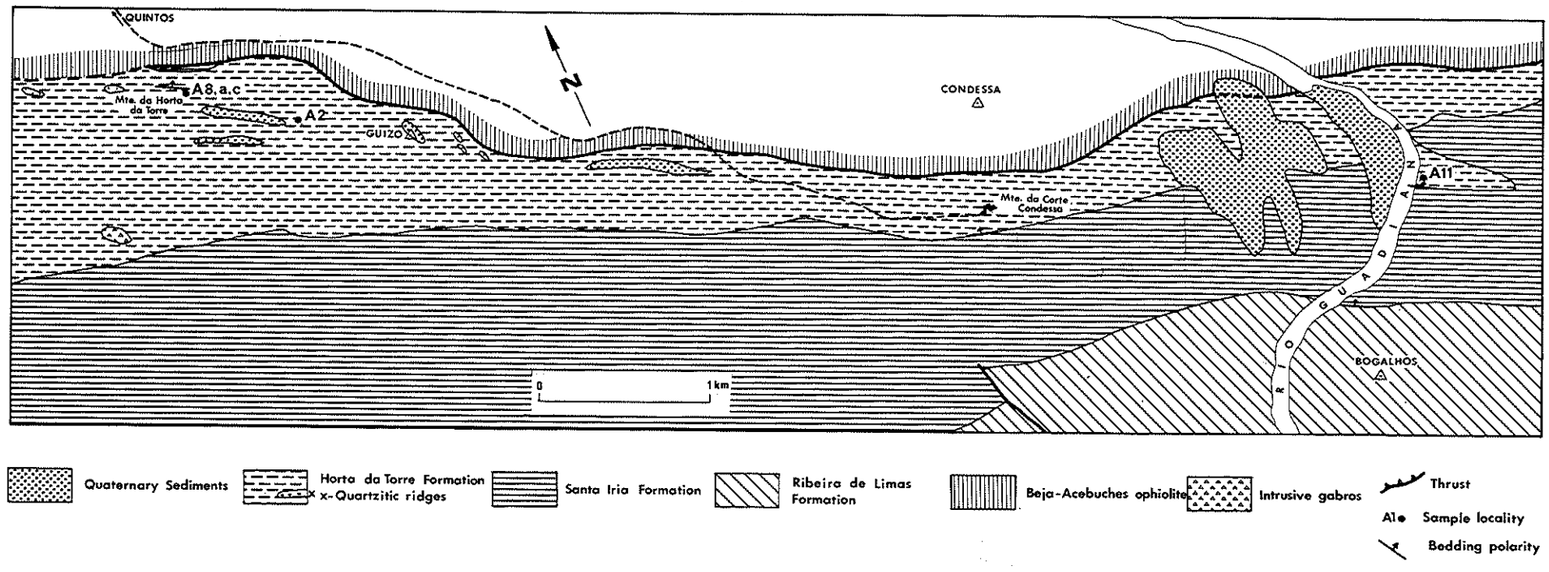

Fig. 2 — Schematic geology of the studied area and sample localities.

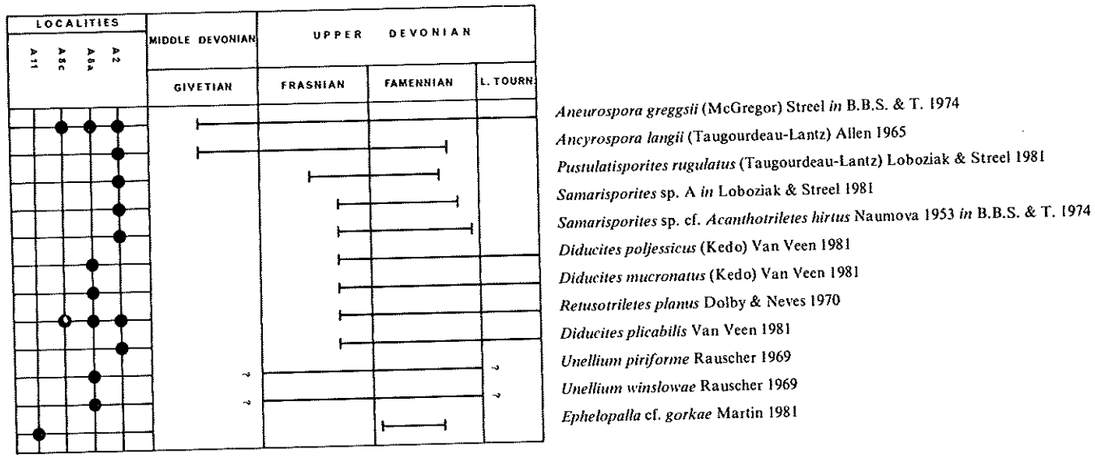

Fig. 3 — Stratigraphic distribution of the palynomorphs of the Horta da Torre Formation.

The age range of acritarchs *Unelium piriforme, U. winslowae* and *Ephelopalla* cf. *gorkae,* is frequently ascribed to the upper Devonian (RAUSCHER, 1969; MARTIN, 1981), the last one in lower to middle Famennian strata only. Putting all these data together it seems plausible that the Horta da Torre Formation is of lower to middle Famennian age.

Age determination based on spore and acritarch assemblages must be interpreted carefully on account of possible sedimentary remobilizations. The extremely fine siliceous sediments from which the palynomorphs were recovered, and the absence of high age range mixed specimens seem good criteria to invoke little, if any, sedimentary reworking.

DISCUSSION AND GEOLOGICAL IMPLICATIONS

The discovery of lower to middle Famennian palynomorphs in the Horta da Torre Fm, a new lithostratigraphic unit of the Ferreira-Ficalho Group, allow some comments on the stratigraphic correlations so far erected within the context of the South Portuguese Zone. The Santa Iria and Ribeira de Limas Fms, which underly the Horta da Torre Fm, were correlated respectively with the Gafo and Atalaia Fms that occurs in the south limb of the Pulo do Lobo Antiform (SCHERMERHORN, 1971; CARVALHO *et al.,* 1976). The Gafo Fm was locally subdivided into Gafo and Represa Fms (CARVALHO, 1976) The latter is not mapped all along the south limb of the Pulo Antidorm, and is considered a lateral variations of the Gafo Fm. The correlations between these units were based on their similar lithologies and on assumption that the Pulo do Lobo Antiform is an anticlinorium. L. J. SCHERMERHORN (1971) and D. CARVALHO *et al.,* (1976) have also suggested a lateral equivalence, although diachronous, between those units and the stratigraphic sequence of the Pyrite Belt.

The lowest lithostratigraphic unit of the Pyrite Belt (fig. 1) is the Phyllite Quartzite Formation (PQ for short), whose top has yielded conodonts and macrofossils of middle to late Famennian age. The early to middle Famennian age now obtained for the Horta da Torre Fm shows that all the units of the Ferreira-Ficalho Group are older than the PQ, or at least older than its top.

If the Atalaia, Gafo and Represa Fms were southern equivalents of the units of the Ferreira-Ficalho Group, than they should also be older than middle Famennian. However, having in mind the terrige-

nous composition of all these units and assuming the southward progradation of the sedimentation through the time, it is suggested that the Gafo and Represa Fms may be of upper Famennian to lower Tournaisian age.

All these facts (and inferences) together point to interesting geological implications.

a) The Horta da Torre and Santa Iria Fms are less deformed than the underlying Ribeira de Limas and Pulo do Lobo Fms. This deformational contrast can be explained in terms of structural level variations but can also be ascribed to an unconformity. Moreover, the northern boundary of the Horta da Torre Fm is marked by the Beja--Acebuches ophiolite suite. This is preserved just at the contact between the South Portuguese and Ossa Morena Terranes and may be indicative of a major geosuture after closing of a small ocean (or back arc basin?). In spite of the existing faults field mapping from Serpa (Portugal) and Aracena (Spain) regions suggests that the Horta da Torre Fm stratigraphically overlies the ophiolite suite which should be older than the lower Famennian. Unfortunately the exact age of this ophiolite is still a matter of conjecture and only indirect inferences can be made. Metabasalts interbedded in the Pulo do Lobo Fm show oceanic affinities and their lateral correlation with the Beja-Acebuches ophiolite is here admitted. But the problem still remains once no age information is available for the Pulo do Lobo Fm. If an unconformity exists between the pair Horta da Torre/Santa Iria Fms and the underlying Ribeira de Limas/Pulo do Lobo Fms than a lower or middle Devonian age for the Pulo do Lobo Fm, and indirectly for the ophiolite suite, seems plausible. The present geological setting of the Beja-Acebuches ophiolite would so imply a pre-Famennian collisional event between the South Portuguese and Ossa Morena zones (MUNHÁ *et al.*, 1986).

A similar age and geological setting has been recently described to the Lizard Complex in Cornwall (BARNES & ANDREWS, 1986).

b) The widespread bimodal (basalt/rhyolite) volcanism of the Pyrite Belt (MUNHÁ, 1983), which indicates lithospheric extension, took place between the upper Famennian and the lower upper Visean. From the upper Visean to the middle Westphalian the extensional regime turned to a compressive one, that gave rise to deformation of thin-skin type and synorogenic flysch sedimentation (RIBEIRO *et al.*, 1983; RIBEIRO & SILVA, 1983). The tectonic deformation of the Pyrite Belt is therefore younger than the pre-Famennian collision between the South Portuguese and the Ossa Morena Terranes. Sucessive tensional and compressional episodes and contemporaneous left lateral shearing in the Pyrite Belt are indicative of strike-slip orogenic deformation (SILVA *et al.*, in press).

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Plate I

(all photographs are X900)

Fig. 1,2 — *Ancyrospora langii* (Tangourdeau - Lantz) Allen 1965
Loc. A_2 L.233.1555. 1 - Transmitted light; 2 - Reflected light.

Fig. 3 — *Aneurospora greggsii* (Mc Gregor) Streel *in* Becker, Bless, Streel & Thorez 1974. Loc. A_2 L.271-0935. Distal surface.

Fig. 4 — *Diducites poljessicus* (Kedo) Van Veen 1981
Loc. A 8a. L.310.0087.

Fig. 5 — *Diducites mucronatus* (Kedo) Van Veen 1981
Loc. A 8a. L.331.2047.

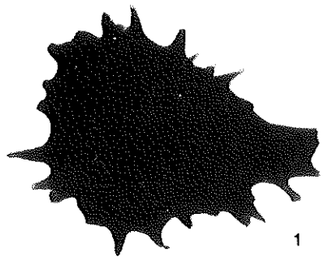
Fig. 6 — *Pustulatisporites rugulatus* (Taugourdeau — Lantz) Loboziak & Streel, 1981. Loc. A_2 L.233.2296.

Fig. 7,8 — *Diducites plicabilis* Van Veen 1981.
Loc. A_2. L.233A. 1900. 7 - Transmitted light; 8 - Reflected light.

Fig. 9,10 — *Aneurospora* sp. 9 - Loc. A_2 L.233,1905. 10 - Loc. A_2; L.233.1780.

Fig. 11,12 — *Samarisporites* sp. cf. *Acanthotriletes hirtus* Naumova 1953 *in* B.B.S.T., 1974, Loc. A_2 L.218.1162; 11 - Reflected light; 12 - Transmitted light. Proximal surface.

Fig. 13 — *Aneurospora* sp. A *in* Loboziak, Streel & Vanguestaine 1983.
Loc. 8a. L.310.1150.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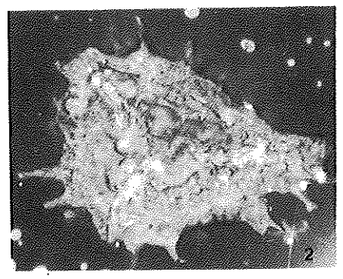
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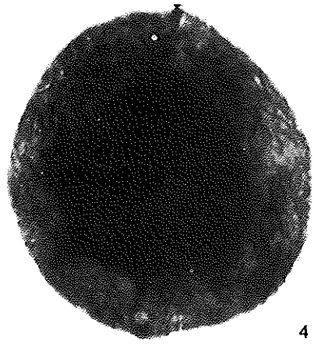
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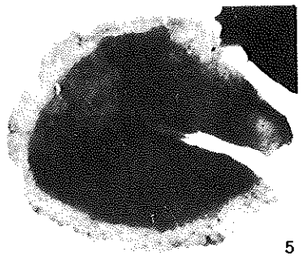
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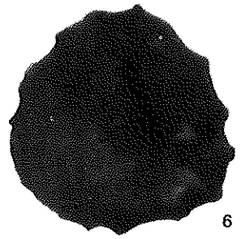
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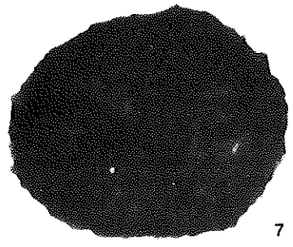
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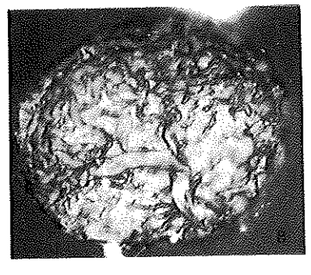
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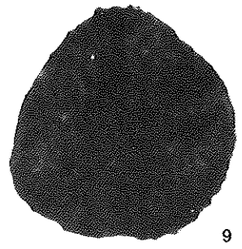
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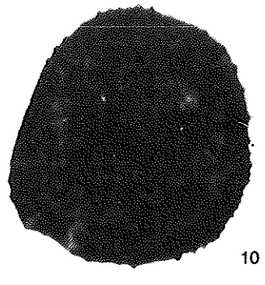
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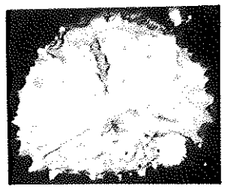
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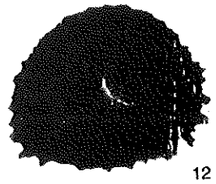
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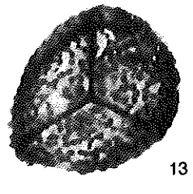
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Plate II

(all photographs are X1600)

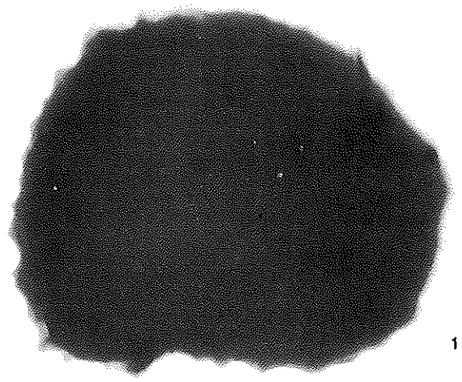
Fig. 1,2 — *Samarisporites* sp. A. *in* Loboziak & Streel 1981
1 - Loc. A_2. L.233A.0977; 2 - Loc. A_2 L.233A.1284.

Fig. 3 — *Retusotriletes planus* Dolby & Neves 1970
Loc. A 8a L.325.1279.

Fig. 4 — *Ephelopalla* cf. *gorkae* Martin 1981
Loc. Allc. L.328.0584.

Fig. 5 — *Unellium piriforme* Rauscher 1969
Loc. A 8a L.310.0818.

Fig. 6 — *Unellium winslowae* Rauscher 1969
Loc. A 8a L.288.1031.



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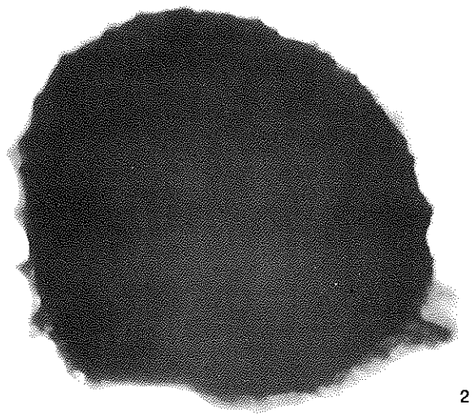

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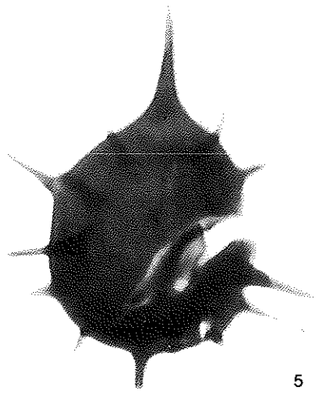

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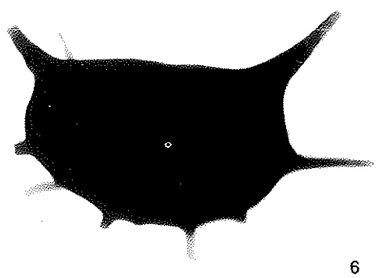

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