Early Phanerozoic trace fossils from the Sierra Albarrana Quartzites (Ossa-Morena Zone, Southwest Spain)

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Three ichnogenera are described from a 50 to 500 m thick shallow-water sandstone-shale sequence (Sierra Albarrana Quartzites). The ichnofauna consists of the burrows of worm-like animals (Arenicolites, Monocraterion, and Skolithos). The age of this formation, previously considered to be Precambrian or Palaeozoic, has been the subject of discussions. We may now assign it an Early Phanerozoic age, in agreement with the known stratigraphic distribution of the ichnofossils found.

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Introduction

The Sierra Albarrana Quartzites (Delgado, 1971) are situated in the Ossa Morena Zone, immediately SW of the boundary with the Central Iberian Zone (Fig. 1A). Lithologically this formation consists of siliciclastic rocks with some rare amphibolite intercalations. The rocks have been deformed under sillimanite-zone conditions during the Hercynian orogenesis (Dallmeyer & Quesada, 1989; Quesada & Munha, 1990; Azor et al., in press; Azor et al., in prep.). The age of the Sierra Albarrana Quartzites has caused a controversy, since it was considered to be Precambrian (Delgado, 1971, Garrote, 1976, Quesada et al., 1990) or Early Palaeozoic (Apalategui et al., 1983). The

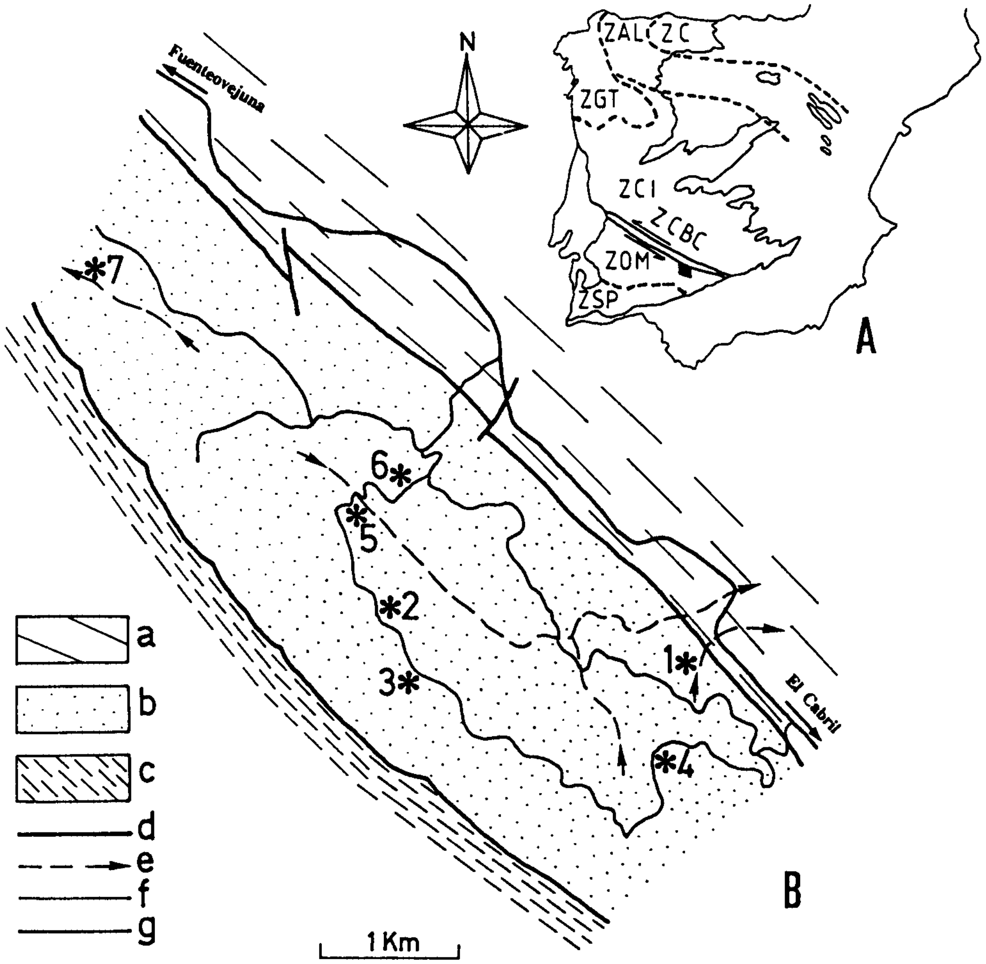

Fig. 1 A: Situation of the Sierra Albarrana area (black parallelogram) in the Iberian Massif.
ZC: Cantabrian Zone; ZAL: West-Asturian Leonese Zone; ZGT: Galicia Tras-os-Montes Zone; ZCI: Central Iberian Zone; ZOM: Ossa Morena Zone; ZSP: South Portugese Zone; ZCBC: Badajoz-Córdoba Shear Zone.
B: Map of the outcrop area of the Sierra Albarrana Quartzites.
a: schists, gneisses and metagreywackes with minor quartzites; b: Sierra Albarrana Quartzites; c: migmatic gneisses with interbedded metagreywackes, quartzites and amphibolites; d: lithological contact; e: streams; f: paths; g: roads; *1-*7: fossil localities.

recent find of trace fossils (Azor et al., in press; Azor et al., in prep.) allows to decide for an Early Phanerozoic age. The aim of this paper is to give a systematic description of the ichnofossils found in the Sierra Albarrana Quartzites.

The specimens are kept in the collection of the 'Nationaal Natuurhistorisch Museum' (National Museum of Natural History), Leiden, The Netherlands, under registration numbers RGM 293 300 through 293 304.

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GEOLOGICAL SETTING

The Sierra Albarrana Quartzites consist of siliciclastic rocks, mainly feldspathic sandstones and quartzites with some greywackes, schists and gneisses. There are some amphibolite intercalations that seem to represent pre-deformational dyke or sill-shaped intrusions in the siliciclastic sequence. The total thickness of the sequence is c. 500 m in the northwestern area; towards the southeast the thickness diminishes, due to ductile deformation with shearing. To the southeast of the sector mapped in Fig. 1B the thickness is only 50 m. The sedimentary structures, parallel and cross lamination of small and medium size, and the fossil content, suggest a shallow marine environment. Probably the formation lies unconformably on a unit of gneisses and amphibolites, and it is concordantly overlain by schists, gneisses and metagreywackes with quartzite intercalations (Azor et al., in press; Azor et al., in prep.).

LOCALITIES

The fossils described in this paper were found at the localities indicated in Fig. 1B by the numbers 1 through 7. In the following list their UTM co-ordinates are given, and, though the Sierra Albarrana Quartzites are strongly folded, an approximation of their height in metres above the lowest bed of the formation is made.

Loc. no.	UTM co-ordinates X:Y	approx. height
1	l30S TH 865195	400 m
2	30S TH 841200	450 m
3	30S TH 844196	430 m
4	30S TH 861188	470 m
5	30S TH 839208	480 m
6	30S TH 844209	450 m
7	30S TH 821225	300 m

Systematic descriptions

Ichnogenus *Arenicolites* Salter, 1857

Arenicolites sp.
Pl. 1, figs. 1-2.

Material — RGM 293 300 (sample AA59) from loc. 1, containing at least four specimens, and several well-preserved specimens seen in loc. 3.

Description — Sand infilled U-shaped burrows, oriented perpendicularly to the bedding plane. The burrows are seen at the upper surface of the sandstone beds as short cylindrical or dome-shaped extensions, either circular (4 to 8 mm diameter), or oval (due to tectonic deformation); the ends of the U-shaped tubes are 12 to 18 mm apart.

Remarks — The burrows are only visible on the upper surfaces of the beds; in sections perpendicular to the bedding plane they are not visible, so the presence or absence of 'Spreite' cannot be observed. Nevertheless, the absence of disturbed sediment between the tube pairs, and of a dumb-bell structure (see Pl. 1, fig. 2) excludes its attribution to *Diplocraterion*. The paired occurrence of the tubes distinguishes them from *Skolithos*.

Ichnogenus *Monocraterion* Torell, 1870

Monocraterion sp.
Pl. 1, figs. 3-5.

Material — RGM 293 301 (sample AA58) and two well-preserved specimens from loc. 2; one well-preserved specimen from loc. 1; one specimen from loc. 3.

Description — Funnel structures oriented perpendicular to the bedding plane, with a straight central axial tube. The burrows are filled in with sand, and show a diameter of 20 to 28 mm at the top, and a diamter of 4 to 13 mm of the central cylinder; their depth varies between 32 and 80 mm (Table 1). In all specimens one may observe a downward deflection of the sedimentary laminae around the trace, displaying both 'concordant' (Pl. 1, fig. 4) and 'discordant' (Pl. 1, fig. 5) funnels (Crimes et al., 1977).

Plate 1

Arenicolites sp.
Fig. 1. RGM 293 300, loc. 1.
Fig. 2. Field photography, loc. 1.

Monocraterion sp.
Fig. 3. Field photography, loc. 2.
Fig. 4. Field photography, loc. 2.
Fig. 5. Field photography, loc. 1.

Skolithos linearis Haldemann, 1840
Fig. 6. Field photography, loc. 6.

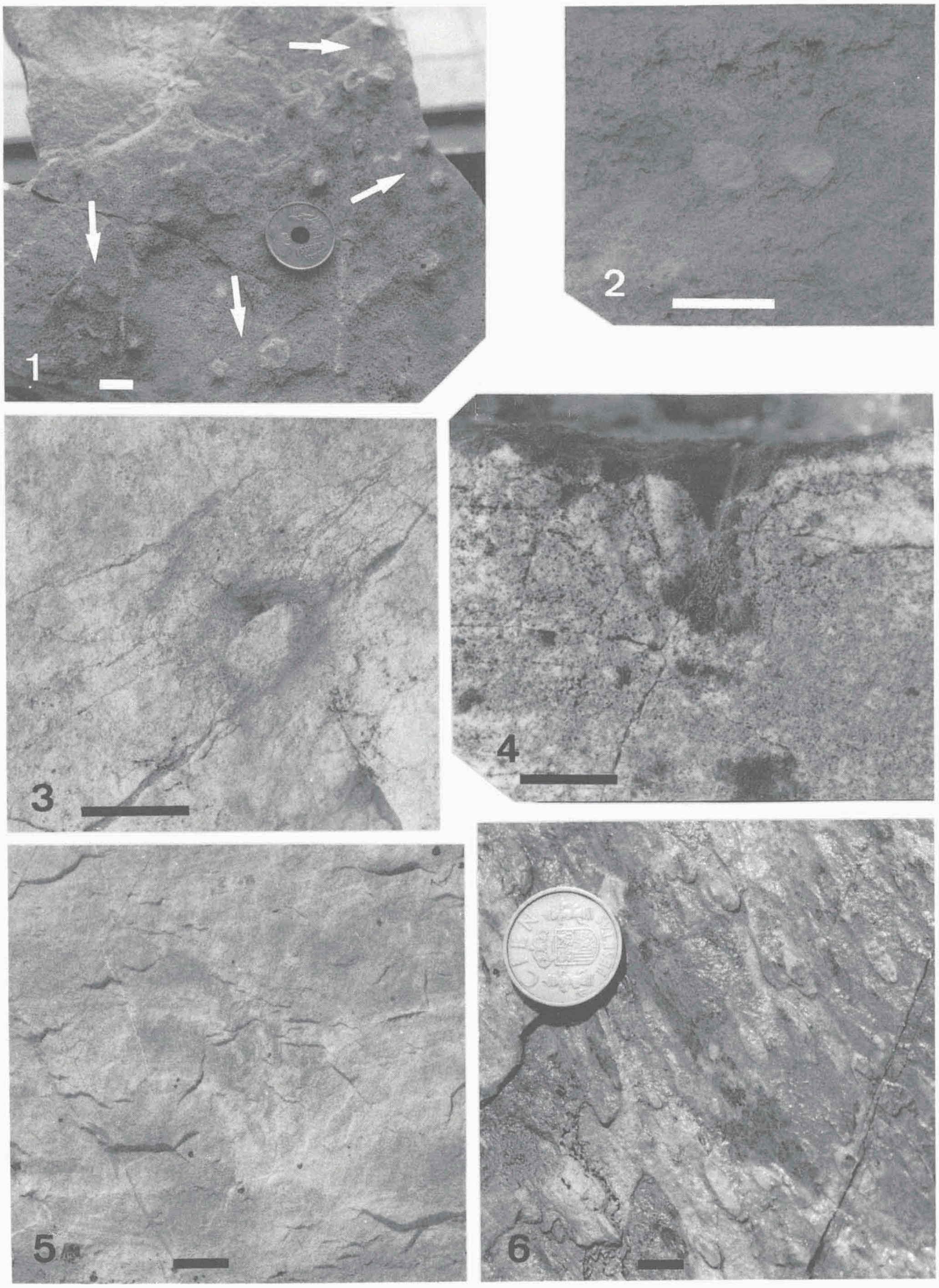
1
2
3
4
5
6

Table 1. Dimensions in mm of specimens of *Monocraterion* sp. in localities 2 (A and B), 3 (C), and 1 (D).

	A	B	C	D
Maximum funnel diameter	28	26	20	54
Diameter axial cylinder	13	4	5	16
Depth	80	32	—	86

Ichnogenus *Skolithos* Haldemann, 1840

Skolithos linearis Haldemann, 1840
Pl. 1, fig. 6.

Material — RGM 293 302 (sample AA65, loc. 7), RGM 293 303 (sample AA278, loc. 4), RGM 293 304 (sample AA293, loc. 6); material observed in the field at loc. 2, 3, 4, 5, 6, and 7.

Description — Vertical, unbranched, sand-filled tubes, which are generally elliptical in cross-section due to tectonic deformation. The specimens, several centimetres long, and on the average with a diameter of 5 mm, are generally found crowded in distinct levels parallel to the stratification. All specimens are flattened and rotated in the direction of the main cleavage, which generally is at an angle with the bedding plane.

Stratigraphic implications

Ichnofossils are poor index fossils. However, they have a certain importance in a discussion on the age of the Sierra Albarrana Quartzites, that have been attributed to the Precambrian by various authors (see above). Our material contains none of the ichnogenera, that are restricted to the Late Precambrian (Vendian) according to Crimes (1987). This author states, that *Skolithos* and *Arenicolites* are known from the Vendian, throughout the entire Phanerozoicum, into recent times. On the other hand, *Monocraterion* has never been cited from rocks older than the Tommotian (Early Cambrian), according to Crimes (1987). Therefore the Sierra Albarrana Quartzites are better correlated with Phanerozoic rocks than with Precambrian rocks. Furthermore, in view of the relations between the different formations distinguished in the field, and of the tectono-metamorphic history, an Early Phanerozoic age (Cambrian or Ordovician) of the Sierra Albarrana Quartzites fits better than a Precambrian age (Azor et al., in press; Azor et al., in prep.).

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