UNESCO-IUGS. IGCP PROJECT Nº 96 MESSINIAN CORRELATION
MESSINIAN SEMINAR Nº 3.- FIELD TRIP Nº 2 (Sorbas)
SEMINARIO SOBRE EL MESSINENSE Nº 3.- EXCURSION Nº 2 (Sorbas)

AN EXCURSION TO COASTAL AND FLUVIAL SEDIMENTS OF MESSINIAN -PLIOCENE AGE (SORBAS MEMBER AND ZORRERAS MEMBER) IN THE SORBAS BASIN, SE SPAIN

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GENERAL

In the Sorbas basin a succession of three members together called the Caños Formation rests on top of Messinian reef deposits, on shallow marine sandstone or on deeper marine marls (DRONKERT, 1976)(see Fig. 1). The lowermost of these members, consisting largely of selenitic gypsum deposits, is called Yesares Member. The Yesares Member is overlain by coastal and basinal sediments of the Sorbas Member, deposited during continued hypersaline conditions. Finally on top of the Sorbas Member pink coloured silty and sandy clays were deposited with fluvial and lagoonal intercalations near the base and a marine intercalation at the top (Zorreras Member). The base of the Zorreras Member is of Messinian age (ostracods; pers. comm., D. van Harten), whereas the top probably is Pliocene in age (normal marine fauna).

THE SORBAS MEMBER

The Sorbas Member is 75 m thick at the most. The Member consists in the lower part mainly of laminated limestone, marl and clay. These laminites are identical to intercalated laminites between the gypsum layers of the Yesares Member and are laid down in a quiet water environment below wave base. The upper part of the Sorbas Member mainly consists of calcareous sandstones deposited in a beach barrier environment. Around the town of Sorbas the upper part of the Sorbas Member can be divided into three subunits (A-B-C);(see fig. 2,4 and 5). Subunits A and B comprise two phases of regressive coastal outbuilding, whereas subunit C comprises

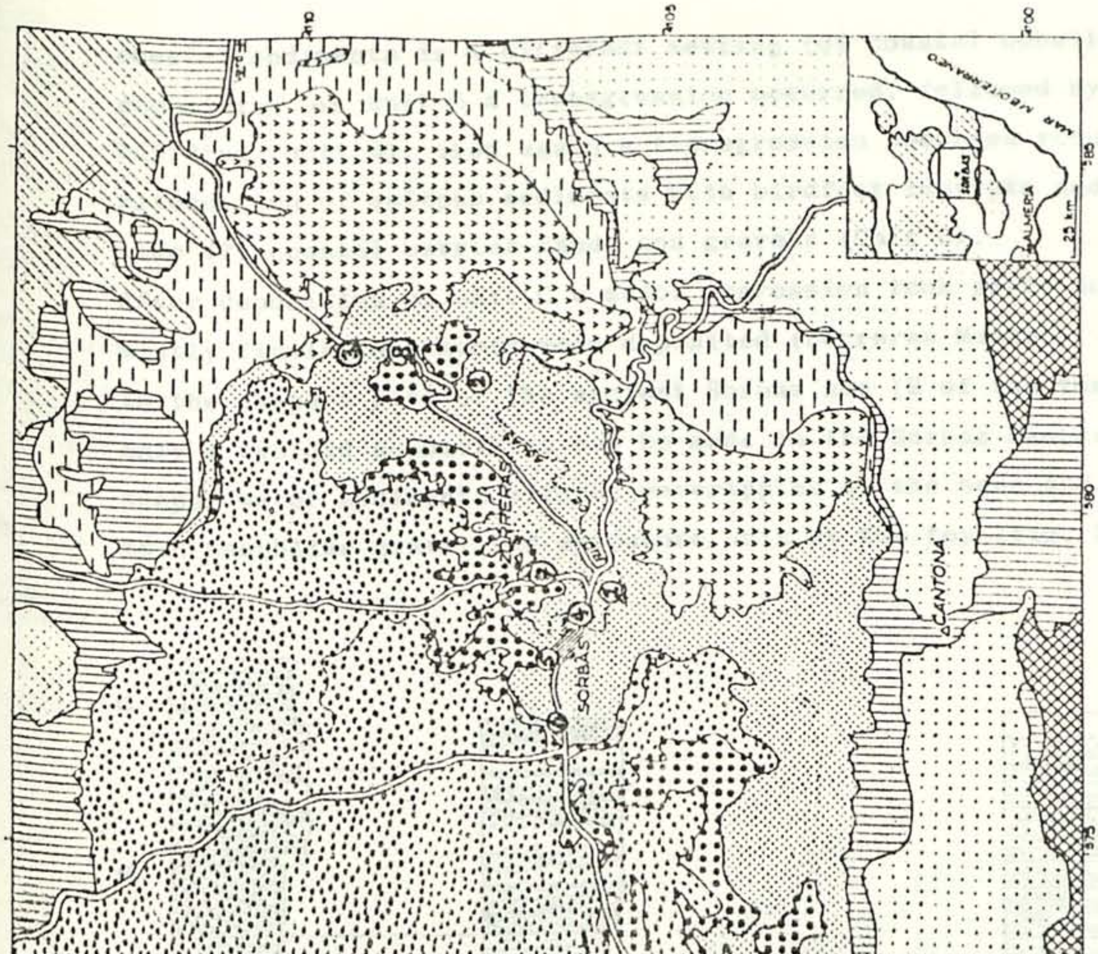


Fig. 1. Geological map of Sorbas basin with position of excursion stops (1-8). Map from Dronkert (1976).

coastal sediments in a different setting (of coastal upbuilding). After deposition of unit A a transgression occurred, followed by coastal outbuilding (unit B), then again a transgression occurred resulting in an alternation of saltpan sediments with birdfoot imprints and chenier-like (?) coastal barrier-sands and gravels (Unit C).

After deposition of unit C a major regression took place and hereafter mostly fluvial sediments were deposited (Zorreras Member).

In the deepest part of the ancient Sorbas sea (E of the town of Sorbas) only a twofold subdivision can be made in the Sorbas Member: laminated deeper water sediments without waveripples at the base and a single, thin beachlike gravel and sandstone unit at the top (fig. 2, column 3).

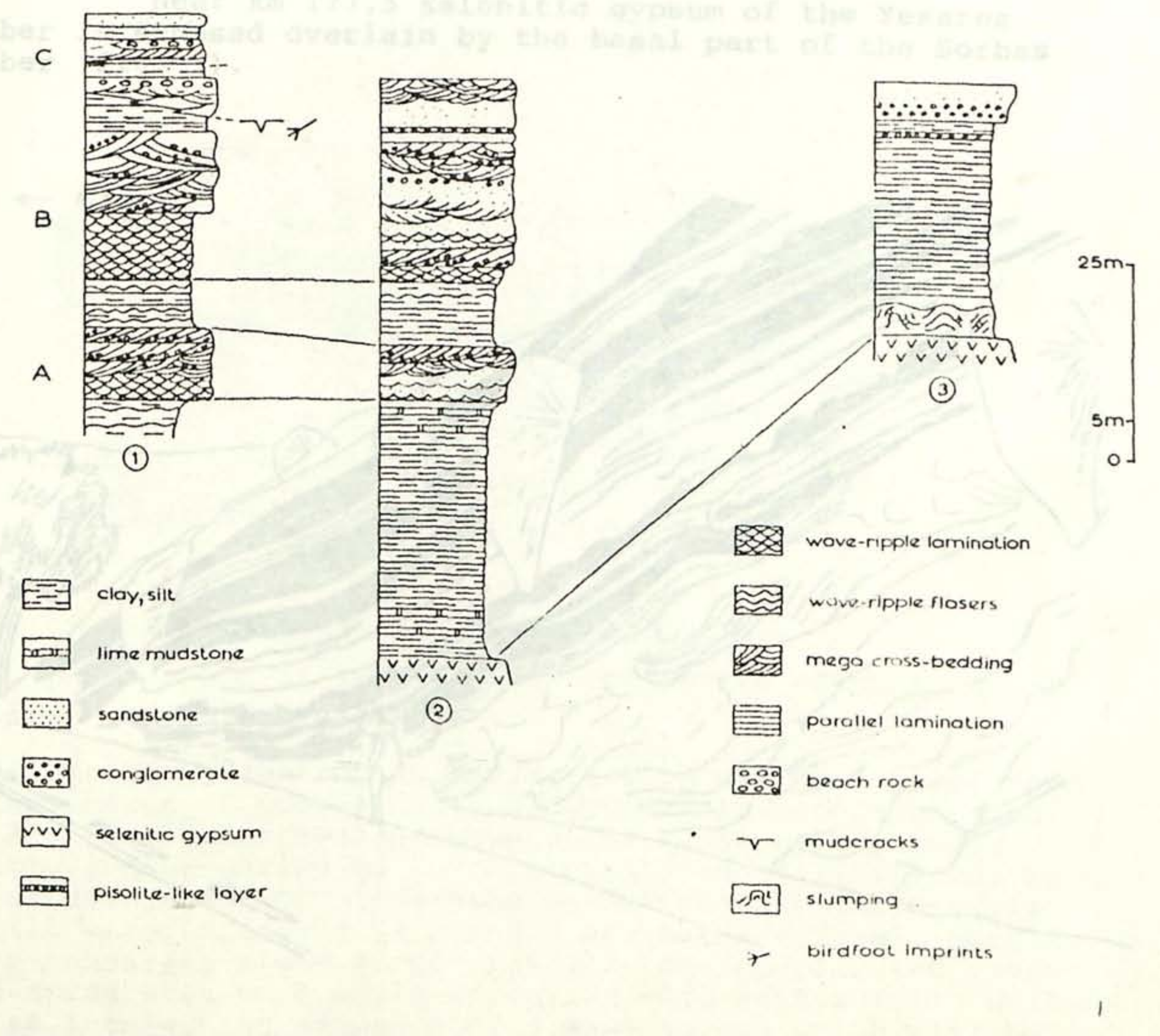


Fig. 2. Three stratigraphic columns of Sorbas Member (Pagnier, 1976). Column 1 near Sorbas; Column 2 Rio de Aguas (see stop 1) and Column 3 (see stop 2).

STOP 1 Rio de Aguas; leave main road, S of the town of Sorbas follow riverbed 2 km downstream; this stop is the same as stop 7 of the introductory excursion by Dronkert & Pagnier. Along the Rio de Aguas a general view can be obtained of the Sorbas Member overlying thick gypsum layers of the Yesares Member.

STOP 2 Km 176,5 carretera Almeria-Vera; leave main road, walk 250 m to S; exposure in side barranco of Rio de Aguas.
Deepest part of the sea in Sorbas time (fig. 2, column 3). Poor exposure of selenitic gypsum in the floor of the barranco. Above the gypsum occur 25 m of dark grey laminated limestone, clay and siltstone. In the top a pisolite-like layer occurs. The laminated unit is overlain by a 1 m thick slump mass of brown sand covered by a beach-like gravel conglomerate in which Helix was found. Then follow pinkish coloured sediments of the Zorreras Member.

STOP 3 Km 177,3-177,5 carretera Almeria-Vera.
Near km 177,5 selenitic gypsum of the Yesares Member is exposed overlain by the basal part of the Sorbas Member (fig. 3).

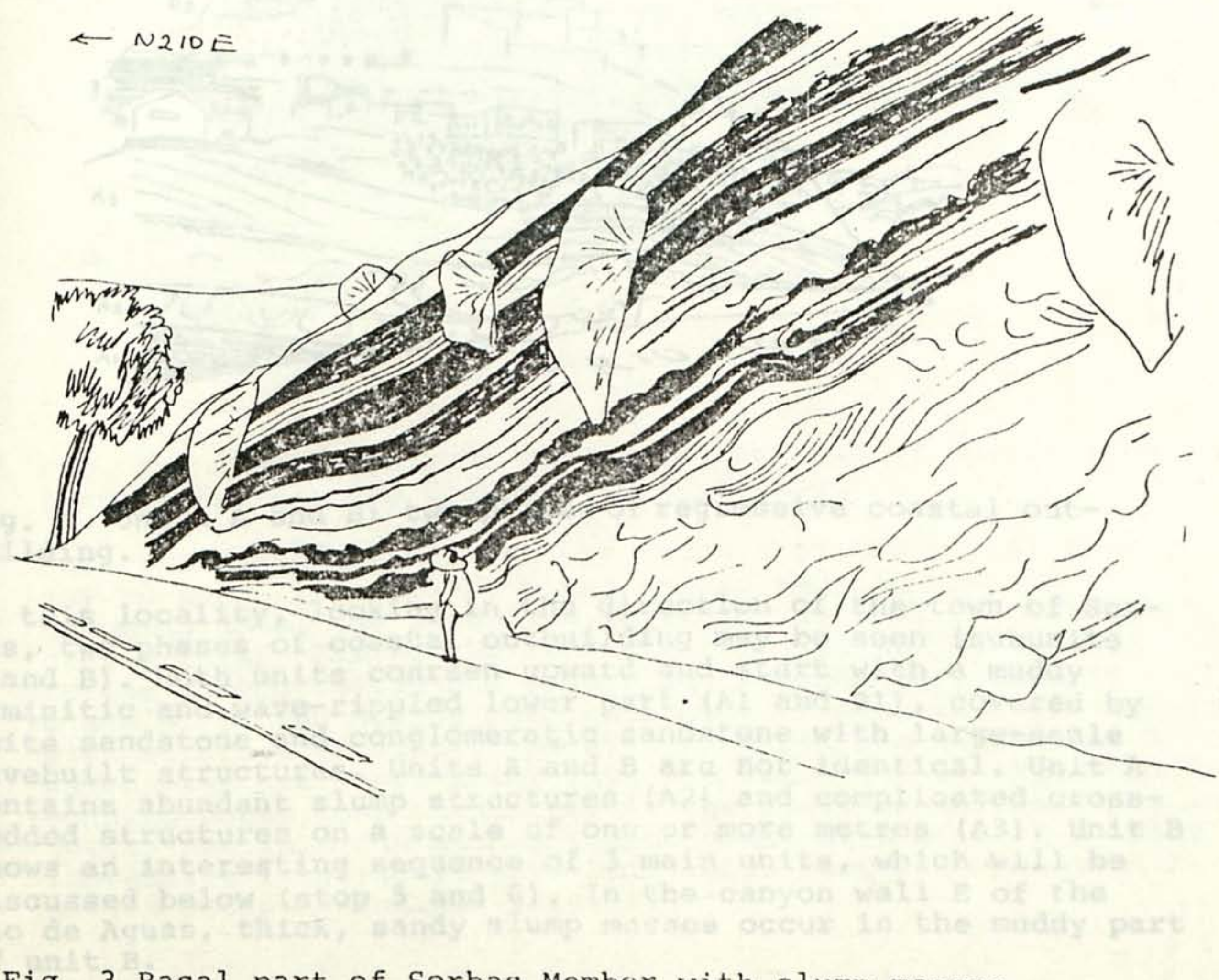


Fig. 3 Basal part of Sorbas Member with slump masses.

Unfortunately, the contact is slightly tectonized. In the basal part of the Sorbas Member clayey and limestone laminites occur in the lowermost part above the massive gypsum together with thin gypsum layers and a few thin turbidite sandstonebeds. Slumped horizons frequently occur (fig. 3). In one of the slumps a limestone mass displays synsedimentary deformations, as well as cavities that originally contained gypsum crystals. The thickness of the laminites here is about 35 m. In the upper part a few laminated stormlayers occur (see also fig. 6). The laminites are overlain by a mainly sandy unit with abundant wave ripples, slump structures and also large wave-built sedimentary structures. With the aid of different types of wave ripples andmega-cross bedding, as well as grainsize and mud-sand distribution, it can be shown that in this upper part at least two phases of shallowing occur, separated by a phase of deepening.

STOP 4 Km 171 carretera Almeria-Vera; near the bridge E of the town of Sorbas (fig. 4).

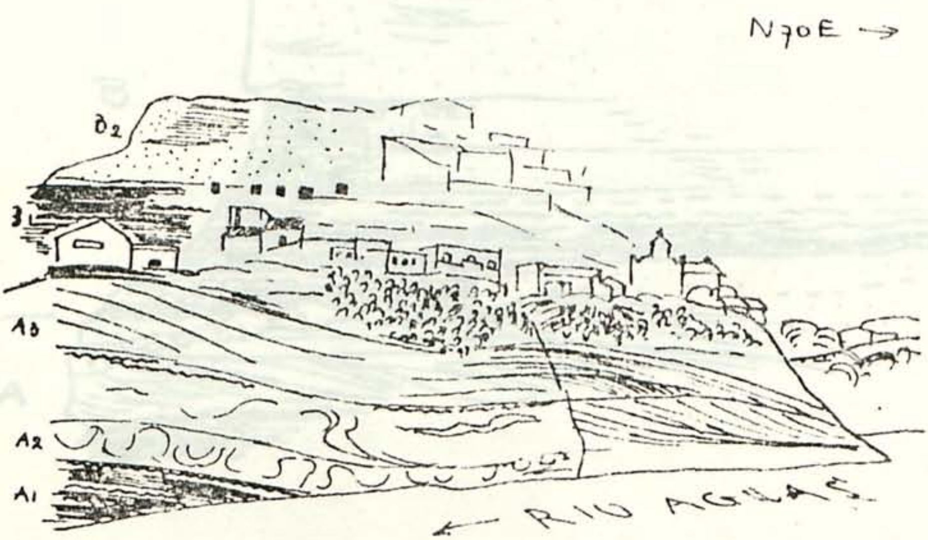


Fig. 4. Units A and B: two phases of regressive coastal outbuilding.

At this locality, looking in the direction of the town of Sorbas, two phases of coastal outbuilding may be seen (subunits A and B). Both units coarsen upward and start with a muddy laminitic and wave-rippled lower part (A1 and B1), covered by white sandstone and conglomeratic sandstone with large-scale wavebuilt structures. Units A and B are not identical. Unit A contains abundant slump structures (A2) and complicated cross-bedded structures on a scale of one or more metres (A3). Unit B shows an interesting sequence of 3 main units, which will be discussed below (stop 5 and 6). In the canyon wall E of the Rio de Aguas, thick, sandy slump masses occur in the muddy part of unit B.

STOP 5 Km 169,5 carretera Almeria-Vera; near the dam W of the town of Sorbas (fig. 5,6,7 and 8).

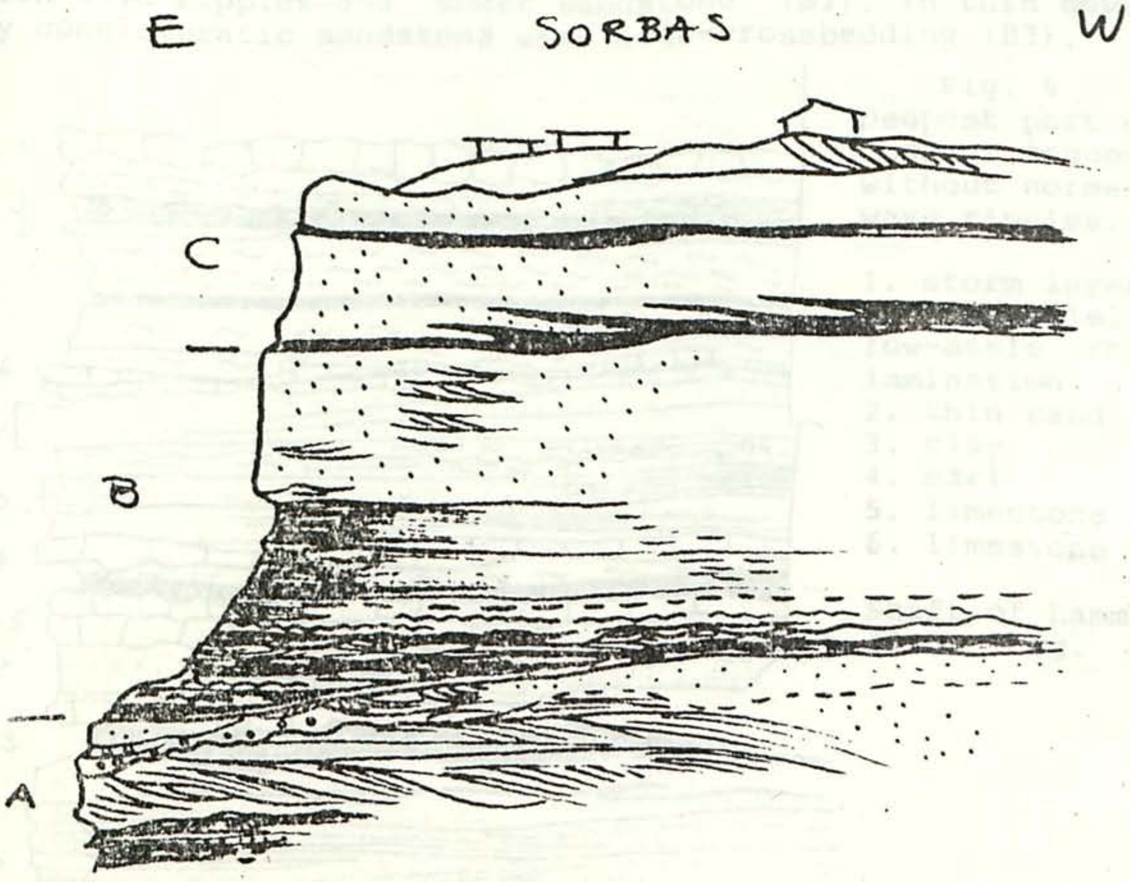


Fig. 5 - Canyon wall, NW corner of the town of Sorbas with 3 subunits (A-B and C); composite picture.

Here the three subunits of the toppart of the Sorbas Member may be seen (fig. 5). Note the W-ward wedging out and stepping up of the sandstone layers of subunit C, over a clayey layer. Taking the footpath from the dam northwards to the canyon floor, one passes the sediments of subunit C and B. In the clayey intercalations of subunit C (elsewhere with birdfeet imprints, see stop 6) caves are excavated, in which pigs are kept. Going into the direction of the municipal washing house, one encounters in the floor of the canyon a small gorge, cut into sandstones and conglomerates of unit A. Here impressive large-scale wave-built bars occur, commonly with convex cross-lamination (fig. 5).

Smaller ripples on top of these bars, a gradual increase in marl and clay content and a decrease in the number of wave-rippled beds, indicate a deepening of the sea (transgression).

Following the canyon in W-ward direction towards a dry waterfall a very interesting sequence formed by coastal outbuilding can be seen in unit B (fig. 8). This sequence consists of a muddy part Fig. 8, B1), followed by sandstone with wave-ripples and "sheet sandstone" (B2), in turn covered by conglomeratic sandstone with mega-crossbedding (B3).

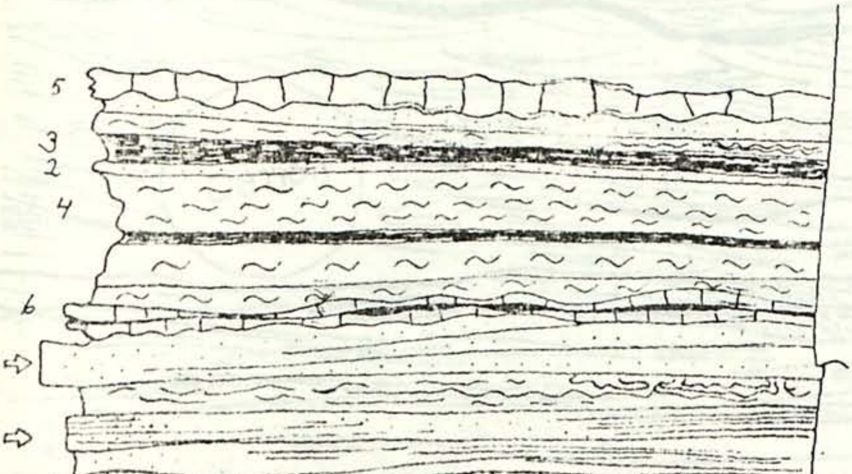


Fig. 6
Deepest part of coastal sequence without normal wave ripples.

1. storm layers with parallel and low-angle cross-lamination
2. thin sand layers
3. clay
4. marl
5. limestone
6. limestone flaser

Shaft of hammer is 30 cm long.

In the muddy part B1 of the sequence laminites of clay, marl limestone and sandy storm layers (fig. 6) show an upward increa of wave-rippled sandflasers (fig. 7). In some places crinkled limestone masses seem to replace diagenetically parts of B1. In our opinion, the transition of B1 to B2 marks the transition from shelf mud to coastal sand, corresponding to the normal wave base in Sorbas time.

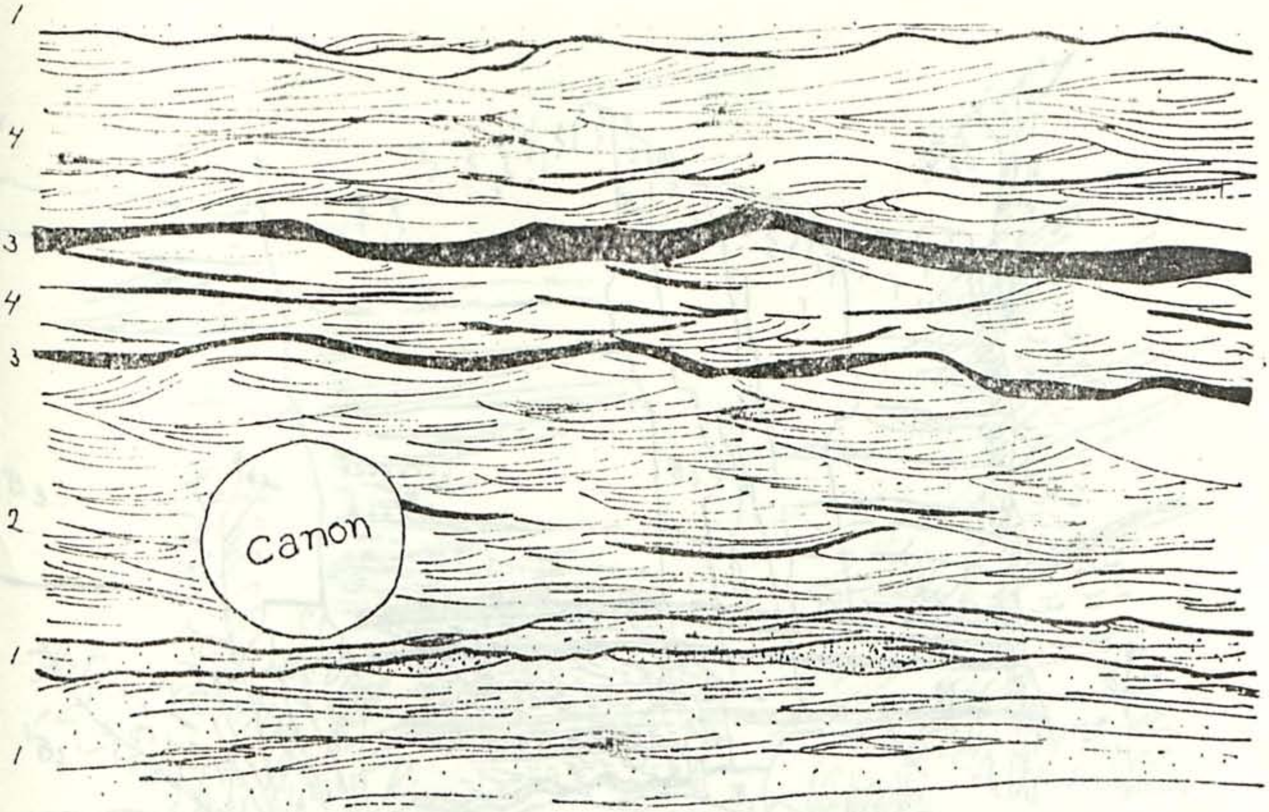


Fig. 7. Muddy part of coastal sequence (B1) with abundant wave ripple sand flasers (2 of greater size; 4 of smaller size); laminated storm layers (1) and clay draping the ripple surfaces (3). Lenscap has diametre of 5 cm.

The sandstone of unit B2 (fig. 8) shows abundant wave ripple troughs and intercalations of "sheet sandstone", the latter occurring more frequently in upward direction. Loose blocks on the canyon floor reveal, that the sheet sand contains primary current lineation and in places small quartz pebbles. The structure therefore, is made by bottomcurrents generated by shallowing waves (transitions can be seen from wave ripples to sheet sands).
The conglomeratic sandstone (B3) mainly contains trough-shaped mega-cross bedding and large flaser-like sandstone bodies, with transitions from one type to the other. The megatroughs resemble tidal herringbone structures and the megaflasers are identical to Campbell's truncated wave ripple laminations. There can be no doubt that both types are made by waves, as other tidal or current-made structures are lacking. B3 also contains a few high-angle and low-angle longshore bars and small-scale wave-ripples. The top of the sequence (B4) is heavily burrowed.

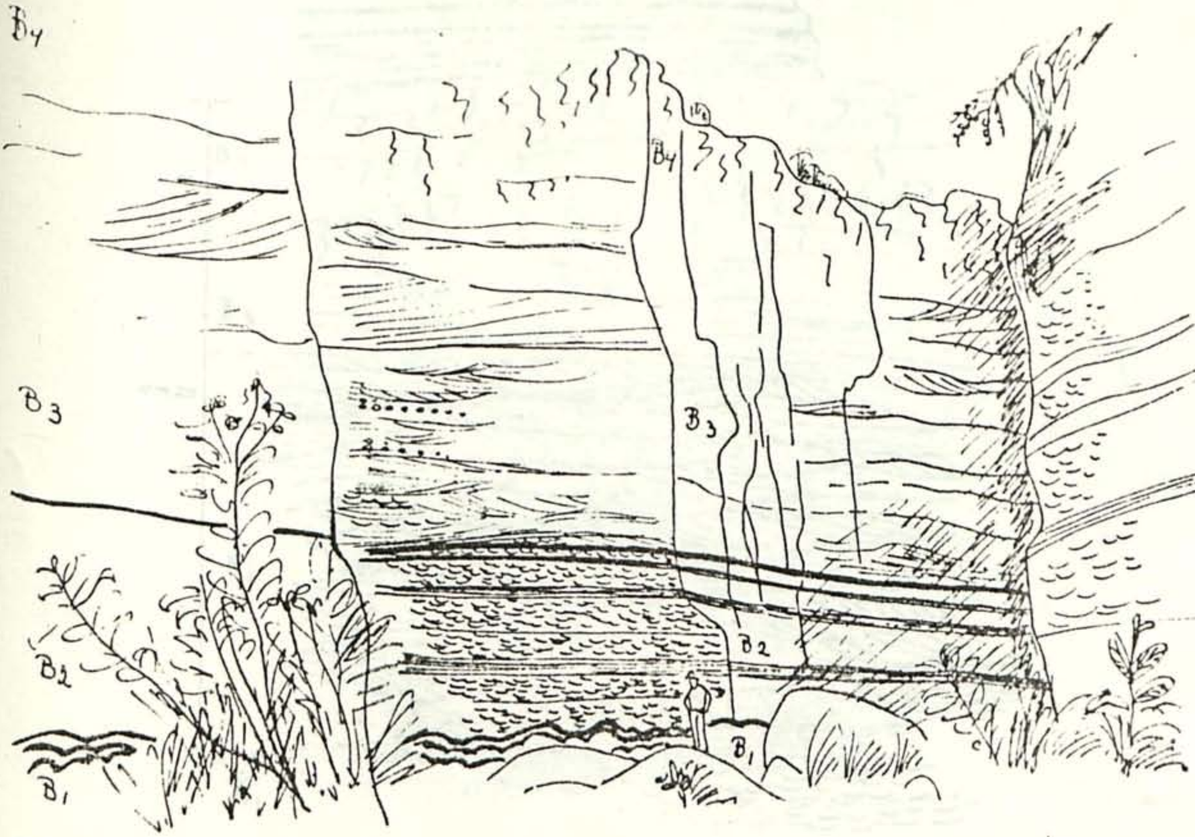


Fig. 8. Regressive coastal sequence with 3 main units: muddy B1; sandy B2 with wave-ripples and sheet sands; conglomeratic B3 with wave-built mega-crossbedding; B4 burrowed top part of B3.

STOP 6 Km 168,5 carretera Almeria-Vera; near Butano gaz station of the town of Sorbas (fig. 9,10,11 and 12).

At this locality, in the dry riverbed that parallels the main road, beaches and birds of Sorbas time can be studied. In a narrow canyon, in the floor of the riverbed, the top part of unit B can be studied (fig. 9), with beautifully exposed beach-swash laminations and beachrock breccia (fig. 10). The E-ward dipping beach lamination indicates an eastern position of the sea in Sorbastime.
Fig. 9 shows on top of wave-rippled sand and sheet sand (fig. 9, B1) trough-shaped mega-crossbedding (B2), which in this place demonstrates a dominant direction towards the east, seaward, at right angles to the shore. Beach-swash laminations (fig. 9, B3) overlie the cross-bedded part. The top of the sequence is again heavily burrowed (B4). Unit C with muddy (C1) and sandy intercalations form the valley sides of the barranco.

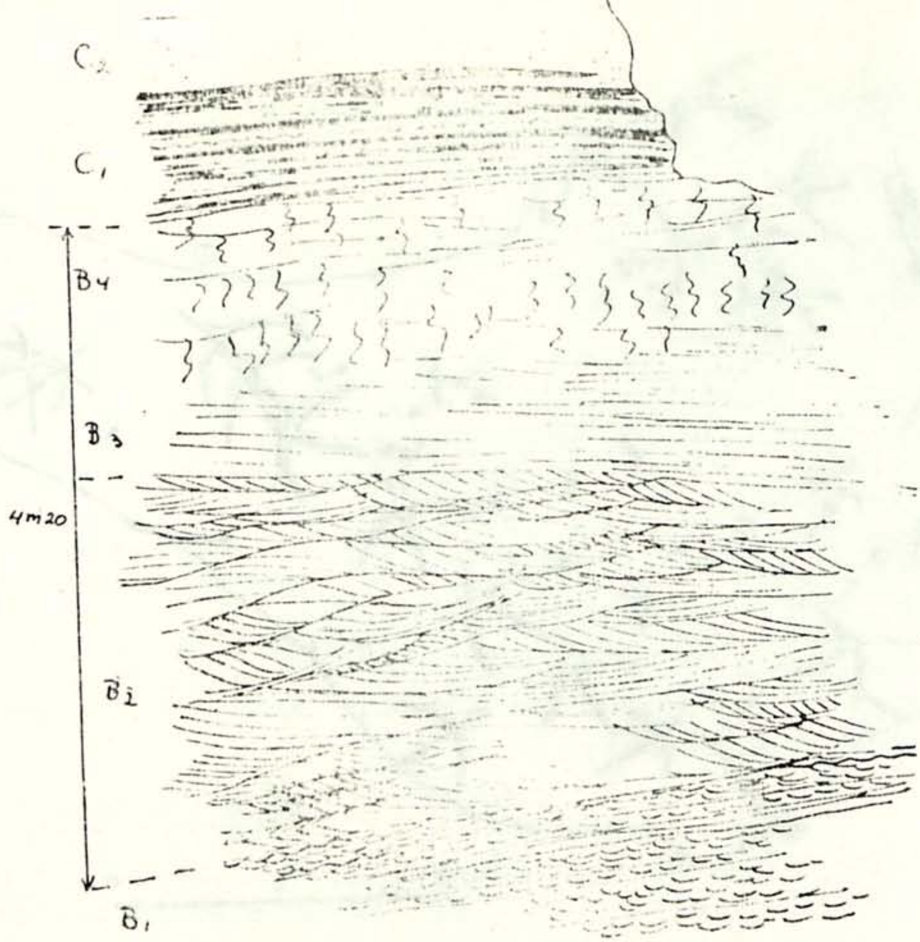


Fig. 9. Regressive coastal sequence (B), with beach-swash laminations in the top part; overlain by saltpan deposits with birdfoot imprints (C1) and chenierlike (?) beach barriers (C2).

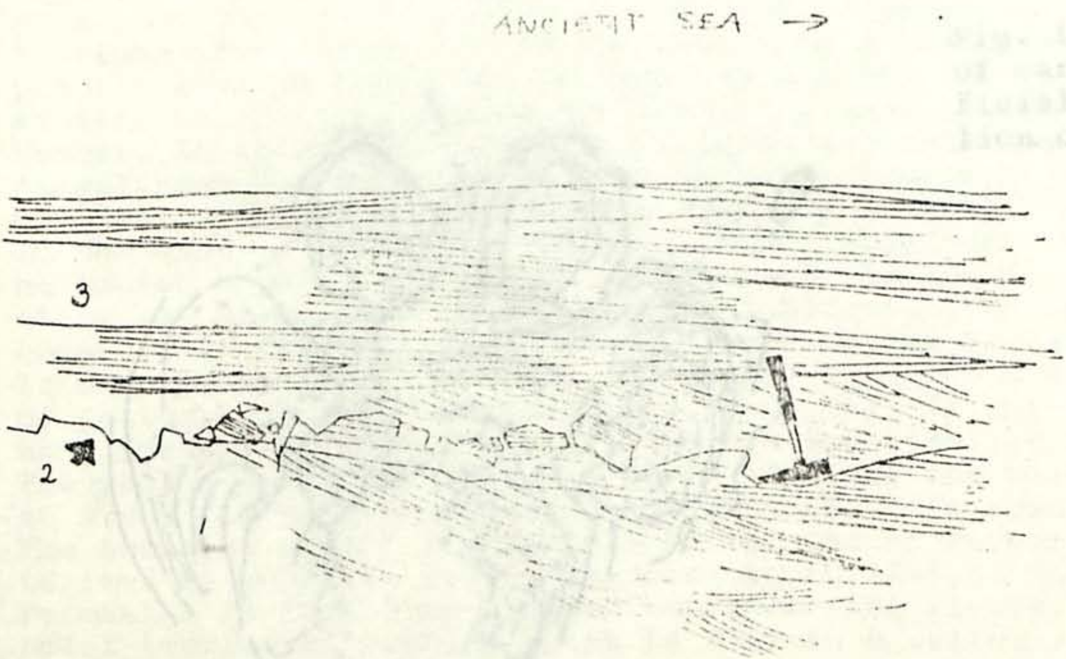


Fig. 10. Beachrock breccia covering erosionsurface (2) in previously cemented coastal sand (1); on top beach swash-lamination (3). Handle of hammer is 30 cm long.

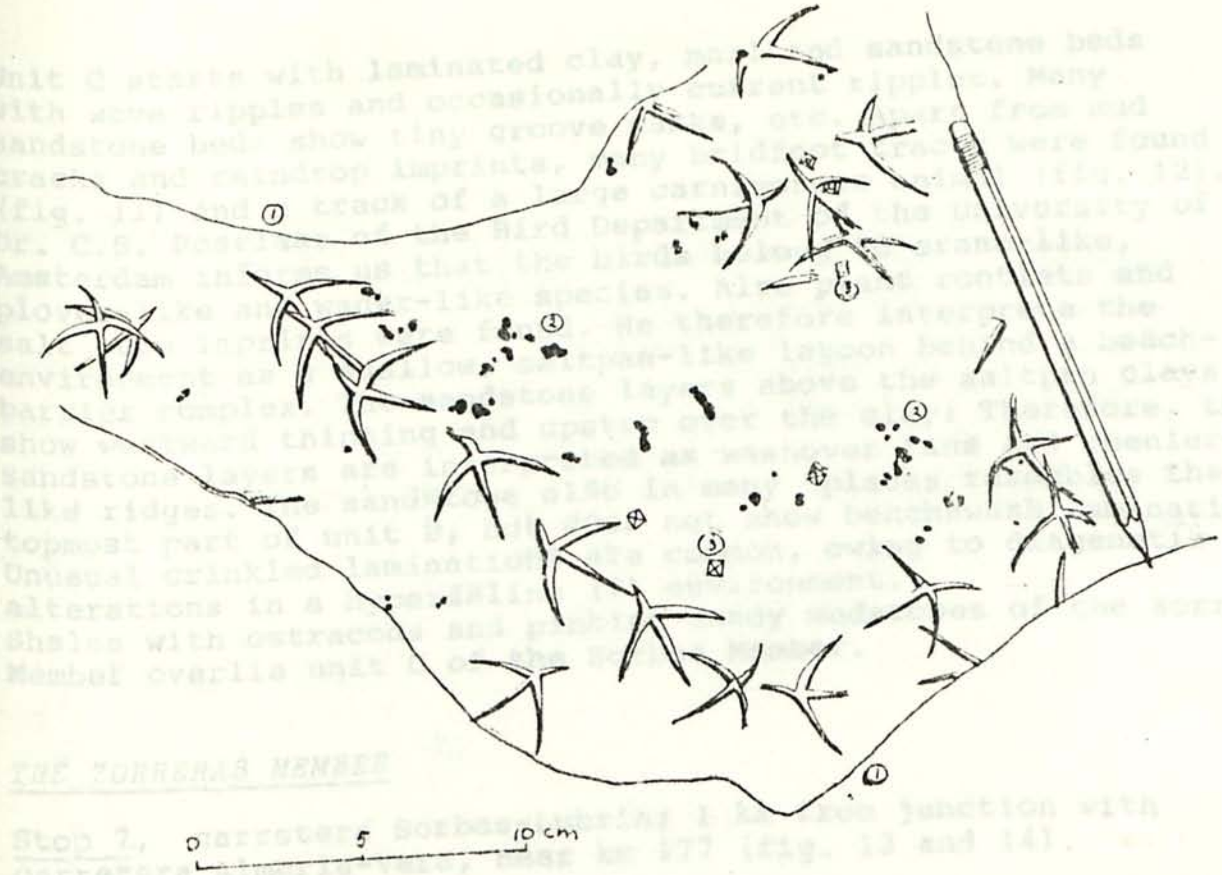
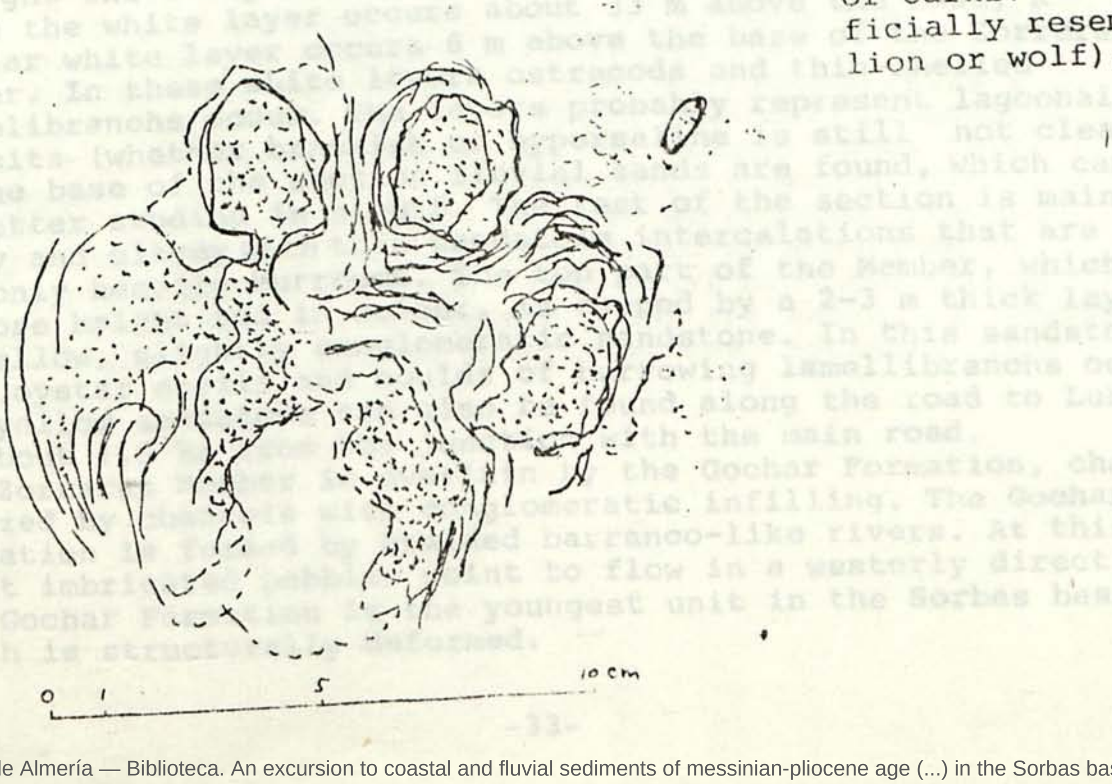


Fig. 11. Lower surface of bedding plane (Unit C1) with bird-foot track (1); small burrows (possibly pick marks) (2) and marks of dissolved halite-cubi (3).

Fig. 12. Footprint of carnivore (supe ficially resemblin lion or wolf).



Unit C starts with laminated clay, marl and sandstone beds with wave ripples and occasionally current ripples. Many sandstone beds show tiny groove marks, etc. Apart from mud cracks and raindrop imprints, many bridfoot tracks were found (fig. 11) and a track of a large carnivorous animal (fig. 12). Dr. C.S. Roselaar of the Bird Department of the University of Amsterdam informs us that the birds belong to crane-like, plover-like and wader-like species. Also plant rootlets and salt cube imprints were found. We therefore interprete the environment as a shallow, saltpan-like lagoon behind a beach-barrier complex. The sandstone layers above the saltpan clays show westward thinning and upstep over the clay. Therefore, the sandstone layers are interpreted as washover fans and chenier-like ridges. The sandstone also in many places resembles the topmost part of unit B, but does not show beachswash lamination. Unusual crinkled laminations are common, owing to diagenetic alterations in a hypersaline (?) environment.
Shales with ostracods and pinkish sandy mudstones of the Zorreras Member overlie unit C of the Sorbas Member.

THE ZORRERAS MEMBER

Stop 7, carretera Sorbas-Lubrin; 1 km from junction with carretera Almeria-Vera, near km 177 (fig. 13 and 14).

The best general view of Zorreras Member can be obtained around the Zorreras hill (450 m high). Figure 13 with the ceramic clay quarry in the centre shows the pink coloured shaly Zorreras Member (2-4), overlying white sandstones of the Sorbas Member (1) and capped by the conglomeratic Gochar Formation (5). Intercalated in the pink coloured Zorreras Member a bright white layer (3) can be seen from a distance. At this place the white layer occurs about 33 m above the base; a similar white layer occurs 6 m above the base of the Zorreras Member. In these white layers ostracods and thin-shelled lammelibranchs occur. The layers probably represent lagoonal deposits (whether brackish or hypersaline is still not clear). In the base of the section fluvial sands are found, which can be better studied in stop 8. The rest of the section is mainly silty and clayey with thin sandstone intercalations that are commonly heavily burrowed. The top part of the Member, which is more bright red in colour, is capped by a 2-3 m thick layer of yellow, slightly conglomeratic sandstone. In this sandstone many oyster shells and moulds of burrowing lamellibranchs occur. The yellow sandstone can also be found along the road to Lubrin at about 1,5 km from the junction with the main road.
The Zorreras Member is overlain by the Gochar Formation, characterized by channels with conglomeratic infilling. The Gochar Formation is formed by braided barranco-like rivers. At this point imbricated pebbles point to flow in a westerly direction. The Gochar Formation is the youngest unit in the Sorbas basin, which is structurally deformed.

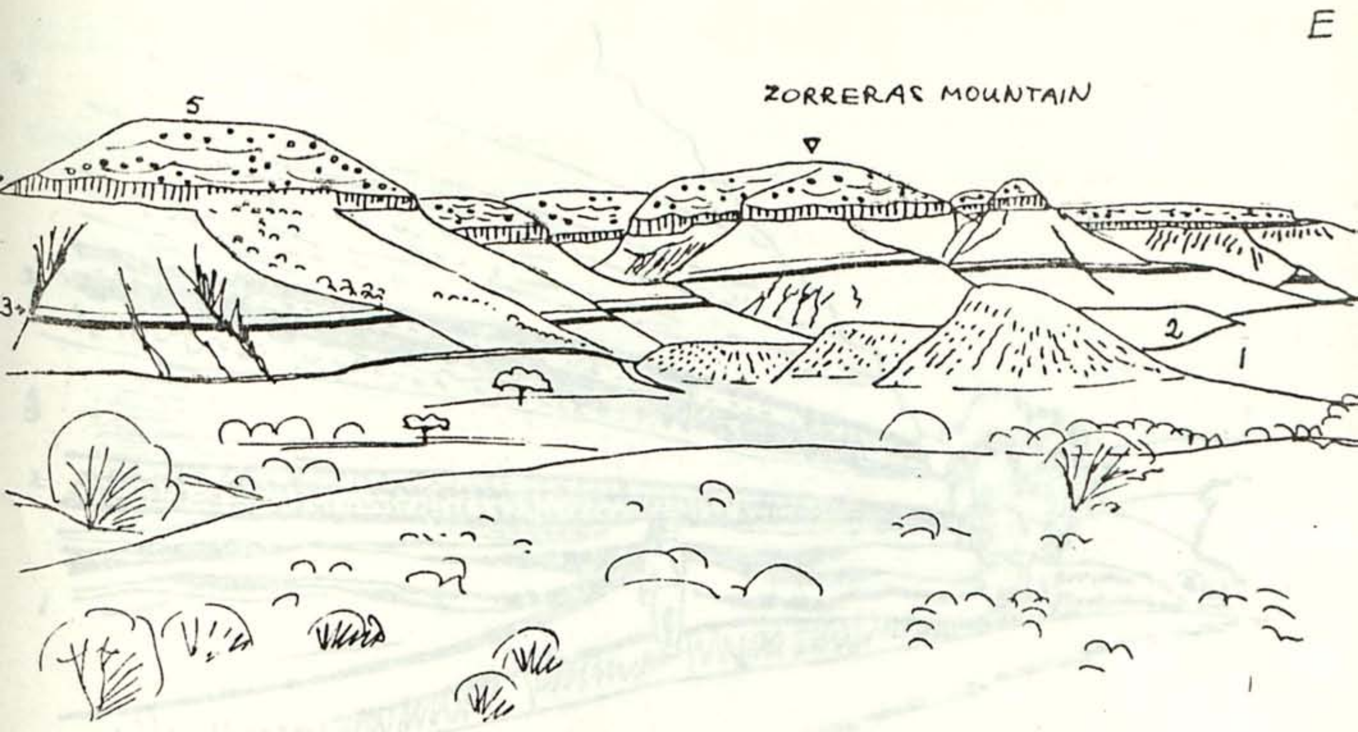


Fig. 13. Zorreras Member (2-4) overlying Sorbas Member (1), capped by Gochar Formation (5).

STOP 8 Km 175 Carretera Almeria-Vera (fig. 14 and 15).

Figure 14 shows two types of fluvial sandstones in the Zorreras Member: channel-filling sandstones and sheet-forming sandstones, separated by finer grained deposits with calcareous concretions (soils). These calcretic paleosoils point to a (semi-)arid climate. In the channel sands thick clay layers occur, locally with desiccation cracks (fig. 15) pointing to ephemeral streams. In this environment the sheet-forming sandstones can be best understood as deposited by episodic sheet floods covering large areas of a flat lying alluvial plain. This plain lay along the sea shore, as deduced from the lagoonal and marine intercalations described above.

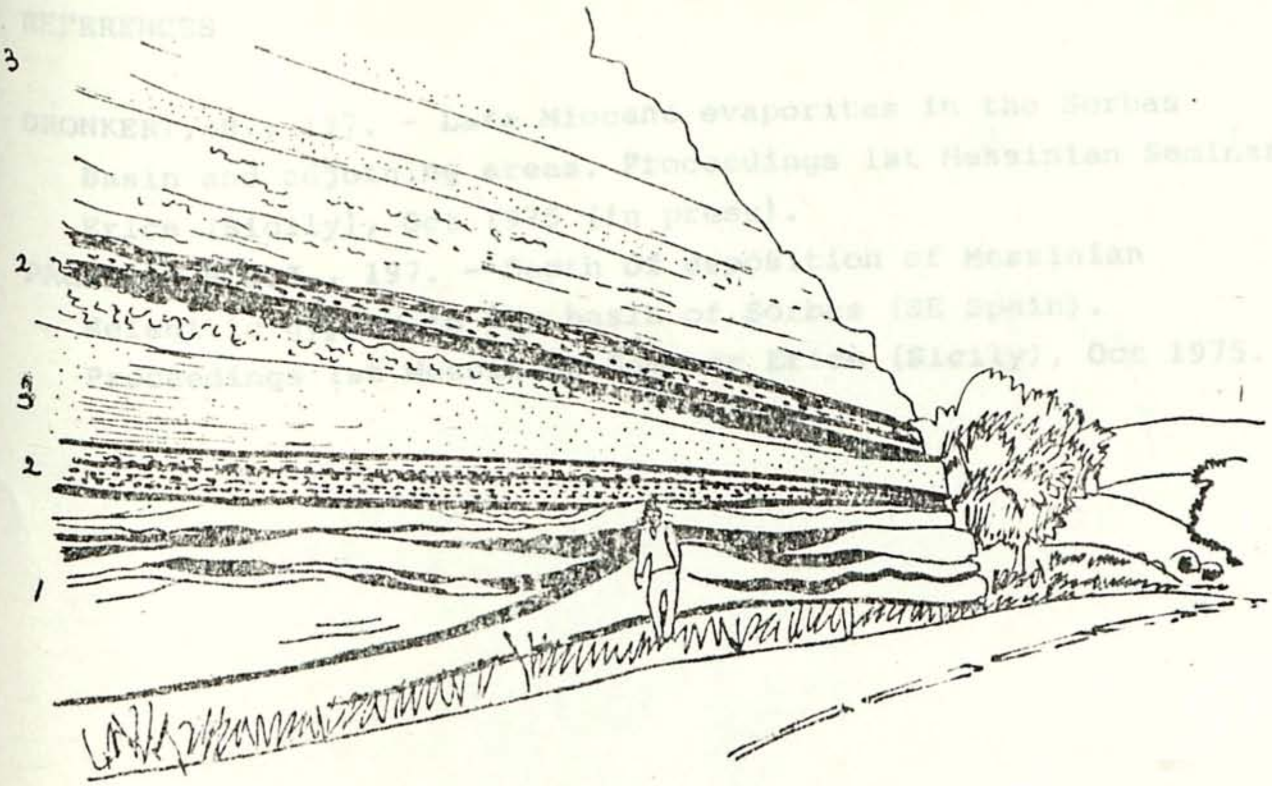


Fig. 14. Zorreras Member with sand-filled fluvial channels (1); calcretic pinkish soils (2) and sheet-forming sandstone, deposited by sheet floods (3).

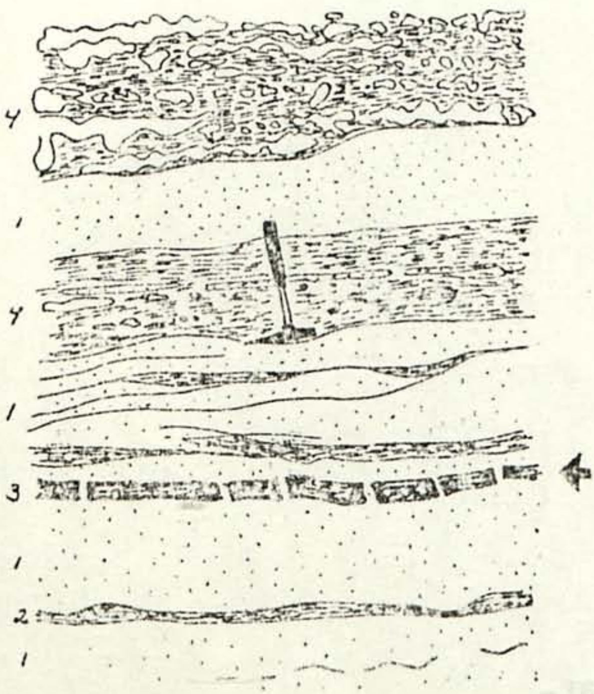


Fig. 15
Detail of Fig. 14. Desiccation cracks in clay layer (3).
1. sandstone
2. clay
4. calcareous nodules in paleosoil
Handle of hammer is 30 cm long.

REFERENCES

DRONKERT, H., 197. - Late Miocene evaporites in the Sorbas Basin and adjoining areas. Proceedings 1st Messinian Seminar Erice (Sicily), Oct 1975 (in press).

PAGNIER, H.M.J., 197. - Depth of deposition of Messinian selenitic gypsum in the basin of Sorbas (SE Spain). Proceedings 1st Messinian Seminar Erice (Sicily), Oct 1975.