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A TWO STAGE DIAPIRIC EVENT IN THE EASTERN PREBETIC

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RESUMEN

Se describen 8 diapiros evaporíticos, que muy posiblemente representen un proceso de diapirismo en el dominio prebético oriental. La historia del emplazamiento de estos cuerpos muestra que la intrusión pudo haber tenido lugar durante dos episodios distintos, bajo regímenes de distensión en el área. El episodio más antiguo motivó una elevación diapírica en niveles del Cretácico inferior, probablemente en forma de «salt walls» sobre fallas del basamento. El episodio más moderno tuvo lugar posteriormente a la deposición de los sedimentos tortonienses y antes de los 7,4 Ma. en que se produce en el área un volcanismo lamproítico.

Palabras clave: *Prebético, diapirismo, penetración diapírica, fallas de basamento.*

ABSTRACT

A description is given of eight diapiric evaporite occurrences that most likely represent true piercement diapirs in the Eastern Prebetic domain. The history of emplacement of these bodies is evaluated and it is concluded that intrusion most likely took place in two distinct episodes during which tensional regimes reigned in the area. The older episode caused diapiric rise to Lower Cretaceous levels, probably in the form of salt walls above basement faults. The younger episode of active diapirism took place subsequent to deposition of Tortonian sediments and prior to 7.4 Ma. lamproite volcanism in the area.

Key words: *Prebetic, diapirism, basement faults.*

Introduction

A regional mapping study on the structure of the Prebetic to the east of the Cazorla-Hellin fold arc revealed a lack of coherent knowledge about the structure of the Triassic occurrences in the area. They have hitherto all been ascribed to some kind of diapirism intruding overlying Jurassic, Cretaceous and Tertiary sediments. Our attention is focussed on those Triassic occurrences that most likely represent true piercement diapirs.

Geological setting

The External Zone of the Betic Cordilleras in southern Spain represents the non-metamorphic sedimentary wedge covering the variscan basement at the south side of the Iberian peninsula. This wedge was deformed in Miocene times, and the epicontinental deposits with intervals of continental sedimentation nearest to the peninsula, are now incorporated in the so-called Prebetic. The continental slope deposits of more southern origin are supposed to be represented nowadays by the so-called Subbetic that has been thrust in NW-direction onto the Prebetic domain. The base of the Subbetic thrust units is formed by Triassic evaporites that served as a detachment level in the original sequence.

The sediments of the Prebetic are of Mesozoic and Tertiary age. Their stratigraphy has been described extensively by various authors (see e.g. García-Hernández *et al.*, 1980; Hermes, 1978). The stratigraphic column shows a diminishing thickness in NW-direction towards the Meseta. Abrupt thickness and facies changes occur at various levels and at specific locations, here inferred to represent basement faults. The thickness of the Jurassic and Tertiary rockpile varies from 800 to 2.000 meters at the longi-

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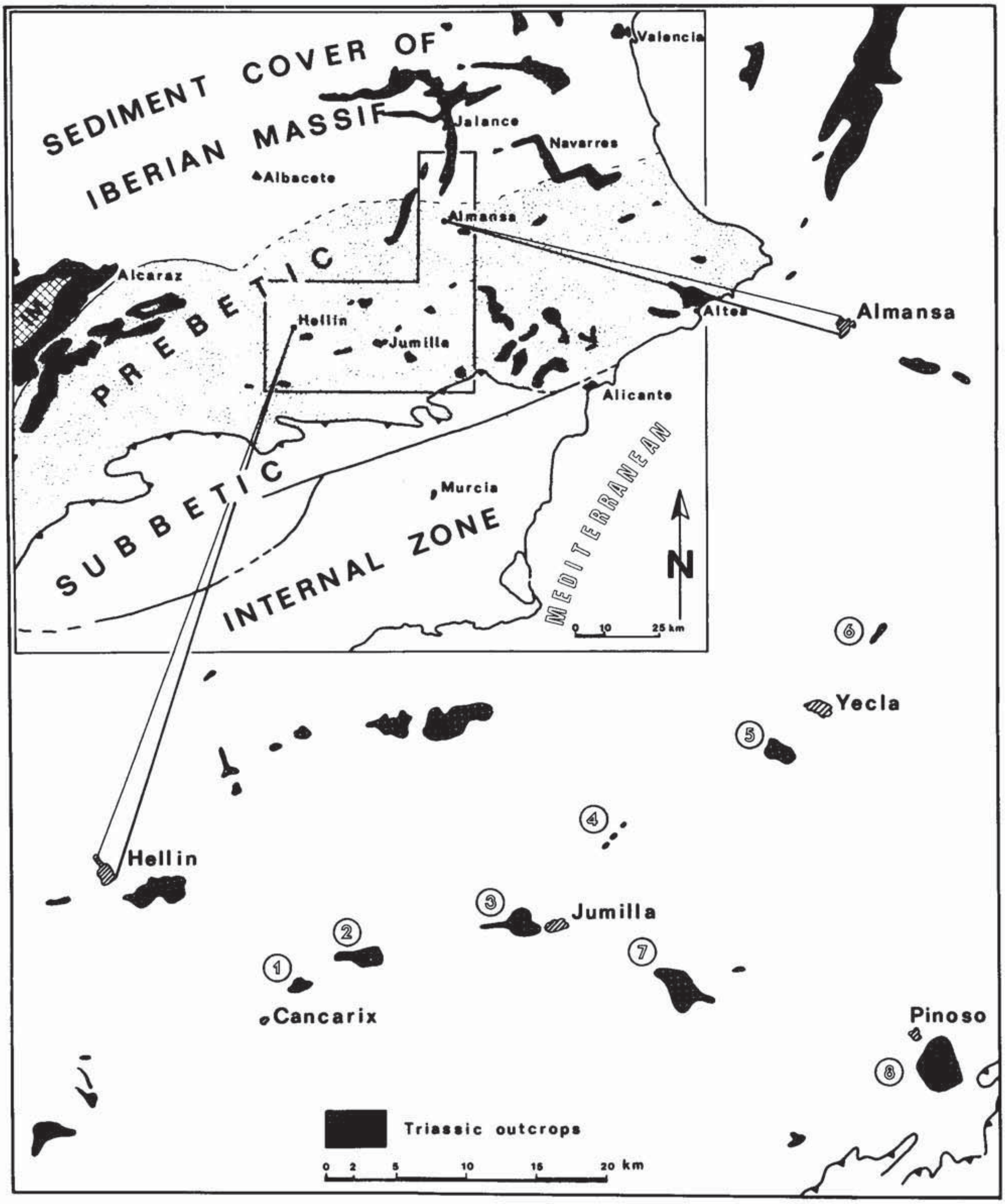

Fig. 1.—The extension of the Prebetic domain in SE Spain and the occurrence of Triassic rock bodies. The diapiric occurrences of this paper are indicated with numbers.

tude of Jumilla, centre of the studied area. The thickness of the Triassic is not known since the Triassic sediments are exposed only in diapriric structures.

Manifestations of a specific volcanism dated at 7.4 - 7.2 Ma. (Nobel *et al.,* 1981) are associated with these diapirs. They occur in zones that are held to represent the locus of basement faults. The volcanic rocks are lamproites know by the names of Jumillite and Cancalite (Fuster *et al.,* 1967). They are found in an ENE-WSW zone running from Cancarix over Jumilla to Yecla (fig. 1).

Mesozoic deformations in the area are deduced from rapid facies changes and thickness variations in the Mesozoic formations. They are repeated vertical movements on basement fault-zones or hinges, reportedly coinciding with the diapiric and volcanic occurrences. The first tectonic activity involving translations of the post-variscan cover is witnessed by non-datable continental deposits of the Colorados formation overlying marine Late Lutetian sediments and covered by Early Miocene rocks (Croese, 1983). Serravallian to Early Tortonian sedimentation took place in tectonically active basins during the main tectonic event (Croese, 1983) which resulted in faulting and localized, probably gravity-induced folding and thrusting. Subsequent distortions are of local character and strongly linked with the diapir occurrences.

Triassic rocks in the KAP rebetics

For the purpose of our present study, the precise stratigraphy of the Triassic deposits is not of prime importance. The interested reader is referred to Orti Cabo (1974) who presents an overview of the Triassic formations in SE Spain that contain the evaporitic layers in the studied area.

The Triassic rocks in the Prebetic are exposed in two types of map patterns: elongate large and elliptical small (fig. 1). In the long stretched zones, as e.g. those to the north and west of Almansa (fig. 1), only small amounts of evaporitic material participate judging from surface observations. They largely consist of red sandstones, silstones and slates with gypsum and carbonate levels; diabases are locally represented. The sequence evidently contains rocksalt since salinas are found in various places. These elongate Triassic zones normally are morphologic depressions surrounded by mountain areas of Cretaceous carbonate rocks. Some of the depressions do not have surficial drainage. Many of them show important infills of Mio-Pliocene and Quaternary sediments. The elongation, direction and spatial distribution of the occurrences suggest their origin to be related to basement block movements.

The circular or elliptical occurrences of Triassic rocks in the studied area pierce through the surrounding sediments. They form isolated mountains of considerable relief and with a radial or circular drainage pattern. Gypsum, anhydrite and clayey marls are the main constituents of the rock body visible in the outcrop. The outermost surface layer usually consists of gypsum with solution residuals and rock fragments of different compositions. It is the caprock of the Triassic evaporite body that evidently constitutes the main rockmass. In a number of occurrences, the presence of huge amounts of rocksalt has been proven. The estimated reserve in the Cabezo de la Sal near Pinoso is in the order of 600.000.000 tons (Rocamora & Rafols, 1980). In the opinion of Orti Cabo (1974) the rocksalt belongs to the lowermost (Jarafuel) formation of the Keuper. The rounded outlines of the occurrences and their relation with respect to the country rock suggests a diapiric origin. Recently, Mancheño Jiménez & Rodríguez Estrella (1985) presented detailed maps of a number of these diapirs.

Both types of Triassic occurrences —elongate and elliptical— are normally ascribed to diapirism (Rodríguez Estrella, 1977), though it is difficult to explain in this way the elongate structures in which only small amounts of evaporitic material are observed to participate. Diapiric ascent certainly seems to have played a role, but fault activity might be a major factor. Rodríguez Estrella (1977) presents in his figures a mechanism according to this idea. Movements along basement faults generate differences in overburden on the Triassic evaporite levels in depth, thus causing upward flow towards zones of weakness in the cover, pushing up the overlying rock sequence. Polveche (1962) ascribes the elongate Triassic occurrence of Finestrat in the easternmost Prebetic to a slow diapiric ascent along preferred lines of tectonic weakness in the overlying Mesozoic sediments. This movement would have started early, influencing the sedimentation. Moseley *et al.,* (1981) interprets the elongate Triassic occurrences at Finestrat and Altea as being emplaced along wrench faults; they are tectonically controled piercement structures.

For the circular occurrences of Triassic rocks Fourcade (1969) suggested a similar mechanism. The close association of volcanics and gypsum diapirs in a restricted zone from Cancarix to Yecla to him indicated that a deep basement fault underlies this zone.

The diapirs

This paper focusses on several non-elongate diapiric structures in the northern part of the province of Murcia and inmediate surroundings. The almost circular form of these phenomena makes a purely diapiric ascent highly probable, without intervening fault activity along fundamental faults. Eight diapirs from the area studied (fig. 1) will be discussed. A few were recently mapped by Mancheño Jiménez and Rodríguez Estrella (1985). Emphasis in this paper will be on the history of emplacement, the rate of uplift and consequently on the factors that contributed to this uplift. The features that the diapirs have in common will be outlined prior to the description of the individual diapirs.

All of the diapirs cut through structures that developed during the youngest orogenic movements in the area which took place between Serravallian and Early Tortonian. They are true piercement diapirs, most of which are observed at the level of the Lower Cretaceous incompetent beds. The association of Lower Cretaceous sediments and diapiric material is very remarkable. Remnants of Upper Cretaceous carbonate formations may be present. The diapirs consist of layers of anhydrite and gypsum with intercalations of clayey marls. The first meters inmediately below the weathering surface always consist of chaotic caprock: a melange of gypsum and residuals of insoluble matter and rock fragments. Only locally —in rapidly eroded gullies— can be observed that the evaporites have been folded intensively and that flow patterns are present. There is clear evidence that in most diapirs a considerable amount of rocksalt is present. In four of the studied diapirs mining of rocksalt still occurs.

Support for the theory that the diapirs in their present form are young structures comes from the significant relief of all but one, varying from 50 up to 300 meters above the surrounding terrain. Because of the high rate of erosion of most diapirs due to dissolution, still existing relief indicates the young age of ascent. According to information from the saltworkings at Pinoso, no recent vertical movement of the diapir can be substantiated. However, due to gravity and favoured by climatological conditions (Talbot & Rogers, 1980), gypsum is flowing sideways from several of the diapirs. Good examples are present at the SW-side of the Cabezo de la Rosa diapir.

A striking feature of all investigated diapirs is the occurrence of volcanics intruded into the gypsum. Whether they now are in situ or have been brought to the surface by the flowing evaporites will follow from the descriptions of the individual diapirs in the following paragraphs.

The *Quijonate diapir* (1) has a surface area of about 1,5 km.² that is almost completely covered by gypsum. Lamproitic dikes fringe the borders of the diapir at the south and northwestern side. The central portion of the diapir contains an ENE-WSW dike in its eastern part only, thus being largely devoid of intrusive rocks. The dikes show pinch-and-swell structures. Since no internal deformation of the dike material could be observed, it is thought that the pinch-and-swell structure is of primary origin and that the volcanics were emplaced in situ. External deformation of the dikes could not be observed either. The slight bending of some dikes is considered an original intrusive feature caused by intrusion along the cylindrical outline of the diapir. In the western central part of the structure, a considerable sink in the relief suggests collapse of the diapir.

Just off the SW side of the diapir, a lamproitic lava originating from the Sierra de Cabras, several km's further to the West, influences lacustrine clays and marls that are held to indicate the Tortonian on the basis of the occurrence of *Micromelladia*. The rocks —lava and lacustrine sediments— have been strongly tilted as the result of halokinetic movements.

The diapir of Quijonate (1) pierces overthrust structures that have been formed during the main deformation period. It cuts through more than 700 meters of Jurassic and Lower Cretaceous sediments.

To the east follows the important *Madax diapir* (2) of La Celia with a surface area of about 5 km.² It is the lowest and least circular of the investigated diapirs with an aspect ratio of about 3 as a consequence of its composite character. The east side is occupied by a relatively old diapir of little topographic relief that has been intruded by the remainder of the Madax diapir body, now showing young erosional features. On the southern side of the diapir one finds a brine producing well and salinas that have periodically been worked. The diapir shows the vivid red colours characteristic for the gypsum of Keuper age. The body is fringed in its eastern half by lamproitic dikes. The dikes roughly follow the contact with the country rock. They locally cut the steeply inward-inclined layering of the gypsum beds. As in the Quijonate diapir, several of the dikes have a curved appearance with no sign of deformation. Off the eastern side of the diapir lie the famous mineralisations and lamproite occurrences of La Celia (Fuster *et al.*, 1967).

The contact relations around the diapir are not clear, partly because the contacts are covered by recent sediments. The elongated E-W form of the diapir seems to be determined by faults, especially along the northern boundary. Several small pipes intrude the country rock. Jurassic rocks only occur in a very small outcrop on the faulted northern boundary. Cretaceous rocks and continental Neogene sediments have been strongly influenced by diapiric uplift, but important gravity faults towards the diapir witness displacements in opposite sense, probably as the consequence of subrosion.

Continental Tortonian conglomerates at the extreme southeastern side of the structure dip off the diapir and they have been intruded by a volcanic pipe. More recent sediments cover the contact. To the north these conglomerates contain erosion products of the diapir. They are furthermore observed to contain intercalations of lava flows and small abortive dike intrusions of the lamproitic suite. Coarse detritus of

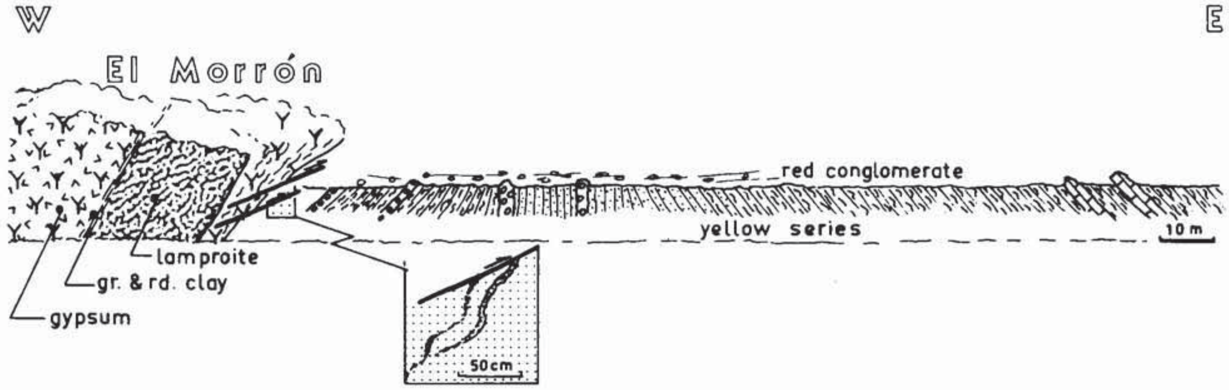

Fig. 2.—The diapir/host rock relation at the east side of the El Morron diapir. The diapiric system is sheared (see inset) over the overturned yellow Tortonian sandstone-marl series that is unconformably covered by red conglomerates. A lamproitic dike is intruded in the green and red clays with gypsum that form the outer rim of the diapir body.

lamproitic matter occurs in the younger part of the formation above an intraformational unconformity. The volcanic rocks from La Celia have been dated at 7.2 - 7.4 Ma (Nobel *et al.*, 1981). All observations so far are indicative of upward migration of the evaporites during the deposition of the continental sediments that are supposedly of Tortonian age, and prior to the lamproitic volcanism.

Movement of more recent date, be it upward migration of the diapiric body or surficial flow away from it, resulted in steepening of layering in recent sediments when approaching the main evaporite body.

The diapir of *El Morron* (3) is situated directly west of Jumilla. Salinas are exploited on its northeastern side. The diapir is surrounded by Tortonian sediments of marine and continental deposition. With the exception of the eastern side, the contacts with the country rock are obscured by recent alluvial deposits. The layering of the adjacent Cretaceous to the west is not indicative of the existence of a rim syncline at this level. In the local geological setting, the occurrence of a huge slab of Liassic dolomite on the SE side of the El Morrón diapir can only be explained by diapiric ascent. Dikes of lamproitic material first mentioned by Moline & Molina (1978) indicate the outerzone of the diapir with the exclusion of the northwestern side. The largest dike occurs on the east side and has a length of 1.5 km with a width of 30 meters. It is slightly concave towards the centre of the diapir. The lamproitic dikes —even the large ones— show no sign of deformation and it is therefore concluded that they have intruded the diapir subsequent to its eplacement. The pathways of intrusion were zones of weakness near the interface of diapir and country rock. A lamproite pipe on the north side of the diapir has been dated at 7.4 Ma.

In the central portion of the diapir some small occurrences of phenoandesitic rocks have been found. The rocks are chemically unrelated to the lamproites. They occur in large angular blocks with secondary mineralizations. These blocks are probably floating bodies in the diapir, broken up while being transported upwards in or by the ascending evaporites.

On the eastern side of the diapir occurs a well exposed section that shows the relation of diapir and country rock. It lies just off the large lamproite dike and is schematically presented in fig. 2. A red, continental conglomerate in subhorizontal position is seen in unconformably relation with underlying yellow marine Tortonian sediments that were overturned by the ascending diapir. The diapir-country rock contact dips diapirwards and exhibits simple shear phenomena in the inmediate contact zone. The first meter of the red conglomerate nearly exclusively contains fragments of lamproite and of gypsum. The Tortonian sediments show a gradual decrease in inclination away from the diapir with the result that the angular relation between these two types of deposits can no longer be observed furtheraway from the diapir. The conglomerate is correlated here with the Tortonian sediments near the Madax diapir.

The series of events witnessed by the El Morron diapir thus seem to include:

1. Intrusion of pheno-andesites in the evaporitic Triassic.
2. Intrusion of evaporites, during or subsequent to deposition of the higher parts of the marine Tortonian sequence.
3. Intrusion of lamproitic rocks.
4. Important erosion and deposition of an unconformable continental conglomerate cover.

The El Morron diapir has a straight offshoot on its west side where a narrow zone of gypsum extends 1.5 km west from the main body in the central part of an E-W mountain ridge that mainly consists of Cretaceous and Neogene sediments. At first sight looking an anticline with both limbs consisting of Upper Cretaceous carbonate rocks, a closer view learns that the structure is of piercement origin. The contacts between the evaporites and the Cretaceous rocks are vertical and the layering in the Cretaceous is variable, though difficult to discern because of the high degree of fracturation and brecciation of the rock. The Cretaceous of the mountain ridge has been elevated about 80 meters above the surrounding terrain consisting of Tortonian marls and clays. When approaching the mountain, the Tortonian is seen to occur in vertical and overturned position, being dragged upwards by halokinetic movements. The stratigraphic thicknesses in addition to the topographical relief can account for an uplift of the diapiric material of at least 200 meters.

Between Jumilla and Yecla, to the south of *Fuente del Pino*, a number of small gypsum occurrences (4) can be found, aligned on an ENE-WSW ridge. Each of these occurrences occupies the centre of a domal structure. They represent small cylinders of evaporitic material with associated red and green Triassic clays, contained in brecciated and intensely faulted Lower Cretaceous sands, sandstones and carbonate rocks. One of the gypsum cores has been mined and it shows perfectly well the circular form of the occurrence and the vertical contact with the country rock. Altered fragments of Lower Cretaceous material with veins of intruded gypsum occur in the diapir. The cylinders pierce a continental sequence of supposedly Tortonian age with a thickness that locally measures up to 80 meters. The location gives the impression that upward migrating evaporitic material pushed large blocks of Creataceous rock through the overlying Neogene. The westernmost occurrence is largest and contains some blocks of andesitic composition, altered by secondary mineralisation.

A reconstruction of the history of the diapirs of Fuente del Pino shows that intrusion occurred after the deposition of a continental Neogene sequence in the depression between the Sierra del Buey in the south and the Sierra de la Cingla in the north. This sequence had been deposited unconformably over Lower Cretaceous rocks that most probably were already in contact with evaporitic Triassic material since the small dimension of the diapirs makes a very undeep provenance most likely. The upward migrating evaporite cylinders pierced the roughly 100 meters thick Neogene sequence, creating with this vigorous intrusion the mountain ridge now containing the Cerro de los Bujes.

The diapir of *Yecla* (5) at three kilometers to the SW of the town of Yecla pierces a well-developed anticlinal structure in Upper Cretaceous carbonate rocks. The caprock of the diapir is up to 2 meters thin at the top. Few Cretaceous and Liassic remnants cover the diapiric body. The gypsum layer inmediately under the caprock shows small scale folds and chaotic flow patterns, together with mylonites and shear zones in which boudinage of gypsum-anhydrite veins is well developed. A gypsum melange obscures the diapiric contacts with the country rock as the result of sideways flowage of the gypsum layer.

Relating the Cretaceous rocks in the anticline to its remnants on top of the diapir, a vertical uplift of over 80 meters can be established to have occurred. This uplift could be considerably more in view of the remnants of the dragged southern limb of the anticline that occur several hundreds of meters away from the diapir to the south. Located between these Cretaceous remnants and the diapir lie two small angular fragments of andesitic material.

In the *Mote del Cojo* (6) to the NE of Yecla appears a regularly bedded, vertical to steeply inclined and highly fractured formation that is pierced on its SW extreme by a circular diapir with a diameter of 40 m and consisting of banded gypsum. The formation consists of grey, platy dolomites with algal lamination that alternate with stratified gypsum levels. The formation could be ascribed to the Supra Keuper. It occurs amidst Lower Cretaceous incompetent beds and it forms the central part of a vertically limbed anticlinal structure in Upper Cretaceous dolomites. The banding in the gypsum of the diapir is strongly contorted and shows foldaxes dipping at 70 to 90°.

The structure of the Monte del Cojo seems to indicate a forceful emplacement of the Supra Keuper formation with neglectance of the Jurassic, resulting in an anticlinal structure without Jurassic being involved. Piercement followed suite in a single location.

To the south of Jumilla rises the *La Rosa diapir* (7) to about 200 meters above the surrounding terrain. It is a diapir of considerable size and of elliptical outline. An appendix at its SE-end proves to be a superposed body in which rocksalt has been brought to the surface. It contains only small amounts of anhydrite. The salt is mined in an open pit where the caprock can be seen to reach a thickness of about 15 meters.

At the KAP and SW of the diapir, Tortonian sediments of marine and continental provenance have been pierced and dip away from the diapir. Locally they have been pushed over and are now inclined in overturned position towards the diapir. At the S side the steeply inclined unconformable contact of Lower Cretaceous rocks and coarsely clastic continental deposits of the Colorado formation of Late Lutetian - Early Miocene age (Croese, 1983) is cut by the diapiric structure. Here, the caprock locally overflows the country rock glacierlike.

The gypsum caprock is rich in secondary iron minerals. Haematite occurs in perfectly shaped, euhedral crystals, probably as a consequence of crystallisation in an environment with little resistance. Euhedral black magnesite individuals and iron cross twins of limonite have been found. These findings are indicative of important hydrothermal activity in the caprock. Several small volcanic bodies and angular fragments of andesitic composition have been found at the west side of the diapir.

The last diapir to be discussed here is in the area of Pinoso where the evaporites of the *Sierra de Sal* (8) have been elevated neary 300 meters above the surrounding plane. Recent sediments obscure the contact relations of the diapir and its host rock, making it difficult to determine the age of piercement. In the SW a series of continental Neogene sediments have been draped by the diapir.

History of emplacement

The extremely restricted amount of Jurassic rock elements within and directly without the diapirs just described, bears directly on the diapir's emplacement history, especially since Cretaceous remnants are by far more frequent. It cannot be explained by a simple and continuous emplacement history, nor by differences in competence between the carbonate rocks of Jurassic and Cretaceous age. Forcefull piercement of an overburden normally leads to incorporation in the diapir of fragments of rigidly behaving overlying levels, being brought to the surface by the rising diapir. The Upper Cretaceous remnants in the diapirs are considered to have been emplaced in this way, and so are some dolomite remnants of SupraKeuper/Infra-Liassic age. The disruption of regional fold structures as developed in Cretaceous carbonate rocks documents the piercing of the Upper Cretaceous to have occurred post folding of Serravallian-Tortonian age.

The absence of Jurassic rockremnants in the diapirs needs a different explanation and so does the restricted occurrence of Jurassic bordering the diapirs. It seems to witness an earlier piercement of the Jurassic series under different geological conditions. This earlier upward migration of Triassic evaporites should then have occurred with little vertical constraint, piercing the 600-700 m. thick Jurassic sequence that normally covers the Triassic mothersalt. It could have done so in two fundamentally different ways. In the first, emplacement is by means of continuously repeated undeep intrusion and extrusion as explained by Bishop (1978) for the general case. The time of emplacement is Jurassic and probably also Lower Cretaceous. In the second, unhindered piercement of the Jurassic occurred at a later moment along faults in a tensional regime at those places where the rigid Jurassic carbonate level had been disrupted at the locus of inmediately underlying basement faults. The rising diapir might have caused a slight doming of the resistent Upper Cretaceous while intruding with little lateral constraint at the level of the incompetent Lower Cretaceous Utrillas formation.

Since thickness variations of the sediments around individual diapirs are not known due to the lack of subsurface data, little can be said with determination about moments of diapiric activity and about the proceses contributing to the sedimentation around the diapirs, being either of tectonic or of depositional character. Only on the basis of circumstancial evidence and theoretical considerations can be decided on the mode of emplacement during the first piercement event, and on the moment at which the diapirs rise to Lower Cretaceous levels. Extrusive diapirism under conditions of sedimentation like those pertaining during deposition of the Utrillas formation, certainly should have left its imprint on the rocks. However, no insolubles of Triassic evaporite derivation have been found in this formation. Nor can earlier diapiric movement be documented within the realm studied. Unhindered Upper Cretaceous (-Palaeogene) rising as the mode of emplacement is therefore favoured in view of the important distensional movement at that time along the basement faults as reflected in the facies and thickness distribution of Upper Cretaceous sediments. The circular outlines of the diapirs do not suggest a direct relation with basement faults, but their regional arrangement does.

We thus envisage the formation of «salt walls» above basement faults as the result of Upper Cretaceous distension. It is followed subsequently by diapiric transection of Upper Cretaceous carbonates that participate in the regional fold structure. This second diapiric event led along the Cancarix-Yecla lineament to local diapiric movement resulting in the circular diapirs. The intrusion placed Upper Cretaceous and Tortonian sediments in steep position. Lamproitic rocks subsequently intruded along the side-walls of the already emplaced diapirs. These 7.4 Ma intrusives give no indication of important deformation that could result from subsequent diapiric ascent.

Participation of a large mass of Infraliassic without noticeable folding in the Monte del Cojo (7) and there absence of the main body of Jurassic sediments therein, indicates the freeing of the Infraliassic material along faults and its sideways intrusion in the incompetent Lower Cretaceous Utrillas formation. The freedom of movement it implies is the result of the original position of the Infraliassic between the plastic layers of the Triassic and the Liassic.

The diapirism in the area thus occurred in two distinctly separated time intervals. There is no evidence in the sediments, nor in the structures for continuous diapirism during lengthy periods of time.

The older diapiric event is coupled to a distensional tectonic regime that reigned in the Prebetic during the Mesozoic and Paleogene, and that relates to the character of passive continental margin of the area during that period. Little can be said about the velocity of this older diapirism that occurred prior to the main deformation episode of Serravallian- -Tortonian age.

Looking for the cause of the diapirism, it can be decided that the thickness of the post-Triassic sedimentary column is insufficient to be held responsible for diapirism by differential loading and buoyancy as the result of density contrast between the relatively light Triassic evaporite series and the heavier overing sediments. Overburden thicknesses in excess of 1500 m are accepted to be necessary for the evaporites to obtain the required viscosity for this mechanism (Gussow, 1968). Strata dipping away from the diapir that are in the buoyancy model held to be the result of non-piercement folding of the overburden preceding intrusion, are reported from the Pinoso occurrence only. Is it coincidence that the thickness of the post Triassic here amounts to about 1800 m, whereas the maximum thickness in the area of the other diapirs amounts to about 1000 m? At least for these other diapirs tectonic pathways of reduced vertical constraint are a necessity to lead the mothersalt to higher levels. These ways are not difficult to envisage in view of documented sedimentary facies and thickness changes along suggested basement faults. Buoyancy is one of the mechanisms in the ascent of the diapirs along the tectonic discontinuities. The higher thermal gradients that logically existed along the basement faults, might have been necessary in decreasing the viscosity of the evaporites, thus stimulating diapiric movement.

In the case of the younger event of active diapirism, the ascent of diapiric matter is restricted to the time span between the folding and thrusting in the area and the lamproitic volcanism, i.e. a period of about 6 Ma, or between the deposition of the Tortonian sediments and the volcanism, i.e. 3 Ma. The tectonic regime along the Cancarix-Yecla lineament is thus witnessed to have changed rapidly from compressional during the deformation phase to tensional during the intrusion of the volcanites, thereby allowing diapiric ascent. Rapid changes in regime like this one are in the Prebetic situation ascribed to a continuous tensional regional situation in which gravitational respons to tilting of basement fault blocs caused compressional regimes of only local importance.

The strongly localized, vigorous piercement during the younger diapiric event caused gravity gliding away from the diapirs, creating structures that do not conform in direction with those generated during earlier tectonic episodes.

In order to account for such local diapiric rise, it seems that local causes need to be sought. Our thoughts center on heating of the salt mass by intrusion of volcanic material. The intrusion is envisaged to have occurred in depth within the salt wall formed during the first diapiric event and with the salt mass blocking, or at least slowing down the upwards escape of volcanic matter. The volcanics dissipate their heat to the salt, causing expansion and drastic decrease of viscosities, thus facillitating diapiric ascent. Columns of hot salt may have forcefully intruded the overburden as a result of convection. Volcanic dikes now could reach the earth's surface along the ways of least resistance offered by the diapir's side-walls.

The two-step cooling of the magma inherent to this explanation seems to be witnessed by a highly differentiated 1.5 km dyke in the El Morrón diapir that shows evidence of filter pressing. It could have occurred when the pressure on the magma caught beneath or within the evaporites, was suddenly reduced due to the ascent of the evaporites.

The relation of diapirism and volcanism here presented should not be confused with that envisaged by O'Brien (1957) for the Cambrian salt diapirism in Persia, where cooling and therewith shrinking volcanic pipes offered the necessary space for salt to surge upwards.

In order to fit this two stage diapirism of true piercement diapirs from the Jumilla area into surrounding domains within the Prebetic, it is first of all necessary to look into the stratigraphic development and the structure of the domains.

On the basis of an extensive study of literature and on his own field observations, Rodríguez Estrella (1977) produced isopach and isofacies maps for the Prebetic to the East of the Jumilla area. They indicate a generally southward deepening environment of deposition with ENE-WSW oriented depocenters, reflected in changing sediment thicknesses. These changes in sediment thickness, most likely induced by faulting of the basement underlying the basin of deposition, agree with a southward steepening of the area of deposition as can be judged from submarine sliding since Aptian times. The Aptian also marks the start of active diapirism; reworked and probably extruded Triassic material is reported by Leclerc & Azema (1976) in Upper Aptian to Maestrichtian sediments. This active diapirism should have played a role in the distribution of sediment thickness of the Senonian that locally unconformably overlies Cenonian and Turonian sediments. During the Tertiary, diapirism is witnessed to have been active since the Ypresian, leading to gravitational gliding of masses reported to have occurred since the Lower Miocene (Rodríguez Estrella, 1977).

The impression is that diapirism to the east of the Elche-Villena crosslineament has proceeded since Aptian times in a vertically unconstrained manner, even forming extrusions at some locations. This diapirism is thought to be related to the increasing, but southwards diminishing, sediment thickness on top of the Triassic evaporites, forcing plastic Triassic upwards and away from the Iberian continent to form incipient ridges on the oceanside of the sedimentwedge (Bishop, 1978).

The development of the diapirs in this eastern area seems to contrast strongly with that in the Jumilla area. In this eastern part, downbuilding of the sedimentbasin around the diapirs could have been effective, at least since the Aptian. In the Jumilla area, however, there is no indication for such behavior, probably as the result of a more restricted basinal subsidence.

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