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DIATOMITE DEPOSITS IN SOUTHEASTERN SPAIN: GEOLOGIC AND ECONOMIC ASPECTS

by

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Introduction. Commercial diatomite deposits are widely extended in circum-Mediterranean areas, and elsewhere within Neogene formations in Europe. Spanish contribution of diatomites to the world production is limited in comparison with other main producer countries, but it is significant for regional markets in Western Europe and North Africa. Total production of diatomites in Spain exceeded 60,000 tons in 1982—1983 (official statistics, Ministery of Industry). It means a considerable increase, bearing in mind that spanish diatomite production reached up only 20,000 tons in the last seventies.

This noteworthy increase has been reached due to extensive explotation of diatomite deposits in some areas of SE Spain (prov. of Albacete), which have replaced other previously main producer areas.

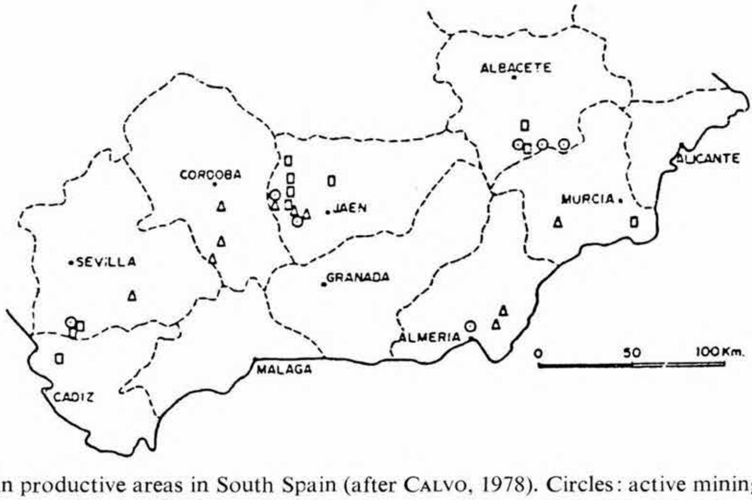

Fig. 1. Main productive areas in South Spain (after CALVO, 1978). Circles: active mining, squares: previous productive areas, triangles: non economic diatomite deposits

Diatomite deposits in Spain are restricted to the southern regions (Fig. 1). Diatomites occur in Miocene and Pliocene formations, both continental and marine. The highest concentration of active mining is sited, at present-day, in south Albacete. First references on diatomites in this area belong to AREITIO (1873), who published some brief reports on diatoms found in a few levels near Hellín. These former data were gathered up by AZPEITIA (1911) in his synthetical study on spanish diatoms. No more references on these deposits can be found until the paper by MARGALEF (1953), who updated the previously used palaeontological nomenclature and made an extremely detailed study on palaeoecology inferred from the diatom associations. The stratigraphy of the Neogene formations in which diatomite deposits are included was studied by JEREZ MIR (1973), CALVO et al. (1978), and BELLON et al. (1981). Further descriptions of diatomites in the region belong to CALVO et al. (1978), CALVO (1980), CALVO and ELIZAGA (1985).

Geologic setting

Diatomite productive areas are located in the most external zones (Prebetic Zone) of the Betic Ranges, to the southeast of the Iberian Peninsula (Fig. 2). A major structural feature, the Subbetic Front, is extended in the vicinities of the study area. Miocene continental basins were the result of generalised extensional movements, subsequent to a main compressive phase during the Early Tortonian (CALVO et al., 1978). Afterwards, sedimentary filling of those basins occurred during the Vallesian and Turolian, as indicated by mammals (CALVO et al. o.c.) and radiometric data.

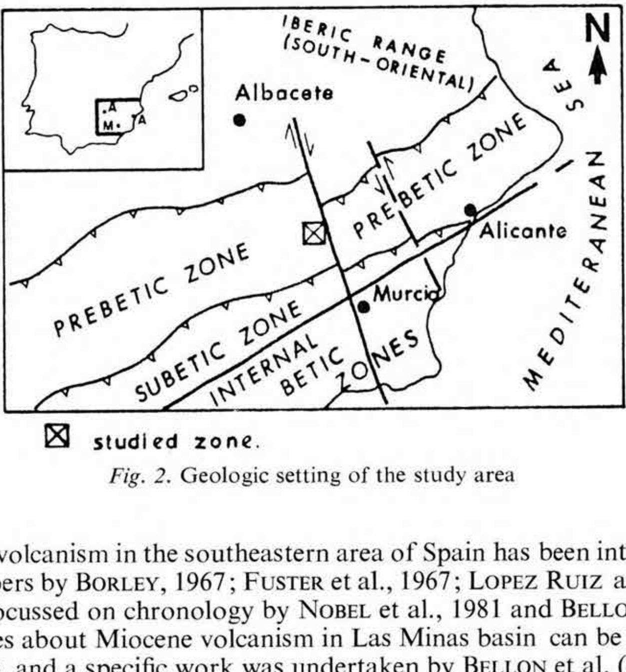

Fig. 2. Geologic setting of the study area

Neogene volcanism in the southeastern area of Spain has been intensively studie (petrologic papers by BORLEY, 1967; FUSTER et al., 1967; LOPEZ RUIZ and RODRIGUEZ 1980; papers focussed on chronology by NOBEL et al., 1981 and BELLON et al., 1983). Some references about Miocene volcanism in Las Minas basin can be found in some of these papers, and a specific work was undertaken by BELLON et al. (1981) to determine the radiometric age of volcanic rocks in the Cerro del Monagrillo. A K/Ar age of 5.7 ± 0.3 Ma. was reported for these rocks. However, some uncertainties remained on the lithostratigraphic relationships between the volcanism and the Neogene sequence.

Neogene lithostratigraphy

Continental bearing diatomite formations disconformably overlied previous marine sequences of Middle Miocene age in the study area. Middle Miocene marine deposits consist of monotonous sequences of marly platform facies and biocalcarenitic, more littoral, deposits (Calvo, 1978) that discontinuously covered the area before retreat of the sea towards the south. The youngest marine deposits in the study area have been dated as lower Tortonian (Usera et al., 1979; Bellon et al., 1981).

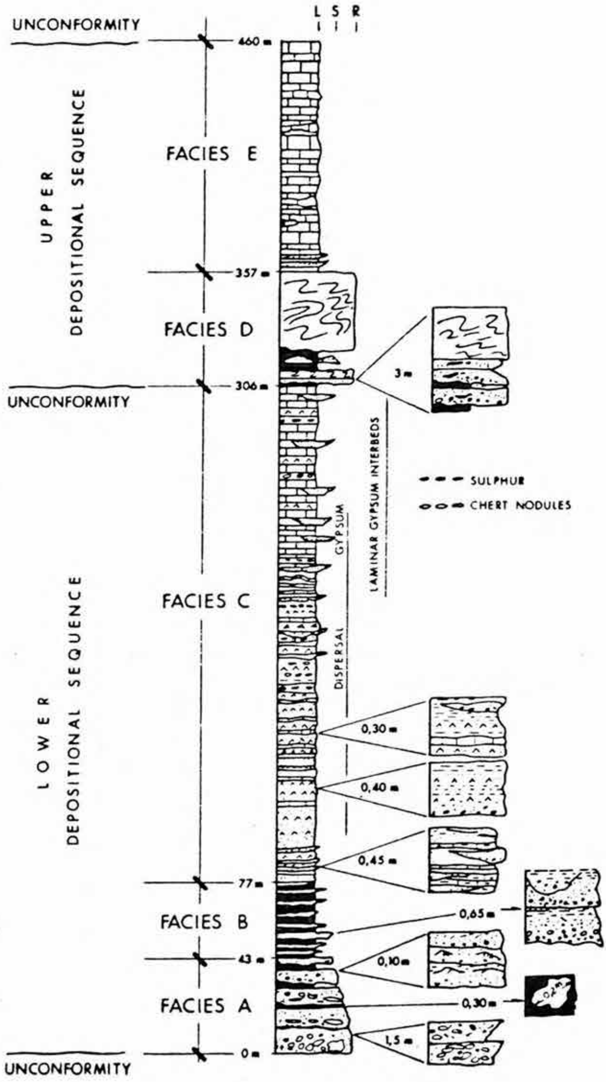

Fig. 3. Lithostratigraphic log of Miocene continental deposits in the western side of the Cenajo basin (after Calvo and Elizaga, 1985)

Investigations on diatomites have been focussed on three distinctive, although partially interconnected, basins. Two of them (Las Minas and Cenajo basins) show the most complete sequences of continental Miocene formations. Greatest thickness observed reaches up about 460 m in the western side of the Cenajo basin. Probably, this thickness value is greater in the central part of Las Minas Basin, but no drilling or geophysic data are available.

Surrounding reliefs (Mesozoic: conglomerates and sandstones, limestones and dolostones; middle Miocene: bioclastic carbonates and marls) supplied detritus to marginal areas in the basins. Outcropping terrigenous marginal deposits are specially well exposed where Triassic protruded the Neogene formations.

Two major Depositional Sequences have been recognized within the continental Miocene deposits. The Lower Depositional Sequence is up to 306 m thick in the western part of the Cenajo basin. It is made up by a fining upward sequence of conglomerates, interbedded sandstones and shales, and shaly gypsiferous beds passing upwards to predominant carbonate sediments. Three distinctive facies have been consequently defined within the Lower Depositional Sequence (Fig. 3).

Upper Depositional Sequence reaches up some more than 150 m in the described section. Two main facies can be easely distinguished. Clastic and strongly deformed-to-brecciated carbonate and diatomaceous sediments form the lower facies (facies D), overlying deposits of the previous sequence. A continuous succession of laminated chalks and diatomites (facies E) tops the section at this point.

Both main Depositional Sequences are largely extended along the Cenajo basin and also they can be detected in the larger Las Minas basin. The latter one displays a more definite gypsiferous sequence (tabular continuous gypsum beds with formerly economic deposits). An outstanding feature in this basin is the occurrence of the above mentioned volcanic rocks of the Cerro del Monagrillo. Besides the radiometric data obtained, physical evidences for an intra-Miocene age of this volcanism also may be shown. They will be discussed below.

Sedimentary evolution

Miocene continental basins in the study area behaved as tectonically controlled, close lake systems. At least during some periods, partial connection among the different basins must be suspected, but no definitive criteria have been yet found to prove it. Sedimentary fill of the basin was accomplished by means of both detrital supplies from surrounding reliefs and autochtonous chemical and/or biogenic lacustrine deposits. Vertical sequences of the major facies, as previously described, closely reflect a progressive enlargement of the lake facies and, probably, a relative deepening of the water bodies.

Results from the sedimentological analysis, the Lower and Upper Depositional Sequence (CALVO and ELIZAGA, 1985) may be summarized as follows:

Lower Depositional Sequence

Facies A (thinning-upwards conglomerate—sandstone sequence): it represent a first stage of lake fill by adjacent small alluvial fans. Coarse detrital sheets entered the lake leading to a slow fill and subsequent transgression of the lacustrine facies.

Facies B (channeled and sheet sandstones interlayered with lutites): they are interpreted as even-exposed, marginal lacustrine deposits with a progressive minor clastic inflow.

Facies C (mudstones with thin sandstone sheets and gypsum): it represents a steady transgressive trend in lake deposition. Lower part of this facies may be ascribed to sedimentation in more or less shallow, slightly saline, lacustrine areas, with gypsum precipitation and further sulphur nodules development. Upper part of the facies is carbonate predominant, with minor clastic inflow (thin lenticular sandy sheets) by micro-density currents.

Upper Depositional Sequence

A sharp sedimentary discontinuity indicates the lower boundary of this sequence. Basinal conditions were reached at the end of the underlaying depositional unit. An initial event of large clastic inflow is represented by conglomerate—sandstone turbidite beds, that was continued by a 30 m thick single intraformational sedimentary slump structure (Fig. 4). Major descriptive features in this slump are translational and rotational slides, as well as slump-breccias. As pointed out above, facies D includes frequent diatomite beds, altogether with laminated chalks and thin sandstones.

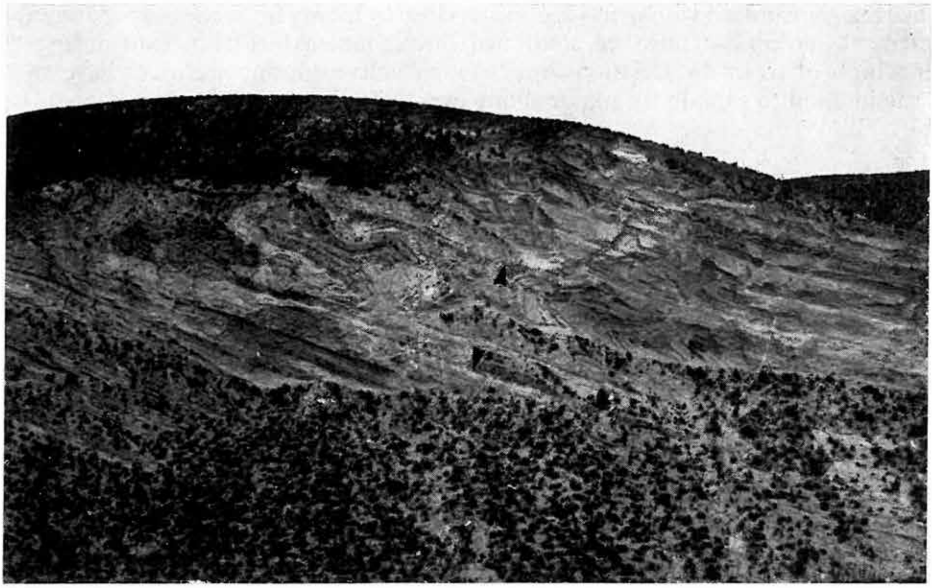

Fig. 4. General view of strongly deformed lacustrine deposits (Facies D). Arrows mark the base and the top of the slumping facies

Upper limit of the slump deposits is also marked by a sharp discontinuity. A thick, up to a hundred meters, sequence of very regular laminated chalks and diatomites tops the Miocene sequence in the study area.

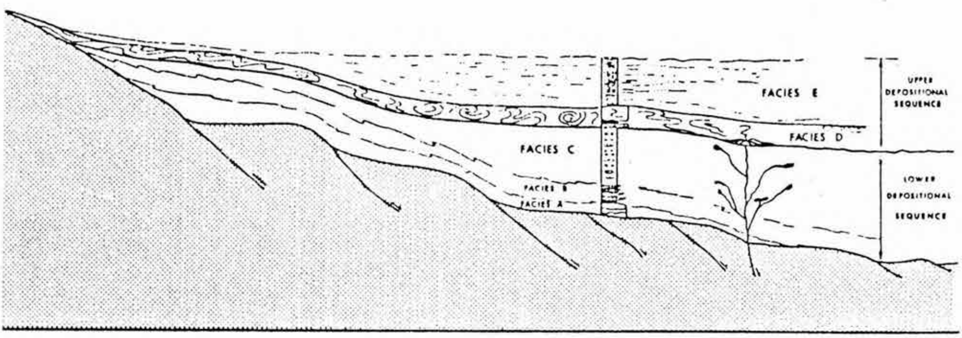

Fig. 5. Sketch of successive stages of sedimentation in the studied basins. Note tectonic readjustment of the lake floor, as well as the proposed localization of vulcanism in the Neogene sequence

Sedimentary evolution of the basins has been summarized in Fig. 5. Progressive deepening of the basins was accomplished through relative fault-controlled movements of the floor lake. The emplacement of volcanic rocks took place in the area after sedimentation of the Lower Depositional Sequence. Physical evidences of volcanic rock fragments mixed with marly sediments close to the slump facies corroborate that statement. Volcanism must be continued throughout a further period during the deposition of facies D. Relationships between volcanism and tectonics have to be borne in mind to explain the major slump event affecting lacustrine facies.

Discussion

The lithostratigraphic and sedimentological analysis of continental Miocene deposits in two of the main diatomite producer basins in SE Spain allow us to point out some main conclusions concerning the origin of these diatomite deposits. The continental character of the deposits is revealed by associated faunas (fishes, ophidia, amphibians, micromammals (CALVO et al., 1978) and the diatoms themselves, although some periodical brackish conditions can be deduced from the analysis of this flora (SERVANT-VILDARY, 1986). Also, the geological evolution of the area asserts this idea.

A close relationship between post-Alpine lamproitic volcanism (NOBEL et al., 1981) and the flourishing of diatoms in the basins may be proved, bearing in mind the occurrence of volcanic traces within the Upper Miocene sequence. So, volcanic traces have been found after the sedimentation of the Lower Depositional Sequence. Volcanism was indeed coincident with a tectonic readjustement of the basins, that triggered largescale delapsional events. Volcanic rocks have been dated at 5.7 ± 0.3 Ma, i.e. Turolian. It is also in agreement with the chronostratigraphic data deduced from mammal faunas found near the top of the sequence (Upper Turolian) (CALVO et al., 1978).

Diatomite beds are restricted to the Upper Depositional Sequence. So, they have been recognized more or less discontinuously along 154 m. Silica content was analysed thoroughout this interval. Palaeoecological data from fauna and flora associations have not yet been entirely evaluated but new studies are going on now. Anyway, present day evidence deduced from preliminary analysis of diatoms and associated faunes, seem to indicate a rather shallow, this is not very deep, lake during deposition of diatomites and chalks. Palaeobathimetric interpretation in lake basins are usually risky due to the variability of conditions in particular cases. As pointed out by GIBLING et al. (1985), "the depth of water in a perennial lake need not to have been great, and good preservation of laminae directly depends of the upper boundary of anaerobic bottom, that at times may be close to the sediment—water interface". The same idea has been expressed by BUSSON and NOEL (1972), who pointed out the relative independence of bathimetry and euxinic conditions at the lake bottom. So, specific thermal and/or chemical stratification of water in the lake seems to be sufficient for laminite preservation.

Relatively shallow conditions, perhaps ten meters or less depth, characterized the deposition of diatomites in the studied basins. It may be supported by interfingering and alternation of laminites with more littoral deposits (limestones and marls made up by fixed benthic algae and gastropoda) in some areas. Finally, seasonal control of sedimentation may be suspected by common occurrence of laminite couplets. An average thickness of 0.3—0.5 mm has been usually observed for these couplets.

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