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TERTIARY CLASTIC GYPSUM DEPOSITS IN THE MADRID BASIN (SPAIN)

by MEGIAS, A.G. (1), ORDOÑEZ, S. (2) and CALVO, J.P. (2)

(1) Eniepsa Hispanoil. Madrid.
(2) Dpto Petrología. Fac. C. Geológicas. Univ. Complutense

Introduction

The Madrid Basin, located at the center of the Iberic Peninsula, is made up by a thick infilling of tertiary sediments, mainly continental in origin, that was deposited from Eocene to Pliocene times. Neogene sediments in the basin may be separated in four main tecto-sedimentary units (TSU-1: Evaporitic Unit, TSU-2: Intermediate Unit, TSU-3: Arkosic Unit, TSU-4: Terminal Unit) defined by main sedimentary ruptures (MEGIAS et al., 1980, 1981). Inside this scheme TSU-1 and TSU-2 exhibit fairly thick gypsum successions as well as other saline minerals: anhydrite, Na-sulphates, halite, Mg-sulphates, .. (GARCIA DEL CURA et al., 1979). Pre-Neogene sediments are mostly formed by evaporitic facies.

First reference about detrital gypsum in the Madrid Basin was made by SAN JOSE (1975). Several gypsum clastic beds are contained into TSU-1 so as in TSU-2 (MEGIAS et al., ops cit.). Two main types of clastic gypsum deposits may be recognized : mass flow deposits and turbidite deposits. These one are only present into TSU-2 whereas mass flow type deposits are recognized in both units. So far, mass flow deposits exhibiting breccia and slump features have been observed in TSU-2.

Clastic gypsum has been described in the last fifteen years in some different formations, generally associated to deep-basin evporites (PAREA&RICCI LUCCHI, 1972, NESTEROFF, 1973, RICCI LUCCHI, 1973, SCHLAGER & BOLTZ, 1977, VAI & RICCI LUCCHI, 1977, SCHREIBER, 1978) and, less often, to ancient shallow environments (HARDIE & EUGSTER, 1971, SCHREIBER et al., 1976, ..). In all these cases references about clastic gypsum are related to marine environments.

Scarcity of these kinds of deposits has been commonly invocated to low resistance of gypsum to transport so its low durability in environmental conditions. Clastic gypsum described till now is concerned always with subaqueous facies and generally related to high sedimentation rates in marine environments, this is, with relatively high saline concentrations.

Clastic gypsum deposits described in this paper have some particularities because of their continental character. The deposits may be attributed to relatively deep subaqueous environments, though some beds may have been deposited below a shallow water layer.

Description of gypsum clastic beds

The main types of clastic gypsum observed are:

a) Clastic gypsum mass-flow deposits: morphology of the deposits is tongue-like sheets composed of gypsum and/or anhydrite fragments, carbonatic (calcite, dolomite, indured marls) fragments, mixed in a shale sandy matrix. Sometimes clasts are cemented by gypsiferous cement. The deposits are similar to the "layered chaotic gypsum" obsequence thicker than 60m.Such gypsarenites are commonly included in gypsarenite-chemical gypsum and/or carbonate cycles 1-2m thick (Fig.3) These cycles are considered as second order cycles(SHANMUGAM,1980). Overall sequence shows a fining-upward tendency (major relative abundance of chemical layers in top cycles).Moreover,some areas display a nearly total absence of chemical layers.

Clean sedimentary structures are badly seen in gypsarenite beds, probably due to difficult preservation in outcrops.Gypsarenite beds shows rough lamination pararell to bedding.So as,slightly erosive (channelized) lower surfaces are sometimes observed.Low-angle cross-bedding may be seen in some outcrops.

Gypsarenite beds are mainly composed by gypsum grains,1-2mm maximun size mixed with shale.Commonly,grain size grades slowly into chemical layers.Within a gypsarenite bed some minor cycles are often distinguished.Also,some gypsarenite beds are composed by abundant clay chips ranging in size from 2cm to 0.25cm.These clay chips-gypsarenite beds exhibit normal gradding and they are 25-40cm thick.

Thin-sections from detrital gypsum beds commonly permit to distinguish some minor micrometric cycles defined by coarse gypsum crystals which grades to smaller crystals and gypsum mosaic or carbonate mud.Observation of field samples permits to recognize the same disposition (Fig.4).Detrital gypsum crystals exhibit some different textures: elongate,lenticular,equigranular or round crystals.Other minerals are rare within the gypsum grains.Crystals commonly show a paralell bedding orientation trend.

Layered gypsarenite deposits are somewhere.associated to breccia mass flow deposits (massive chaotic bodies of gypsum of RICCI Lucchi,1973).These gypsum bodies are relatively small (thickness no more than 20-30m).Large fragments are composed by fragmented gypsarenite beds,layered carbonates and coarse gypsum fragments.Lower surfaces of these bodies are deeply erosive on layered gypsarenite deposits.Slump features are sometimes recognized in it.

Discussion

Clastic gypsum deposits are infrequent in the geologic record. Gypsum fragments are friable and easily soluble.High sensitivity of gypsum to diagenetic transformations and subsequent wipping out of primary structures get complicated the sedimentological analysis of the deposits.Only fresh cuts,as quarries or road-cuts,get possible and reliable observations about the characteristics of these deposits. By this,detailed analysis of clastic gypsum facies is commonly a hard work.

Formation and preservation of mechanically accumulated gypsum require two conditions from a theoretical point of view:1)high denudation rates in the source rock to prevent slow solution of the evaporites,2)conditions to prevent its destruction after deposition (high sedimentation rates,perhaps saturated conditions).Clastic gypsum mass-flow deposits described above were deposited in proximal areas near basin boundaries submitted to a rapid uplift.Polimictic composition of the deposits and mass-transport evidence support these ideas.Cannibalism processes (VAI& RICCI LUCCHI,1977)or "autophagia" of previous or penecontemporaneous evaporite rocks inside the basin is a suggestif concept to explain the origin of clastic gypsum deposits.Tectodynamic evolution of the basin might have played a role in the development of these "autophagic" processes during some periods (e.g.,deposition of upper TSU-1).Resedimentation of evaporites was made in a "centripetal" way.

Turbidite gypsum is disposed in central and southern parts of the basin (Fig.5).Arrows in this figure indicate probable dominant transport directions of clastic gypsum.Source of deposits was situated at the north in a more elevated area mainly composed by evaporite formations.Location of this area has been deduced from basin analysis and paleogeographic evolution observed in the TSUs.Most proximal fringe around this area refers to the presence of breccia mass-flow gypsum deposits intercalated within gypsum turbidite.Proximal or distal situation of gypsum turbidite is deduced from composition of cycles in different sequences.Chemical layers in the cycles suggest gypsum-saturated waters.Scheme shown in figure 5 evidences a "centrifuge" pattern for the resedimentation of gypsum turbidite.Figure 6 shows the relative disposition of clastic gypsum deposits in a cross-section of the Madrid Basin.

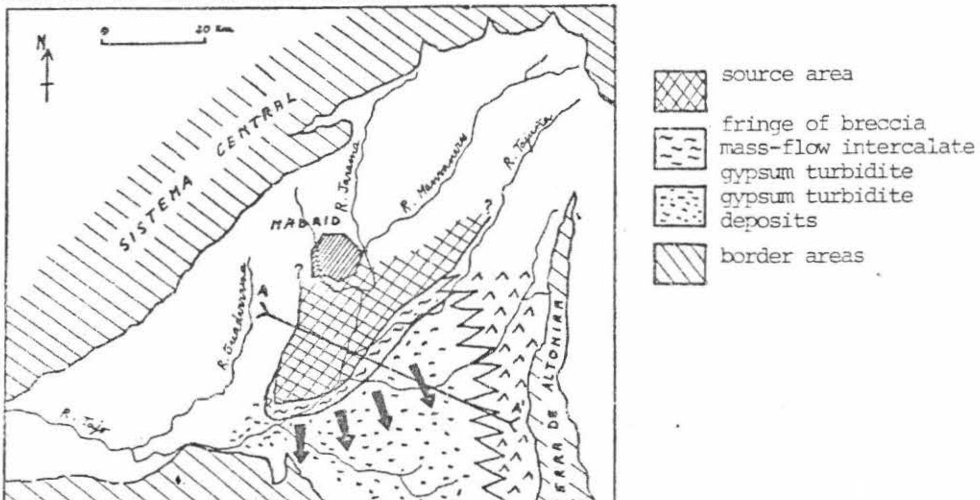

Fig.5

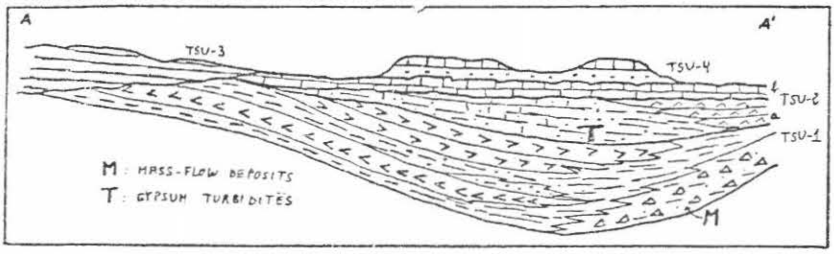

Fig.6

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ABSTRACTS

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