

Authigenic gypsum in a deep sea core from southeastern Arabian sea

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Abstract

Authigenic gypsum has been encountered in a deep sea core RC9-157 from the southeastern Arabian Sea at a depth of 4111 m which is a zone of lysocline. The formation of gypsum in the deep sea region is attributed to the prevailing sulphate rich equatorial waters which were constantly fed by calcium through the dissolution of calcareous tests. Another plausible mechanism that may be proposed is that of the sulphate rich Antarctic bottom water which is playing a vital role in bringing about the crystallisation of gypsum by utilising the calcium available through dissolution.

Introduction

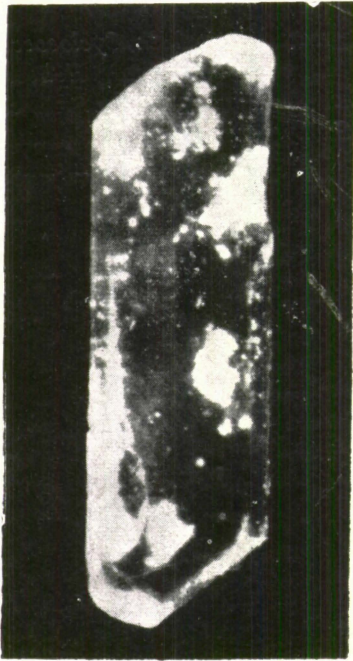
Gypsum is usually formed on tidal flats or on standing bodies of hypersaline water and lagoons (Wells, 1962; Murray, 1964; Kinsman, 1966 and Seisser and Roger, 1976).

Although authigenic gypsum is a common constituent of sediments of the continental shelf and slope, its presence in deep sea regions of lysocline depths appears to be unusual and rare. Recently, Briskin *et al.*, (1978) have reported its occurrence at a depth of 4021m from the Rio Grande Rise, and Xavier *et al.*, (1979) have reported authigenic gypsum in a depth range of 4500-5000m from the Central East Pacific region.

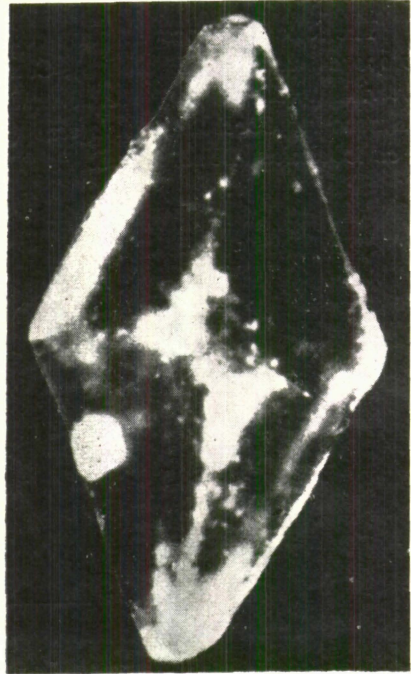
Gypsum has been reported from the continental shelf of the Arabian Sea: from the Gulf of Kutch (Shrivastava, 1968), from Saurashtra coast sediments, (Hashimi, 1974), from the mud banks of Kerala coast (Nair *et al.*, 1968 and Krishnanath, 1971). Recently, Hashimi *et al.*, (1979) have reported occurrence of gypsum in the innershelf sediments of Bombay-Ratnagiri coasts. Seisser *et al.*, (1976) have documented the occurrence of authigenic gypsum crystals from the continental slope sediment off the southwest coast of Africa, the age of which has been assigned to middle Miocene to Pliocene on the basis of calcareous nannoplankton.

During the course of investigation of nannoplankton from deep sea cores in the southeastern Arabian Sea, the author encountered the occurrence of euhedral non-evaporitic authigenic gypsum crystals (Plate I) in one of the deep sea cores RC9-157 (05°47.3'N: 66°34.7'E)—a 3.8m long core collected (Fig. 1) at a water depth of 4111m. The core log reveals that the entire length of the core is affected by dissolution as evidenced by the presence of broken tests of planktonic foraminifera, particularly the keels of *Globorotalia menardii* (d'Orbigny) and *G. tumida* (Brady) as these portions of test appear to be more solution resistant. Arenaceous benthic foraminifera were also noticed. The evidence of dissolution progressively increases from top to bottom of the core. The colour of the sediment is light gray except for a narrow band of brown gypsum-bearing lutite at an interval of 260 cm down the core with beautiful euhedral gypsum crystals.

The gypsum crystals are euhedral, colourless, vitreous and transparent. The length of the crystals varies from 80-350 microns. Twinning has also been noticed frequently (Plate 1), and clusters of bladed crystals of transparent gypsum were observed in the smear slides under the polarising microscope.



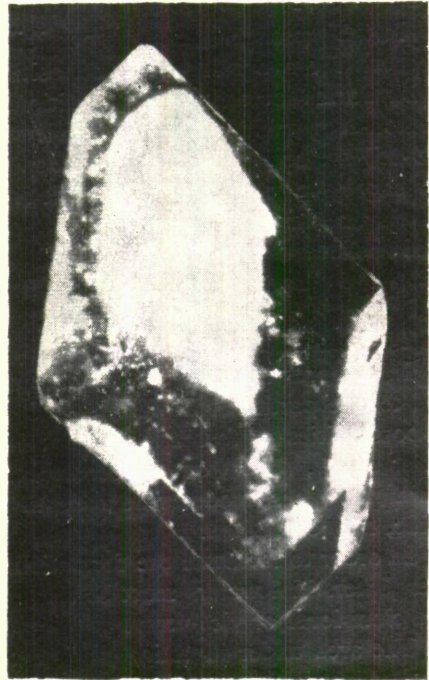
A



B



C



D

30 Microns

Plate I. A-D Euhedral crystals of gypsum in core RC9-157.

Age of the Sediment

The following coccoliths are common in the material studied: *Cyclcoccolithina leptopora* (Murray & Blackman), *C. macintyrie* (Bukry & Brammlette), *Helicosphaera carteri* (Hay & Mohler), *Pseudoemiliana lacunosa* (Kamptner), *Ceratolithus cristatus* (Kamptner), *Coccolithus pelagicus* (Wallich), *Gephyrocapsa oceanica* (Kamptner), *G. caribbeanica* (Boudreaux & Hay). This assemblage belongs to *P. lacunosa* zone of the Pleistocene.

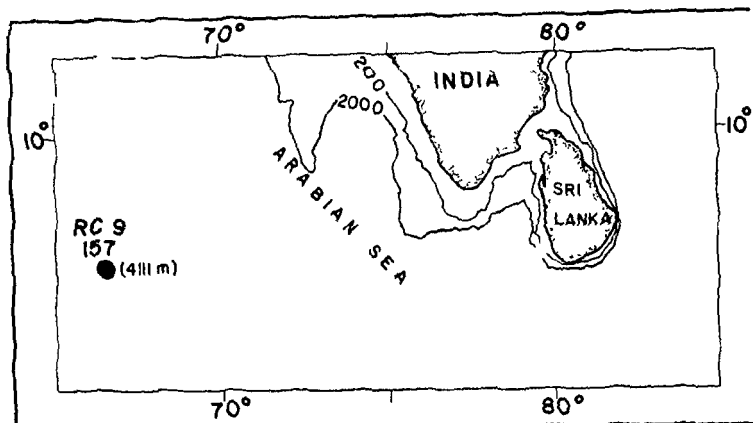


Figure 1. Location of the Core RC 9-157.

Origin of Gypsum

In the present instance the possibility of formation of gypsum by evaporation is ruled out for two reasons: i) deposition under deep water conditions and ii) prevailing normal oceanic saline conditions. Gypsum crystals are therefore authigenic and non-evaporitic in origin. In view of the fact that the gypsum crystals found in RC9-157 are beautiful euhedral transparent crystals with crystal faces intact indicate that they have originated *in situ*. It is essential to ascertain whether these gypsum crystals are authigenic or artefacts of storage dessication. Because, Arrhenius (1963) believes that the occurrence of gypsum may be the result of sulphide oxidation during the storage of the sample. Briskin *et al*, (1978) doubt the occurrence of authigenic gypsum in deep sea cores, because of the possibility of gypsum precipitation upon dessication of interstitial waters at the time of storage of the cores.

In the present case, gypsum appears to be authigenic as its formation is confined to one particular horizon at 260 cm level. In support of the view that there are possibilities of formation of authigenic gypsum in the deep sea, the report of Xavier *et al.*, (1979) on the occurrence of euhedral crystals of authigenic gypsum within manganese nodules at a depth range of 4500-5000 m in the Central East Pacific, may be quoted.

In order to facilitate the formation of gypsum, it is essential that the overlying waters/interstitial waters must be rich in sulphate ions along with a constant supply of calcium ions, or vice versa.

The area under investigation is a zone of divergence and the cold nutrient rich upwelled waters along the equator facilitated biological productivity resulting in rich plankton blooms. After death, these plankton got transformed into organic carbon by a process of chemical degradation, subsequently undergoing decomposition giving rise to sulphides which ultimately got oxidised to sulphate ions. Similarly, the cal-

careous plankton after death started gradually sinking and settling to the bottom. Whilst doing so, the calcareous tests were subjected to dissolution when they reached the zone of lysocline, thus releasing calcium ions from calcium carbonate required for the formation of gypsum. When both sulphate and calcium ions reached oversaturation, crystallisation of gypsum took place. The size and euhedral shape of gypsum crystals indicate that the process of crystallisation was fast.

Acknowledgements: I wish to thank Dr. S. Z. Qasim, Director, Shri H. N. Siddiquie for their encouragement and continuous support and my colleagues in the Division for their valuable suggestions. My thanks are also due to Mrs. Dorothy S. Cooke of L-DGO for supplying the core samples collected through ONR Contract N00014 and NSF Contract DES 72-01568 403

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(Received: June 9, 1980)