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22.2. PETROGRAPHY OF A HALITE SAMPLE FROM HOLE 134 – BALEARIC ABYSSAL PLAIN

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INTRODUCTION

Rock salt, belonging to the late Miocene evaporite series, was encountered at 344 meters below the sea floor of the Balearic Abyssal Plain west of Sardinia. A polished specimen from Section 2 of Core 10 of Hole 134[1] is illustrated in Figure 1. The lower half of the exposed face has been made into a thin-section, 4 cm X 6 cm in area.

The geological setting of Hole 134 and a description of the drill cores can be found in Chapter 15, Part I, this volume. The salt layer correlates with the subbottom M-Reflectors, which in turn can be traced directly westward to a zone exhibiting numerous diapirs in the central Balearic Basin.

The recovered salt contains layered halite intercalated with strata rich in detrital sand and silt and peppered with small irregular anhydrite nodules. In Core 8, in particular, the halite contains very thin dark laminae rich in carbonaceous material and pyrite. As yet, the organic matter has not been identified, though there is a distinct petroleum odor at these levels when cut into, and gasoline range hydrocarbons were detected in interbedded plastic oozes within the halite in Core 10, Section 1 (see Chapter 32).

THE HALITE MINERALOGY

The translucent layered halite of Figure 1 includes two distinct types of crystals. The cloudy strata (illustrated with the letter "a" on the sliced specimen) are characterized by rectangularly shaped zones of minute liquid inclusions as typified by "a" in Figure 2, and by large pyramid shaped hopper crystals. This kind of crystal structure has been carefully documented by Dellwig (1955) and has been recognized for a long time in the manufacturing of granier salt (Badger and Baker, 1928). Quoting from Dellwig (1955, p. 89), "crystal growth is brought about by evaporation temperatures below the boiling point in order to prevent turbulence and to permit the formation of a thin surface film of high-density brine. In this film the halite crystals begin to grow. As growth continues the cube tends to sink under its own weight, although its position at the surface is maintained by surface tension. Because only one face of the cube is in contact with the high density film, growth takes place only along its edges. In this manner, while the crystal sinks, growth continues upward and outward along these edges resulting in the hollow pyramid with the apex pointing downward .... When the surface is disturbed, the crystals are broken or swamped and sink. The crystals are extremely delicate and can withstand very little handling. Occasionally, a number of crystals in a small area will become attached to one another to form a crust or mat which will eventually sink as a unit."

The crystal form of the euhedral crystals (the dark dusty texture in Figure 2) is outlined only by the presence of abundant liquid inclusions (of brine) in the form of negative crystals (Dellwig, 1955). As shown in the thin-section photomicrography, the euhedral crystals are sometimes fragmented and partly dissolved. They are surrounded by a clear rim ("b" in Figure 2) of varying width which is also of halite. Studies of modern playas have revealed that the clear anhedral variety of halite is a diagenetic cement and tends to replace euhedral precipitates (D. Shearman, 1970). In advanced stages of replacement, the crystal would be rid of inclusions, except for perhaps a small "dusty" relic in the center.

The clear anhedral crystals range from 50 to 300 microns in size. They comprise individual layers or bands within the halite deposit. Such interlamination of the "dusty" ("a") and clear ("d") crystals is very conspicuous

[1]Site 134 – Latitude: 39° 11.84′N; Longitude: 7° 17.96′E; water depth 2664 meters. Core 10 was cut from 359 to 364 meters subbottom.

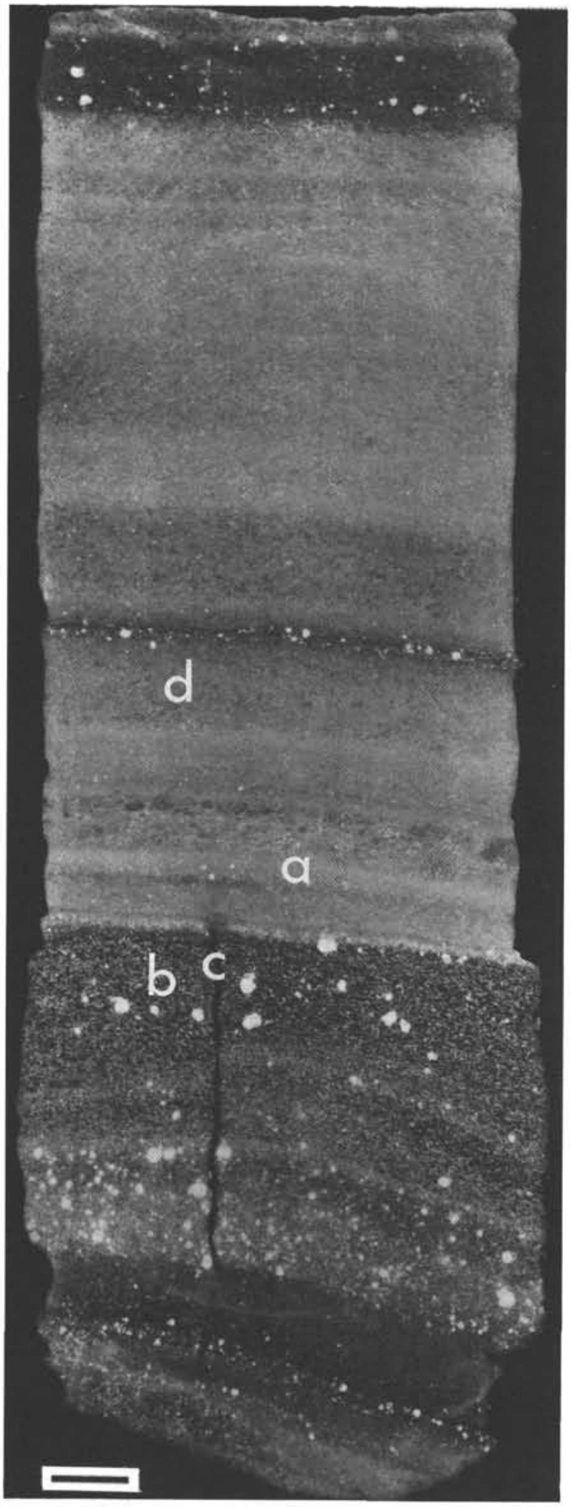


Figure 1. *Polished section (lifesize) of salt layer from Core 10, Section 2 of Hole 134. The halite is interlaminated with translucent strata (d) of clear interlocking anhedral crystals, whereas the cloudy laminae (a) are composed of "dusty" euhedral crystals set in a matrix of clear halite. The dark sand-silt layer (b) is detrital and slightly cross-laminated. Note truncation of the unit at the contact with the light colored halite. The detrital grains include not only quartz, feldspars, and glauconite, but considerable quantities of foraminiferal tests both broken and intact. The dark vein (c) is a halite filled dessication crack beginning at the top of the detrital layer and extending downward through the specimen. Scale bar represents one centimeter. The letters a, b, and c, depict locations of thin-section microphotographs illustrated in Figures 2 and 3.*

in the whole halite unit recovered in Cores 8 and 10 and is markedly similar to that observed in the Salina Salt from the center of the Michigan Basin (Dellwig, 1955; Dellwig and Evans, 1969) and that on the salt flat of Baja California (D. Shearman, personal communication).

THE DETRITAL LAYERS

Distinct layers of silt and sand are interbedded with the halite and examples of the sedimentary fabric are shown at the top and bottom of Figure 1. In thin section the silt has been recognized to include a considerable amount (20-30%) of a calcareous material, which is predominantly in the form of whole or partly broken tests of foraminifera. Figure 3 illustrates thin-section views at ten locations marked "a" and "b" in Figure 1. The tests (a) are apparently reworked; many of their chambers have been filled by micritic carbonate cement. Many broken shell fragments are also present. Less abundant are grains of quartz, feldspars, chert, glauconite, gypsum, and micas (all nearly rounded glazed and worn grains). Those detrital grains (10-15%) are similar in size to the foraminiferal tests. They were probably all blown in by wind. The clear halite matrix constitutes some 30 to 40 per cent of the bulk volume. Although anhedral clear crystals are the dominant type partially preserved euhedral crystals (b) are discernible. Anhydrite is present in the form of spherical aggregates with laths radiating from a nuclear structure and also as individual needle-like laths cross-cutting (c) the euhedral halite crystals. In fact, within the cloudy laminae of the halite proper there are a number of thin bands of randomly oriented anhydrite needles lying intertwined along bedding planes. The spherical anhydrite nodules depicted as the white dots in Figure 1 have been found in modern *sabkha* environments, as the product of early diagenesis of displacement origin (Shearman and Fuller, 1969).

DESICCATION CRACK

A desiccation crack, with a maximum width of two millimeters, is seen in the sand and silt under the halite and is marked with the letter "c" in Figure 1. The crack is now almost completely filled by clear anhedral crystals of halite, however, we note the presence of several foraminiferal tests near the upper end of the crack (Figure 3b, illustrated by "e"). Apparently they had fallen into the crack before it was sealed up by halite.

The crack begins at the top of the basal detrital layer and extends downward more than five centimeters. Several slices through the specimen show that it is an elongate vein most likely produced by shrinkage prior to the deposition of the overlying bands of clear and cloudy halite.

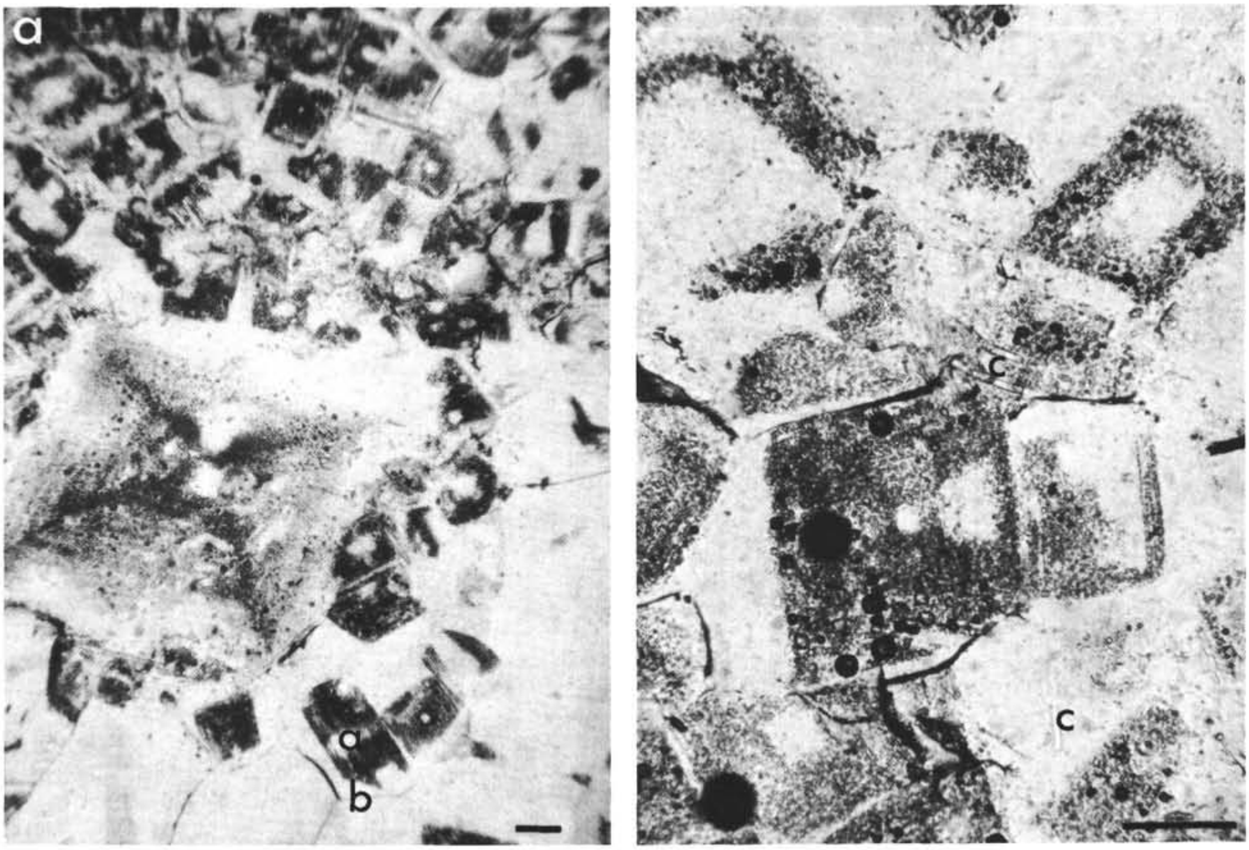
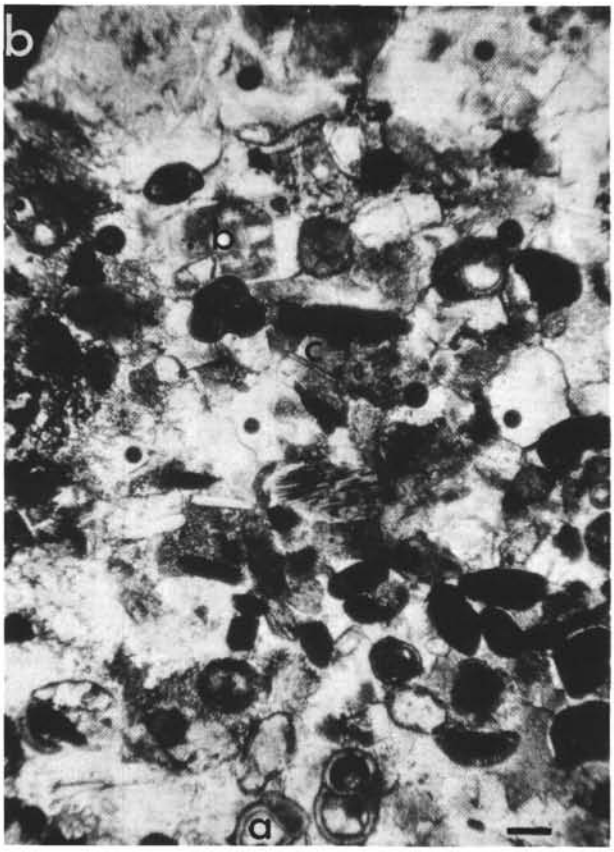


Figure 2. *Thin-section view under polarized light of the euhedral halite crystals (a) outlined by minute liquid inclusions (see enlargement at right). Note the rim of clear halite (b) without inclusions cementing the crystals together. The large hour-glass shaped halite is a good example of a typical hopper crystal. Needle-like anhydrite laths (e) occasionally cut across the halite crystals. Scale bars represent 100 microns.*

COMMENTS ON THE PALEOENVIRONMENT

The detrital sand and silt layers reflect active reworking and size sorting. The layers are slightly cross-laminated: Note the bevelling within and across the top of the layer. Fine-grained silt or clay is present only as the infilling of foraminiferal chambers. The intergranular space is entirely cemented by clear halite. Pieces of indurated carbonate rock (dark objects in Figure 3) are rounded and polished, as are the grains of chert and quartz. In disaggregated samples, many of the quartz grains are frosted and coated with iron-oxide stains. The admixture of the foraminifera and the detrital minerals is believed to have been caused by aeolian transport and winnowing. The desiccation crack is additional evidence of subaerial exposure. Anhydrite nodules were the product of early diagenesis under the supratidal flat, where calcium sulphate replaced detrital silts (Kinsman, 1966; Shearman, 1966; and Kinsman, 1969). Evaporative loss of pore-waters led eventually to the precipitation of halite cement.

The banded halite represents more tranquil depositional conditions in a brine pool. Through a comparison with the occurrence of halite in the salinas of Baja California, one might postulate that hopper-crystals were deposited in a standing water-body. Desiccation of the shallow pools led to solution and reprecipitation of clean halite crystals.



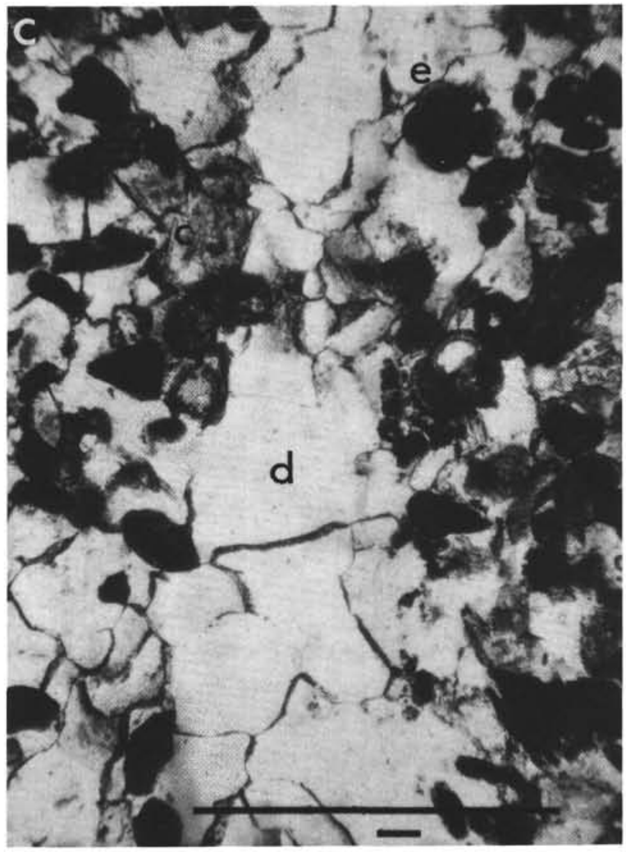


Figure 3. *Halite cemented detrital silt layer. White letters locate the microphotographs on the polished core section of Figure 1. Note the absence of a mud matrix and the rounding of mineral grains and calcareous debris. Calcareous mud, where present, is confined to the infilling of foraminiferal chambers (a). Euhedral salt crystals (b) are occasionally present as well as laths of anhydrite (c). The infilling of the dessication crack by clear anhedral halite (d) is shown at the right. Note the presence of foraminifera (e) in the crack. Small scale bars represent 100 microns. Large scale bar is 1 millimeter.*

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