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ORIENTATED GROWTH OF GYPSUM IN THE MARION LAKE GYPSUM DEPOSIT, SOUTH AUSTRALIA

by

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(with 2 Text-figures and 1 plate)

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Introduction

Throughout the State of South Australia, near the coast, there are many gypsum deposits which were formed in Pleistocene and Recent geological times by evaporation of sea water in stranded arms of the sea, or in inland depressions and lagoons fed by seepage of saline ground waters. The Marion Lake Deposit at the southernmost end of Yorke Peninsula presents a typical form of those deposits formed in inlets of the sea.

The deposit consists of an extensive bed of well crystallized gypsum (rock gypsum) of about 1.2 m in thickness, overlain by seed gypsum in depth ranging from several centimeters to 2.5 m. The main feature of the rock gypsum is its vertical, coarsely crystalline prismatic structure. Individual crystals of gypsum, some of them measure up to 15 cm in length, elongate their c-axes upward in a typical appearance of the parallel-columnar aggregate. Banding of the common growth surfaces is distinctly developed in a wavy horizontal pattern, and follows the upward growth of the crystal faces. In this paper, descriptions will briefly be made on this orientated growth.

Locality and Geological Environment

The deposit is situated near Cape Spencer on the southwestern tip of Yorke Peninsula as shown in Fig. 1. The basement of the peninsula is pre-Cambrian gneissic rocks, in which a granitic gneiss of migmatitic character is the dominant type. Thin deposits of Permian boulder clay and Tertiary limestones overlie the basement rocks elsewhere on the peninsula, but are absent in the Marion Lake district. A Pleistocene calcareous dune-sand formation covers almost completely the district. This aeolinite formation was probably derived from beach sand exposed along low-level Pleistocene shore-line. (DICKINSON and KING; 1949)

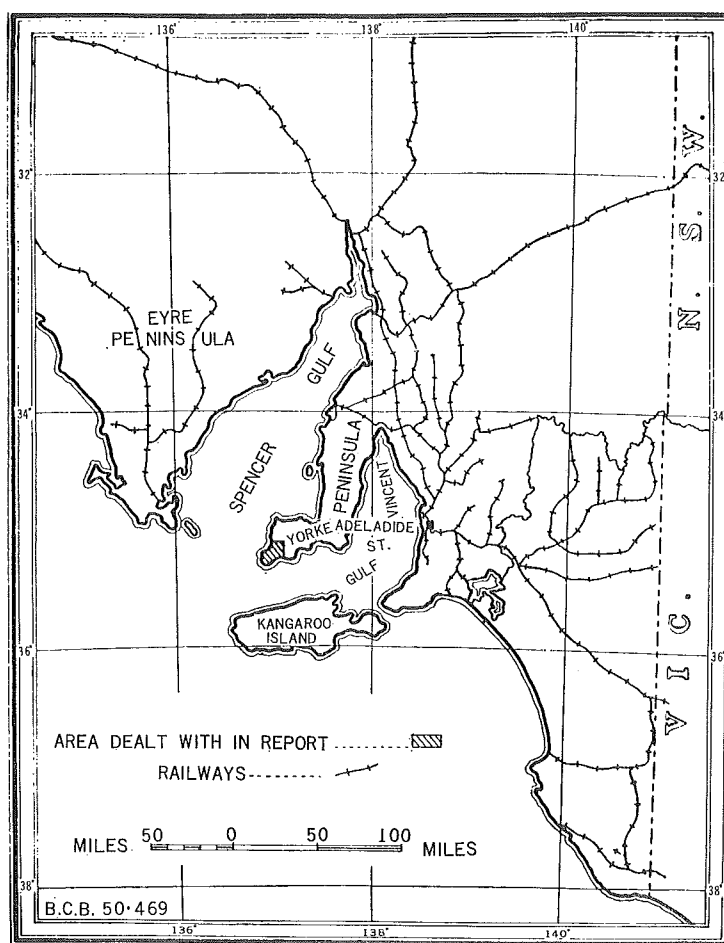


Fig. 1
Index map.

The formation of the Marion Lake gypsum deposit, as well as the formations of many other deposits on the peninsula, is thought to be a consequence of a temporary rise in sea-level in early Recent time and succeeding sudden decline of the sea to present-day shoreline. Shallow inlets were then blocked off from the sea by newer sand-dune, and evaporation and consequent concentration of sea water in the remaining deeper portions of the swamp provided the conditions favorable for the depositions of gypsum and other salts.

Texture of Rock Gypsum Aggregate

Rock gypsum bed is composed of pure prismatic crystals of gypsum elongated in the c-axis direction. The largest crystals observed measure up to 45 cm in length and 15 cm in width. The parallel columnar texture of the aggregate of upward-orientated individual prisms is very distinguished. Since these prismatic crystals are orientated parallel with respect only to their c-axes, and not to the a- and b-axes, the aggregate exhibits in horizontal section a mosaic pattern with pronounced concentric banding (Photo 1). There is, however, not rarely a case where two individual crystals in immediate contact are so specially orientated that they own the (010) face in common for the contact plane. In this case, a regular wavy pattern of common growth bands gives the combination a twin-like appearance as shown in Photo 2.

The wavy pattern of bands above referred to is a combined pattern of the (111) and ($\bar{1}\bar{1}1$) surfaces in common growth. The bands consist of translucent laminae measuring 1.5 mm to 6 mm, separated by much thinner semi-opaque layers. According to DICKINSON and KING (1949), hand-picked material from one specimen gave CaCO_3 content of 0.32% in the translucent bands and 3.50% in the semi-opaque layers. DICKINSON and KING attributed the formation of this banding to seasonal variations of salinity, assuming that each lamina represents half a year's growth; the translucent one for summer and the semi-opaque one for winter. It is very dry in summer and comparatively wet in winter in this region of Australia. The precipitation of gypsum in relation to that of CaCO_3 is to be decreased in winter when salinity is lower.

Considerations

The process in which random-aggregated crystals tend to be orientated in a parallel-columnar aggregate has been well illustrated by GRIGOR'EV (1954, 1961) as shown in Fig. 2. As seen in this figure, the parallel columnar aggregate can be attained in consequence of struggle for space between individual crystals grown on a planar surface; only those crystals whose direction of the maximum rate of growth is steeply inclined to the planar surface can continue to grow in the aggregate. It is therefore obvious that the parallel columnar aggregate is easily attainable for those crystals which have one direction of pronounced growth rate.

GOTO (1966) has recently made calculations for energies gained when a constituent atom is adsorbed on various sites of gypsum crystal, and suggested that gypsum has a prominent growth tendency in the c-axis direction of roughly 80 times greater than those in the other directions. The parallel columnar growth in the c-axis direction of the Marion Lake gypsum is a demonstration of the crystallo-dynamic characteristics of gypsum mentioned above.

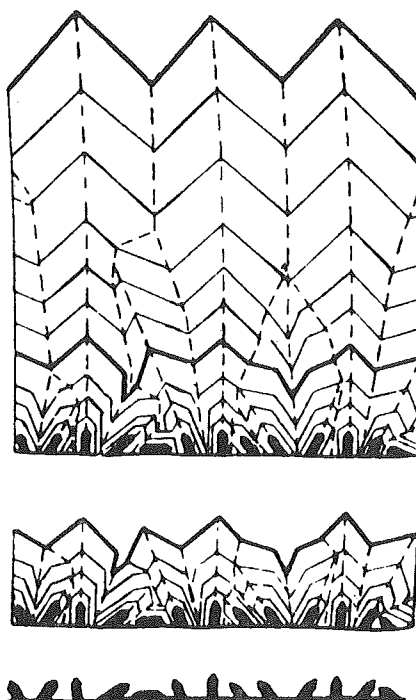


Fig. 2

Schematic diagram showing the stages of the parallel-columnar growth.

Not rare existence of the (010) contact plane in the aggregate may be explained as that such a contact pair of individuals could have grown more quickly and therefore have had more chance to survive among other, less perfectly orientated crystals. It is probable that the re-entrant corner formed when two individuals are combined in parallelism with respect to the three crystallographic axes provides active growth sites which will accelerate the overall growth of the combination.

References

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PLATE 20 AND EXPLANATION

Explanation of Plate 20

Photo. 1 Horizontal section of the rock gypsum aggregate, showing a mosaic pattern with concentric banding.

Photo. 2 Lateral section of the aggregate showing a wavy pattern of the (111) and (iii) surfaces of common growth.

Plate 20

