Karstic surface in the Lower Permian sabkha sequence of the Gipshuken Formation, central Spitsbergen, Svalbard

ØRNULF LAURITZEN

Lauritzen, Ø. 1983: Karstic surface in the Lower Permian sabkha sequence of the Gipshuken Formation, central Spitsbergen, Svalbard. *Polar Research, 1 n.s.*, 157–160.

Some unusual karst structures occur in the upper part of the evaporite-dominated sequence of the Gipshuken Formation. This Lower Permian unit is characterized by interbedded anhydrite and dolomites, and is now interpreted in terms of superimposed sabkha cycles. The karst structures are found in the inner part of Skansdalen in Dickson Land, and have not yet been observed elsewhere in corresponding horizons in Svalbard. These structures, often seen as linked hemispheroids, consist of almost pure anhydrite and are here interpreted as representing the remnants of consolidated sabkhas; the original sabkha plain was flooded and partly dissolved, and abandoned channels between the hemispheroidal structures were then filled with sediments of later sabkha cycle. The younger sediments which fill the relief between and above the structures contain small enterolithic folds which indicate primary formed anhydrite. Anhydrite is still the most common subsurface mineral in these sulphatic deposits, and there is no evidence of gravitational or tectonic movements within these beds.

Ørnulf Lauritzen, Norsk Polarinstitutt, P.O. Box 158, 1330 Oslo Lufthavn, Norway; March 1982 (revised June 1982).

During the summer of 1977 a field party from Norsk Polarinstitutt's expedition visited Skansdalen (Fig. 1), in the eastern part of Dickson Land, in order to investigate sediments of the Gipsdalen Group. The Lower Permian evaporites of the Gipshuken Formation (Cutbill & Challinor 1965) were studied in detail and a horizon with unusual hemispheroidal structures was found (Fig. 2) in the upper part of this sulphatic sequence (Fig. 3). These structures are located in the westernmost part of Skansdalen where a stream has eroded a cliff section through the upper part of the evaporitic sequence.

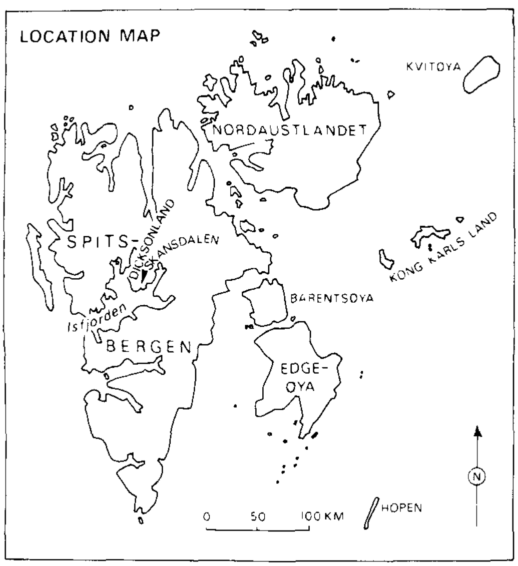

Fig. 1. Location map with place names mentioned in the text.

The studied structures are restricted to the top of the evaporite-dominated beds of the Gipshuken Formation; they are overlain by approximately 115 metres of dolomites with scattered sulphate nodules which are sharply bounded from the overlying Vöringen Member of the Kapp Starostin Formation (Fig. 3). The Gipshuken Formation is exposed in gently dipping sequences in the area north of Isfjorden, and the formation was originally assigned to the 'Upper Gypsiferous Series' of the Permo-Carboniferous by Gee, Harland & McWhae (1953). The formation comprises greyish dolomites intercalated with bedded and nodular sulphates. The Gipshuken Formation is generally assigned to the Artinskian stage of the Lower Permian, a period of general regression in Svalbard. Sediments of the Gipshuken Formation suggest shallow to restricted marine environments throughout the Svalbard archipelago during the Artinskian; areas with evaporitic beds (e.g. north of Isfjorden) represent lagoonal to supratidal environments with superimposed sabkha cycles (Lauritzen 1981) and short periods of shallow marine deposition.

Description

The surface and its structures described here are all restricted to the upper part of one single continuous anhydrite bed which can be followed laterally for several hundred metres. This bed, the uppermost prominent anhydrite horizon, is about 1 m thick in the intervals between the rises or hemispheroids, though these structures themselves have up to 3 m relief. The most well-developed of these structures is found innermost in Skansdalen (Fig. 2), and is about 4 m high in the observed section.

This single section gives no information on the three-dimensional shape of these structures. However, smaller but similar structures are exposed in the same cliff and bed, and show lateral separation in order of tens of metres. Exposures which show more than two-dimensional cross-section indicate an almost hemispheroidal shape. It is possible, however, that some of the structures may have a more elongated, ridge-like geometry. The hemispheroids or ridges themselves display few internal structures. The anhydrite is white, pure and homogeneous, quite unlike many of the other sulphatic beds lower in the formation which show chicken-wire structures (Lauritzen 1981). The nature of the upper surface and of the contact with the siderock are important aspects of these structures. The upper surfaces are usually smooth, but the upper left part of the feature shown in Fig. 2 contains a depression filled with darker sediment. Note also the overhang on the upper right side seen in the same figure. The siderock on either side of this hemispheroid is quite different; it consists of dark, thinly bedded dolomite with almost no anhydrite to the left, while on the right side of the section (Fig. 2) it is sulphatic with enterolithic folds and minor finely laminated beds of dolomite. The sediments abut both sides of the hemispheroid with a sharp angular disconformity, but rest comformably on the top of the structure.

The hemispheroidal structures observed average about 1 m in height, but vary from the largest about 2 m high, (Fig. 2), to minor irregularities on the upper surface of the sulphate bed. The dolomitic sediments found in connection with the structures contain several of the development features of gypsum/anhydrite described by Lauritzen (1977). The tubes (subtype IIc) are here positive infillings in burrows, and are found in association

Fig. 2. The highest of the hemispheroidal structures on the karstic surface, as exposed in Skansdalen, Svalbard.

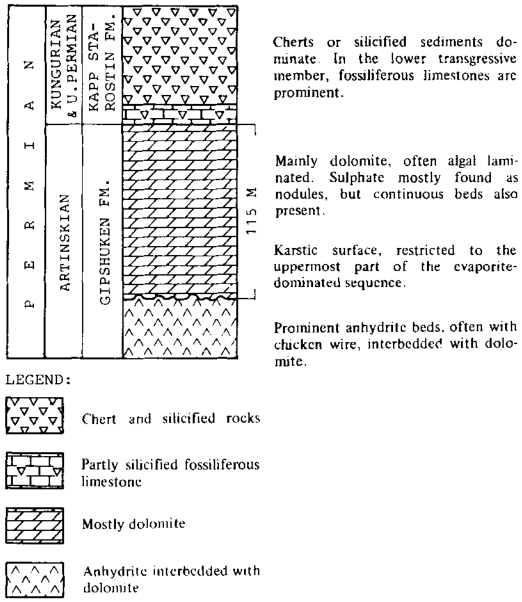

Fig. 3. Stratigraphic setting of the karstic surface exposed in Skansdalen.

with cross-bedding and ripple marks, reflecting a shallow energetic environment.

Discussion

Although at a distance the hemispheroidal structures appear to be miniature growth diapirs, their relationship to the associated beds rules out this interpretation; the total facies association also excludes tectonic forces as a mechanism producing diapirs. Erosive surfaces are common in evaporitic sequences of the sabkha type, as described by e.g. Kendal (1979), but documentation of the Gipshuken Formation elsewhere (Lauritzen 1981) has yielded few erosion or solution surfaces. The studied surface is interpreted here as a karstic surface, an interpretation not inconsistent with a general sabkha setting, here illustrated in Fig. 4.

(a) Precipitation of anhydrite in a supratidal coastal sabkha environment, ultimately pro-

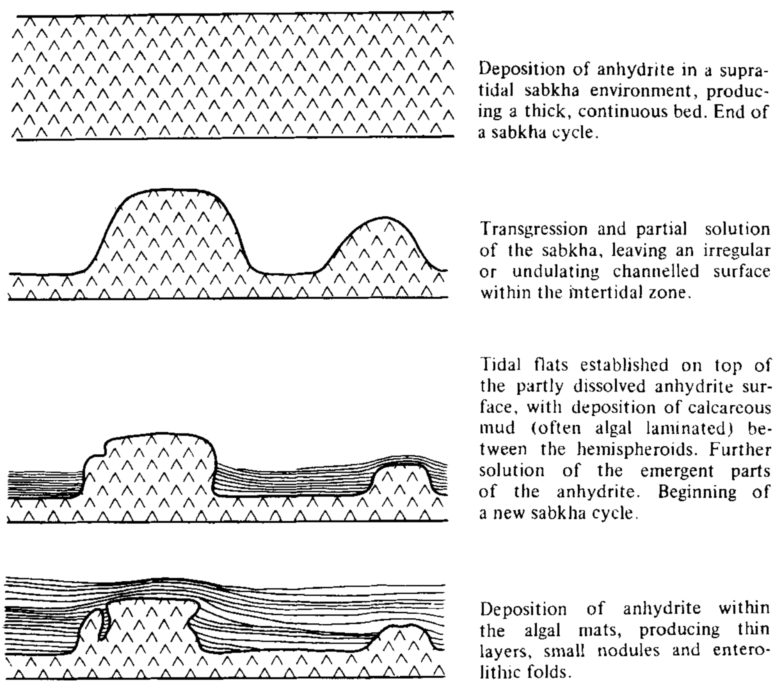

Fig. 4. Steps in the development of the karstic surface in anhydrite, as seen in the Gipshuken Formation in Skansdalen, Svalbard.

ducing a thick, continuous bed which represents the culmination of a sabkha cycle. This bed must have had a primary minimum thickness of about 3 metres.

(b) The sabkha surface was subsequently transgressed or flooded by sea water. This resulted in partial dissolution and an irregular, undulating upper surface with hemispheroidal or ridge-like structures.

(c) Partial emergence and establishment of a tidal flat environment on the karstic top of the anhydrite unit led to deposition of calcareous mud, often algal laminated in the hollows (channels) between the remaining positive structures. Solution of the higher, exposed parts of the structures continued, and dissolved anhydrite was partly reprecipitated in the siderock. Beginning of a new sabkha cycle.

(d) Further deposition of anhydrite within algal mats, producing thin layers, smaller nodules and enterolithic folds. The whole structure was now covered, and smaller depressions within its top were filled with sediments before total burial.

Acknowledgements. – I thank Dr. David Worsley for his criticism and help and for improving the English text. Thanks also to Espen Kopperud for help with the final figure drafting.

References

Cutbill, J. L. & Challinor, A. 1965: Revision of the stratigraphical scheme for the Carboniferous and Permian rocks of Spitsbergen and Bjørnøya. *Geol. Mag. 102*, 418–439.

Gee, E. R., Harland, W. B. & McWhae, J. R. H. 1953: Geology of central Vestspitsbergen. Part I. Review of the geology of Spitsbergen with special reference to central Vestspitsbergen; Part II. Carboniferous and Lower Permian of Billefjorden. *Trans. R. Soc. Edinb. 63*, 299–356.

Kendal, A. C. 1979: Continental and supratidal (sabkha) evaporites. *In* Walker, R. G. (ed.): Facies models. *Geoscience Canada, Reprint Series 1.*

Lauritzen, Ø. 1977: Development patterns of gypsum/anhydrite in Lower Permian sediments of central Spitsbergen – a suggested classification. *Norsk Polarinst. Årbok 1976*, 5–20.

Lauritzen, Ø. 1981: Development of the Gipshuken Formation (Lower Permian) at Trollfuglfjella in central Spitsbergen, Svalbard. *Norsk Polarinst. Skr. 176.*