Sr ISOTOPIC ANALYSIS OF ANHYDRITES AND PSEUDOMORPHS OF CALCITE AFTER ANHYDRITE FROM VISEAN ROCKS OF HEUGEM (SOUTH LIMBURG, NETHERLANDS) AND ST-GHISLAIN (SW BELGIUM)¹

Short note

by

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(2 figures, 2 tables and 1 plate)

RESUME.- Une analyse isotopique du Strontium d’anhydrite et de calcite pseudomorphé provenant d’anhydrite dans des calcaires du Viséen moyen suggère une origine synsédimentaire en même temps que le dépôt de carbonates en eau de mer normale. Les rapports $^{87}\text{Sr}/^{86}\text{Sr}$ sont très semblables à ceux d’anhydrites et celestite viséennes dans le sondage de St-Ghislain (SW Belgique).

ABSTRACT.- Sr isotopic analysis of anhydrite and calcite pseudomorph after anhydrite from Middle Visean limestones suggest that the evaporites were formed synsedimentarily with the deposition of carbonates in normal sea water. The $^{87}\text{Sr}/^{86}\text{Sr}$ ratios are very similar to those of Visean anhydrites and celestite from the St.-Ghislain borehole (SW Belgium).

INTRODUCTION

The Wales-London-Brabant Massif was surrounded by a large carbonate platform («Kohlenkalk» or Carboniferous Limestone) in Dinantian times. On this platform evaporitic precipitates locally formed from time to time during the Tournaissian (notably Eyam and Hatheron boreholes in Central England; George et al. 1976) and Visean (notably St.-Ghislain borehole in SW Belgium and Epinoy borehole in NW France; Rouchy, 1986).

The presence of evaporites in Devonian and/or Dinantian rocks east of the Brabant Massif has been postulated because of the occurrence of small gravity lows in South-Limburg (the Netherlands; Kimpe et al., 1978, Bless et al., 1980b). In fact, the Heugem-1/1a borehole in Maastricht discovered a limited number of thin lenses of anhydrite and calcite pseudomorphic after anhydrite in Middle Visean (V2a) limestones (Bless et al., 1981).

The Middle Visean rock sequence of Heugem is rather anomalous in several aspects. First of all it is extremely thick. At least 388 m have been drilled whereas the base of the Middle Visean has not been recognized. This is the more surprising since Middle Visean (V2a) rocks do not occur to the south in Hermaelle-sous-Argenteau, Visé, Val-Dieu and Moresnet, or show a reduced thickness to the WNW in Kastanjelaan and Halen and to the east in the Aachen area (fig. 1; Bless et al., 1980a, Kasig, 1980). Moreover, the Middle Visean of Heugem is marked by frequent high Zn content (often more than 1500 ppm Zn) and high C-org content (0.5 - 2 %), impoverished macrofossil assemblages and frequently restricted microfossil assemblages (radiolarians, sponge spicules, restricted marine ostracode assemblages). And finally, there is the presence of anhydrite and calcite pseudomorphic after anhydrite (Pl. 1, tab. 1) pointing to either ephemeral evaporitic conditions during the Visean or to the squeezing of pre-Middle Visean (Devonian?) evaporites into the Dinantian strata (Stoppel, 1982; Bless et al., 1986).

¹ Manuscrit reçu le 1er décembre 1986.
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In order to shed some new light on the time of formation and the depositional environment of the evaporites in the Heugem borehole, the Sr isotopic compositions of some samples of anhydrite and calcite pseudomorphic after anhdydrite have been investigated.

**Sr ISOTOPIC ANALYSIS**

Three samples from 390.9 m, 431.2 m and 457.45 m have been purified carefully by handpicking under the binocular to obtain 20 mg substance of each sample. For comparison four anhydrite samples and a celestite sample from the Visean of St.-Ghislain (Rouchy, 1986) have been prepared in the same way.

After decomposition of the sample with 6 N HCl, Sr was separated by conventional ion exchange techniques. The mass spectrometric analyses of the Sr composition have been carried out at the Zentrallaboratorium für Geochronologie in Münster with methods described by Kramm et al. (1983). The data were corrected for mass fractionation and the Sr standard NBS SR 987 (\(^{87}\text{Sr}/^{86}\text{Sr} = 0.71014\)) in the same way as done for the data of Phanerozoic sea water (Burke et al., 1982), which are used here for comparison.

The three Heugem samples are characterized by \(^{87}\text{Sr}/^{86}\text{Sr}\) ratios which are identical within the limits of analytical error (tab. 2). The mean \(^{87}\text{Sr}/^{86}\text{Sr}\) ratio is 0.70768. The values for the anhydrites from levels 2193.5 m, 2209.3 m and 2405.0 m of St.-Ghislain are slightly lower (mean \(^{87}\text{Sr}/^{86}\text{Sr} = 0.70753\)) than those of Heugem, whereas the Sr composition of the anhydrite from level 3107.0 m of St.-Ghislain is more radiogenic (\(^{87}\text{Sr}/^{86}\text{Sr} = 0.70796\)). The St.-Ghislain celestite data match those of Heugem within the range of error.

Comparison of the above Sr data with those of Phanerozoic sea water (fig. 2) yields two important conclusions.

The \(^{87}\text{Sr}/^{86}\text{Sr}\) ratios fixed in the Heugem and St.-Ghislain samples (except that of level 3107.0 m in St.-Ghislain) are very low for Sr in
seawater during Devonian and Carboniferous times. They are reached by seawater Sr exclusively during the Middle Mississippian of the North American time scale used by Burke et al. (1982), which correlates with the Visean age of the European time scale. This fact presents evidence for the Visean age of the anhydrites and calcite pseudomorphic after anhydrite in both St.-Ghislain and Heugem. It clearly indicates repeated ephemeral evaporitic conditions for the area east of the Brabant massif (South-Limburg) during Middle Visean times. The data do not support the hypothesis of squeezing of Devonian evaporitic rocks into the Dinantian strata of Heugem.

![Graph showing Sr isotopes during Phanerococic](image)

Fig. 2. \(^{87}Sr/^{86}Sr\) of seawater during Phanerococic (after Burke et al., 1982). In the magnified Devonian and Carboniferous part of the diagram the \(^{87}Sr/^{86}Sr\) of samples from Heugem-1a (309.9 m, 311.2 m, 457.45 m) and from St.-Ghislain (anhydrites of levels 2193.5 m, 2209.3 m, 2405.0 m and celestite (7 m), anhydrite of level 3107.0 m) are shown relative to the seawater isotopic composition. Dots represent \(^{87}Sr/^{86}Sr\) ratios of marine sediments used by Burke et al. (1982) to construct the seawater evolution line.
Table 2. Sr isotopic composition of anhydrite and calcite pseudomorphic after anhydrite (Calc. ps. Arg.) from cores of Heugem-1a (Maastricht, South-Limburg, the Netherlands) and from anhydrite and celestite of St.-Ghislain (SW Belgium). Stratigraphical levels in Heugem after Bless et al. (1981) and in St.-Ghislain after Groessens et al. (1979).

<table>
<thead>
<tr>
<th>Drill core and sample number</th>
<th>Depth</th>
<th>Stratigraphical level</th>
<th>Sr isotope ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heugem-1a 12:305/10</td>
<td>2193.3</td>
<td>V1b Anhydrite</td>
<td>0.70751 ± 0.00005</td>
</tr>
<tr>
<td>St.-Ghislain 12:305/15</td>
<td>2209.3</td>
<td>V2b Anhydrite</td>
<td>0.70753 ± 0.00007</td>
</tr>
<tr>
<td>St.-Ghislain 12:305/15</td>
<td>2405.0</td>
<td>&quot;V2a&quot; Anhydrite</td>
<td>0.70753 ± 0.00004</td>
</tr>
<tr>
<td>St.-Ghislain 12:306/11</td>
<td>3107.0</td>
<td>V1b Anhydrite</td>
<td>0.70796 ± 0.00003</td>
</tr>
<tr>
<td>St.-Ghislain 12:306/11</td>
<td>?</td>
<td>Calcite</td>
<td>0.70760 ± 0.00004</td>
</tr>
</tbody>
</table>

ACKNOWLEDGEMENT

The cooperation of L. Dejonghe, Brussels, H.R. Langbuth, Aachen and H. Nielsen, Göttingen, who made samples of drill core St.-Ghislain available to us, is greatly acknowledged.

BIBLIOGRAPHY


PLATE 1

Cores from Middle Visean (V2a) of Heugem-1a borehole showing calcite pseudomorphic after anhydrite in dark-grey wackestone (390.9 m and 423.9 m) and partly calcitized enterolithic anhydrite with tepee texture in dark-grey to black wackestone (431.2 m). Note that all three examples consist of relatively thick lower layer and distinctly thinner upper layer, in all cases parallel to bedding plane.