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OCCURENCE OF PSEUDOMORPHOSED ANHYDRITE NODULES IN THE LOWER VISEAN (LOWER MOLINIACIAN OF THE VERVIERS SYNCLINORIUM, E. BELGIUM)

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RESUME. - Dans le Moliniacien inférieur (Dolomie de la Vesdre; Viséen inférieur) différents niveaux présentent des pseudomorphoses d'anhydrite, sous forme de nodules localisés surtout au sommet de séquences régressives, c'est-à-dire dans des dolomies noirâtres et finement litées. A ces nodules qui sont généralement silicifiés, s'ajoutent des nodules dolomitiques, possédant parfois des textures internes de bréchification; souvent, celles-ci caractérisent aussi une pseudomorphose d'anhydrite. La bréchification interne semble résulter du "collapse" d'une structure de type "chickenwire". Les microtextures des différents types de nodules démontrent que la silicification est un processus de remplacement tandis que les nodules dolomitiques correspondent au remplissage d'une cavité.

Deux horizons au moins, possédant des niveaux à pseudomorphoses d'anhydrite, ont été reconnus dans le Dinantien de la partie Est de la Belgique : le premier, dans le Tournaisien supérieur (Ivorien), et le second, décrit dans cette publication dans le Viséen inférieur.

ABSTRACT. - Within the Lower Moliniacian (Lower Visean) Vesdre Dolostone Formation, pseudomorphosed anhydrite nodules have been discovered especially within finely laminated, dark colored dolostones. They mainly consist of silicified anhydrite nodules. Their microtextural features are described and some deductions on their silicification history are made. Some of the associated dolomite nodules obviously have a similar pseudomorphous origin. Attention is drawn also to the formation of internally brecciated dolomite nodules since they may testifie to the former presence of chickenwire structures.

At least two major horizons, characterized by anhydrite pseudomorphs occur within the Dinantian sequence of the eastern part of Belgium; the first is situated in the Upper Tournaisian and the second, which is described in this paper, occurs in the Lower Visean.

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1. INTRODUCTION.

The recognition of evaporites is of major importance in facies analysis and in the reconstruction of the paleogeography. Intensive research on evaporites and evaporite related phenomena started in Belgium only in the late 70. This has to be explained by the fact that untill then no evaporites were found. Since the discovery of evaporitic sequences in the Visean of the St-Ghislain borehole, several Belgian and Dutch geoscientists became aware of the existence of similar or related features in equivalent Dinantian strata. From then on several horizons with pseudomorphosed evaporites were described. At present similar features have been reported from other Pre-Permian stratigraphical levels.

This paper reports on the occurrences of silicified and dolomitized anhydrite nodules in the Lower Moliniacian (Lower Visean) in the eastern part of Belgium. Since these nodules are often the only constituent yielding information on the sedimentation environment of these dolomitized strata, the recognition of these nodules to be pseudomorphous after anhydrite is of major importance.

2. GEOLOGICAL SETTING.

The quartz and dolomite nodules are found in dolomitic strata of the Vesdre basin (E-Belgium). Geographically this basin is situated between Liège and Aachen (Germany). Structurally, it consists of the southern part of the Verviers synclinorium (GRAULICH *et al.*, 1984).

The Dinantian sequence of the Vesdre basin is mainly composed of limestones and dolostones. In a general way the succession can be divided in four major lithological units (from bottom to top : fig. 1) :

- a crinoidal limestone unit, in which a shale intercalation up to 16 m thick, occurs (Hastière, Pont d'Arcole and Landelies Formation; Hastarian = Lower and Middle Tournaisian).

- a dolostone unit which is up to 300 m thick. This so-called Vesdre Dolostone Formation is mainly composed of xenotopic to hypidiotopic dolosparites (XH-type). It is in this formation and more precisely within finely laminated dark colored intervals that quartz nodules occur; they are often associated with cherts. Dolomite nodules are scattered all over the uppermost 220 m of this formation. On top of this formation a dolostone breccia (Walhorn breccia member) is present. An evaporitic solution collapse origin was argued from sedimentpetrographical and from lithogeochemical data (SWENNEN *et al.*, 1982). Cherts in the lower part of this formation yielded a typical Hastarian foraminifer assemblage (Middle Tournaisian), while the foraminifers in the cherts of the uppermost 220 m indicated a Lower Moliniacian, thus Lower Visean age. Until yet no Ivorian (Upper Tournaisian) equivalents have been found; however, they may occur within the outcrop hiatus in the lower part of the sequence (fig. 1). This formation can be traced all over the Vesdre basin. Lateral equivalents occur in the Aachen area (Upper dark dolomite) as well as in the eastern part of the Dinant basin (Sovet and Royseux Formation).

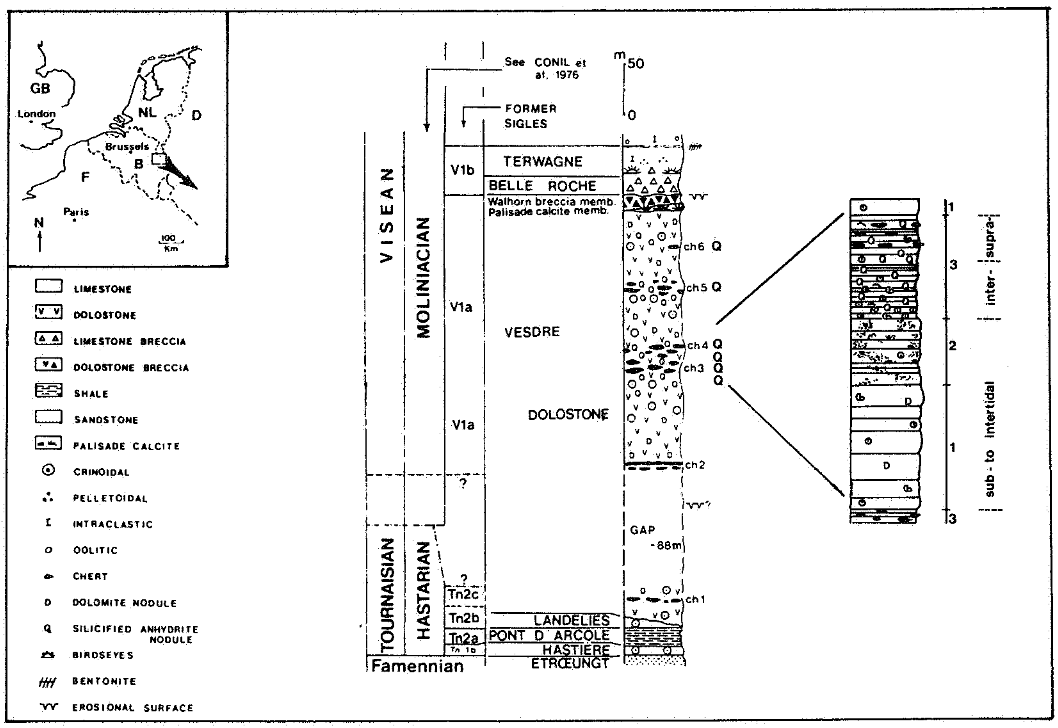

Figure 1 - Geographical situation and stratigraphy.

- a breccia unit, composed of limestone and/or dolostone fragments. A Lower Moliniacian (Lower Visean) age is accepted for this Belle Roche Breccia Formation. These strata were interpreted as evaporitic solution collapse breccias (JACOBS *et al.*, 1982; SWENNEN *et al.*, 1982).

- a limestone sequence; its lower part is mainly composed of micrites, followed by oosparites and biosparites (Terwagne and Neffe Formation : Lower to Upper Moliniacian). The upper part consists of rhythmic limestone sequences (Lives and Seilles Formation : Livian).

These carbonates are overlain by Namurian shales. A stratigraphical gap, comprising nearly the whole Upper Visean (Uppermost Livian and Warnantian) and Lower Namurian (Pendleian : E1) occurs between these strata. More detailed stratigraphical and sedimentpetrographical data are summerized in SWENNEN (1985).

3. THE QUARTZ NODULES.

3.1. DESCRIPTION.

The quartz nodules are especially common in thin-bedded dark colored dolostones occurring at the top of repeating sedimentary regressive sequences consisting (from bottom to top) of (fig. 1) :
- thick to medium thick-bedded gray dolostones;
- medium thick-bedded gray dolostones with a mottled appearance;
- thin bedded dark-gray to black, laminated dolostones. Within these beds fine laminae, up to 1 mm thick, occur.

The quartz nodules are often associated with cherts (plate 1A) and are arranged in semi-continuous horizons, parallel to the stratification. The nodules grade from a few mm up to 20 cm. They have a typical spheroid or oblate spheroid shape. However, less regular shapes also occur. Quartz geodes are less common. They are often characterized by the development of bitumen in their central part. Since these geodes have the same morphological and textural features as the nodules, they are treated together.

The cauliflower outline of the quartz nodules is a diagnostic feature. In detail their surface is found to be covered by rounded cerebral protuberances. As can be deduced from plate 1 B, the nodules expanded during their growth. They therefore have grown in a soft sediment, which has been displaced; this feature indicates an early-diagenetic origin. Due to the coalescence of different adjacent nodules a mosaic texture (= chickenwire) often becomes apparent (plate 1C).

The nodules are lined by a rind of lutecite and/or quartzine, always grading inwards into megaquartz. The centre of the nodules is often filled by calcite and/or dolomite. Sometimes the centre may be occupied by a geopetal collapse structure (plate 1F). In a general way, the following sequence of microtextural features occur from the outer rim to the centre :

1. Interlocking spherulites of lenght-slow chalcedony (mostly lutecite : plate 1G). The diameter of the spherulites ranges from 0.1 mm to 0.2 mm. Locally, a rind of microflamboyant quartz occurs perpendicular to the margin of the nodule.

2. Scattered, large (1 mm to 12 mm) spherulites of lenght-slow chalcedony (mostly quartzine), grading into euhedral megaquartz (plate 1H). A distinct morphological or optical boundary does not exist between the two varieties. The centre of the spherulites is often filled up with dolomite. Relict felted textures, as well as small lath-shaped anhydrite inclusions occur (plate II); they are restricted to the megaquartz. The orientation of these anhydrite relics is independent of the orientation of the spherulitic megaquartz crystals.

3. Mosaic of poikilotopic megaquartz grains with tiny inclusions of anhydrite (plate 2A). These megaquartz grains are sometimes characterized by an undulose extinction. Where organic matter is present, the development of large crystals is apparently inhibited.

4. Scattered individual, mostly euhedral megaquartz crystals sometimes with undulose extinction. Their size ranges from 0.5 to 3.0 mm. Anhydrite inclusions are often arranged in zones parallel to the crystal faces (plate 2B and C); their size may grade up to 1 mm. Locally, a felted texture can be recognized (plate 2D).

5. Around the free terminating crystal faces of megaquartz a rim (0.001-0.06 mm) often occurs. This rim consists of quartz with a fibrous aspect but it is in optical continuity with the megaquartz; also the boundary is sharp. This rim is well developed on the pyramidal crystal faces 10$\bar{1}$1 while it is very thin on the prismatic faces 10$\bar{1}$0 . Sometimes lamellar crystallization gaps, similar to the ones described by Abrey (1980) are present between both; at present they are filled with a dolomite phase. Anhydrite inclusions do not occur in these rims. At the contact with the void-filling phase the quartz rim is often corroded (place 2B, C and E).

6. Calcite crystals with a lath shaped habit. They have a lenght of up to 3 mm and occur in the center of the nodules. They develop often upon the above described quartz rim. They are surrounded by void-filling dolosparite (plate 2F) which replaces partially the calcite.

7. The remaining cavity is filled by a coarse-grained dolomite (with crystals up to 3 mm), characterized by an undulose extinction and by curved crystal faces. They are comparable to the saddle dolomites described by RADKE and MATHIS (1980). In some rare cases equigranular calcite occurs in addition between the dolomite rhombs.

8. Somestimes the centres of the nodules are filled by a geopetal breccia (plates 1F and 2G). This breccia is composed of broken megaquartz fragments of different sizes. These fragments are cemented by the dolomite of texture 7.

Most of the nodules contain the first 7 textures. Textures 2, 3 and 7 make up the bulk of the nodule. The relic anhydrite inclusions are mostly restricted to the megaquartz crystals. There is a general increase in quartz crystal size from the edges of the nodules to the central part.

3. 2. INTERPRETATION.

The macroscopic features already suggest that the quartz nodules are pseudomorphous after anhydrite. Nearly identical morphological structures were described by CHOWNS and ELKINS (1974); WEST (1965) reported similar features in his paper on macrocell structures of anhydrite. This interpretation is also supported by the presence of anhydrite remnants in the megaquartz crystals. The fact that length-slow chalcedony varieties such as quartzine and lutecite occur in these nodules is a supplementary argument (FOLK and PITTMAN; 1971). The above-mentioned mineralogical and textural aspects of the nodules are very similar to those of the nodules interpreted to be pseudomorphous after anhydrite by MILLIKEN (1979).

3. 3. SILICIFICATION HISTORY.

Silicification started with the precipitation of length-slow chalcedony at the margin of the nodules. Afterwards, as FOLK and PITTMAN (1971) described, the length-slow chalcedony stabilizes to become ordinary megaquartz. This feature is clearly present in texture 2 (plate 1H and I) where the chalcedony spherulites gradually passes into megaquartz. Silicification proceeded with the growth of euhedral quartz crystals in the centre of the nodules. In the same direction the silica concentration decreased from high to low (FOLK and PITTMAN, 1971; ARBEY, 1980). The zonal arrangement of the anhydrite inclusions in the megaquartz crystals reflect fluctuations in silica concentration. The next step was the precipitation of a silica rim on the megaquartz crystals. The fact that no anhydrite inclusions occur within this rim could indicate that all sulphates were dissolved at that period. However, another explanation is favoured, namely that the quartz rim is the recrystallization product of lussatine, an opal-CT variety (ARBEY, 1980). Arguments are the presence of a relict fibrous texture, the sharp boundary between the megaquartz and the "quartz" rim and the occurrence of lamellar crystallization gaps. The lack of anhydrite inclusions in this "quartz" rim can simply be explained by the impossibility to incorporate inclusions in a crypto crystalline silica phase, a feature also observed for the lutecite and quartzine phases. This interpretation explains also why these "quartz" rims in contrast with the megaquartz crystals are preferentially corroded. The solubility of quartz is much lower than that of the opal varieties. The corrosion of these rims points towards contact with high alkaline solutions (pH>9; WALKER 1962).

In some exceptional cases, the rate of anhydrite dissolution exceeded the rate of silicification. Therefore quartz crystals dropped to the floor of the resultant cavity, forming a geopetal texture (plate 1F). In the following stage the lath-shaped crystals (now calcite) developed (plate 2F). It is not clear if the morphology indicates a precursor other than calcite (e.g. anhydrite, aragonite, ...). Void-filling saddle dolosparite precipitated eventually.

Only few papers have dealt with the diagenetic environment in which silicification of evaporites occurred. As a result of stable isotope analysis on silicified anhydrite nodules, MILLIKEN (1979) concluded that the earliest replacement by quartzine or micro-flamboyant quartz occurred in waters of composition intermediate between that of seawater and meteoric water. The megaquartz formed most likely in meteoric water. A similar interpretation is favoured here. Arguments can also be found by the association of these nodules with cherts and a different dolostone type (i.e. idiotopic). Last two probably were formed in a similar diagenetic environment (SWENNEN, 1985).

The source of silica is not clear. Siliceous sponge spicules, which were originally composed of highly soluble biogenic opal, were recognized in the cherts only. They are lacking in the dolostones. These sponge spicules could provide most of the silica needed for silicification and chertification. Some corrosion was observed on terrigeneous quartz grains suggesting a possible supplemental source of silica. However, due to its stability under most sedimentary and diagenetic conditions, it is unlikely that this source was significant.

4. DOLOMITE NODULES.

4. 1. DESCRIPTION.

Individual dolomite nodules displaying morphological features similar to those of the quartz nodules are scattered through the Vesdre Dolostone Formation. They are filled by yellow brown colored dolosparite with crystal diametres up to several centimetres. The nodule size varies around 5 cm. Locally the nodules display a chickenwire structure. They too are characterized by a cauliflower shape, with typical cerebral protuberances (plates 1D and E) and the lamination of the dolostone lithology is also clearly influenced by the growth of the nodule (compare plate 1B) indicating its early-diagenetic nature.

In the same levels some nodules occur which are internally brecciated. The following features are present (some of these features are recognisable in plate 2H) :

1. the dark fragments within the dolomite nodule are identical to the surrounding dolostone : their size varies between 0.1 mm and 30 mm;

2. the fragments are always flattened and some display a cauliflower outline;

3. within some nodules the fragments are geopetally ordered; in other nodules the fragments float in the dolomite matrix;

4. the matrix consists of yellow brown dolosparite with crystals up to several centimetres;

5. a cauliflower outline is sometimes still recognisable at the margins; but more often this structure is completely obliterated;

6. the internally brecciated nodules are always larger in size (>10 cm) than the above-described individual dolomite nodules;

7. circumnodular cracks (1-2 mm wide), filled with a similar dolosparite as the matrix occur around some nodules.

Similar internally brecciated structures have never been observed in the silicified nodules. This suggests that the brecciation process occurred after the silicification.

An important field observation is the fact that all transitions from completely internally to partly brecciated nodules occur. A vague relict chickenwire structure is sometimes preserved.

4. 2. INTERPRETATION AND DISCUSSION.

The features of the individual dolomite nodules, such as the cauliflower shape, the chickenwire structure and their association with silicified anhydrite nodules indicate that these scattered nodules have a similar origin as the quartz nodules i.e. that they are pseudomorphous after anhydrite nodules. Sometimes features resembling a gypsum precursor were detected. However, there is an important difference in the formation of the present nodules; the silicification nodules are the result of a replacement process while the dolomite nodules are the result of a cavity infill where the sulphate was dissolved in an earlier stage. This explains why relics of evaporitic minerals have not been found in the dolomite nodules. The brecciated structure is thought to be the result mainly of the collapse of the dolostone inter-nodule fringes occurring in chickenwire structures of anhydrite nodules. Now they form the fragments of the nodules. Small scale stress reduction in the immediate neighboorhoud of the cavities certainly occurred, giving rise to minute circumnodular cracks. The dolosparite in certain instances penetrated along these cracks affecting further the enclosing dolostone.

5. DISCUSSION.

5. 1. SEDIMENTATION ENVIRONMENT.

The recognition of silicified and dolomitized anhydrite nodules within dolostones is of major importance, since the nodules are often the only component yielding information about the sedimentation environment. Indeed, in the enclosing strata most of the sedimentary features are nearly completely obliterated due to dolomitization.

Similar sulphate nodules have been described from recent sabkha-environments (CURTIS *et al.*, 1963; KINSMAN, 1966; SHEARMAN, 1966; and others). There they mainly occur within supratidal sequences; they are often associated with algal laminites. The finely laminated beds at the top of the regressive sequences in the considered dolostones are indicative for algal mats. For this reason it seems feasible to accept a similar sedimentation environment for the silicified anhydrite occurrences of the Vesdre Dolostone Formation. This interpretation is argued also by the fact that sabkha sequences were recognized in equivalent Lower Visean (Lower Moliniacian) strata (POELS and PREAT, 1983) in the Vedrin area (eastern part of the Namur basin : fig. 1).

The formation of anhydrite nodules below sea-level as suggested by KALDI (1980), DEAN and ANDERSON (1982) and LOUCKS and LONGMAN (1982) is not favoured here because of the situation of these levels at the top of regressive sequences.

5. 2. OCCURRENCES OF ANHYDRITE RELICS IN THE BELGIAN DINANTIAN.

Recently silicified or dolomitized anhydrite nodules have been mentioned or recognized within different stratigraphical levels of the Dinantian of Belgium. Without being complete, some of the major occurrences will be mentioned. For a general stratigraphical review of the Belgian Dinantian the reader is referred to PAPROTH *et al.* (1983).

Three major horizons have been found; the first two occur mainly in the eastern part of Belgium, while the third is well developed in the western part. They are :

- The Upper Ivorian (Upper Tournaisian).

The anhydrite relics of this level are mainly silicified. A spatial relationship with cherts is apparant. The most important occurrences are situated in the Ourthe and Hoyoux valleys. Both areas belong to the eastern part of the Dinant basin. Similar features, however, less developed have recently been discovered in the western equivalents namely in the Dinant area (Leffe Formation), in the western part of the Namur basin (Tournai Formation) and in the Avesnois area (northern France : Calcaire et Dolomie du Grives) (R. CONIL : communication on the annual meeting of the NFWO/ FNRS contact group on Dinantian stratigraphy.

- The Lower Moliniacian (Lower Visean).

Anhydrite relics occur mainly in the Vesdre basin (Vesdre Dolostone Formation) and eastern part of the Dinant basin (Sovet Formation). In the last area the anhydrite nodules are mostly dolomitized (plate 1E). Continuous layers of anhydrite relics were found near the top of the Sovet Formation. In the underlying dolostones only some of the individual dolomite nodules display the diagnostic features indicating their pseudomorphous origin. From the Namur basin, similar features near Namur have been described by POELS and PREAT (1983).

Within the overlying evaporitic collapse breccias (Walhorn breccia and Belle Roche breccia) only minor traces of silicified evaporites have been found. Continuous beds of dolomitized anhydrite relics as well as individual nodules occur at the base of the Terwagne Formation in the Belle Roche section (eastern part of the Dinant basin). However in other outcrops of the Terwagne Formation anhydrite relics have not yet been observed. Anhydrite relics in the overlying Moliniacian sequences are rare. Only some minor occurrences have been recognized (HANCE, 1982).

- The Livian sequence (Middle Visean) of St-Ghislain (eastern part of the Namur basin).

Different papers have dealt with the evaporitic strata within this borehole (GROESSENS *et al.*, 1979; ROUCHY *et al.*, 1984) and with the lateral equivalents (HENNEBERT and HANCE, 1980).

6. CONCLUSIONS.

The interpretation of the quartz nodules as pseudomorphs after anhydrite was mainly based on the following arguments : their cauliflower outline, the presence of chickenwire structures, the presence of a lenght slow chalcedony fringe and the occurrence of anhydrite remnants in the megaquartz phases. The microtextures within these nodules are compatible with their pseudomorphous origin. Their succession indicates that silica concentration decreased from the nodule fringe to the centre. Several varieties of microtextures in the nodule centre (e.g. quartz rims pseudomorphous after lussatine (opal-CT variety), lath-shaped calcite pseudomorphs, ...) indicate that the pseudomorphose process was complex in the final stage.

Dolomite nodules occur in association with these silicified anhydrite nodules. This association, the cauliflower outline and the development of chickenwire structures indicate that they are also pseudomorphous after anhydrite. Internally brecciated dolomite nodules occur also and are explained by collapse of the dolostone inter-nodule fringes of chickenwire structures. Their presence and recognition therefore is of importance since they are a valuable key for the existance of pseudomorphosed anhydrite nodules. In contrast to silicification of anhydrite nodules, which is a replacement process, dolomitized anhydrite nodules are the result of a cavity infill, indicating that the sulphate was leached out in an earlier stage.

Since these silicified and dolomitized anhydrite nodules occur mainly at the top of regressive sedimentary sequences and within dark colored, laminated dolosparites, a sabkha-like sedimentation environment seems most likely for these levels. However dolomite nodules displaying none of the described features also occur in the Vesdre Dolostone Formation. It is questionable if they have a similar origin and thus if they indicate a similar sedimentation environment.

The systematic study of the position and lateral extension of these anhydrite pseudomorphs will be a helpfull tool in lithostratigraphical correlations and in the paleogeographical reconstruction.

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P L A T E I

A. Field observation of silicified anhydrite nodules (Q) and cherts (CH), occurring within dark colored dolostones (St-Roch quarry).

B. Quartz nodule in crinoidal dolostone. Due to the early-diagenetical growth of the original anhydrite nodule, the surrounding soft laminated sediment was displaced (see dotted line) (diameter camera lens protector : 6 cm) (St-Roch quarry).

C. Aggregate of different silicified anhydrite nodules displaying a typical chickenwire structure (Walhorn quarry).

D. Dolomite nodule occurring in dark colored dolosparite (D). Its cauliflower shape suggests that this nodule is pseudomorphous after anhydrite (St-Roch quarry).

E. Dolomite nodule occurring in crinoidal dolosparite. Its typical outline, characterized by swelling bladed rosettes (compare with CHOWNS and ELKINS, 1974, Fig. 4b) indicates a pseudomorphous origin after anhydrite or gypsum (Belle Roche quarry).

F. Geopetal collapse structure in a quartz nodule (Ch : Chalcedony; Q : megaquartz; D : void-filling dolomite; Br : internal breccia). The internal breccia microtexture is shown in plate 2.G (St-Roch quarry).

G. Texture 1 :
Photomicrograph of interlocking spherulites of length-slow chalcedony and contact between chert (CH) and quartz nodule. Note also the occurrence of parallel orientated microquartz fibers perpendicular to the margin of the nodule.

H. Texture 2 :
Photomicrograph of spherulites of lutecite, which grades into megaquartz. The center of the spherulites is filled by dolomite (D).

I. Texture 2 :
Photomicrograph of lutecite spherulites, which grades into megaquartz. Small lath-shaped anhydrite inclusions (A) occur within the megaquartz phases. Their orientation is independant from the orientation of the quartz phase.

PLATE 1

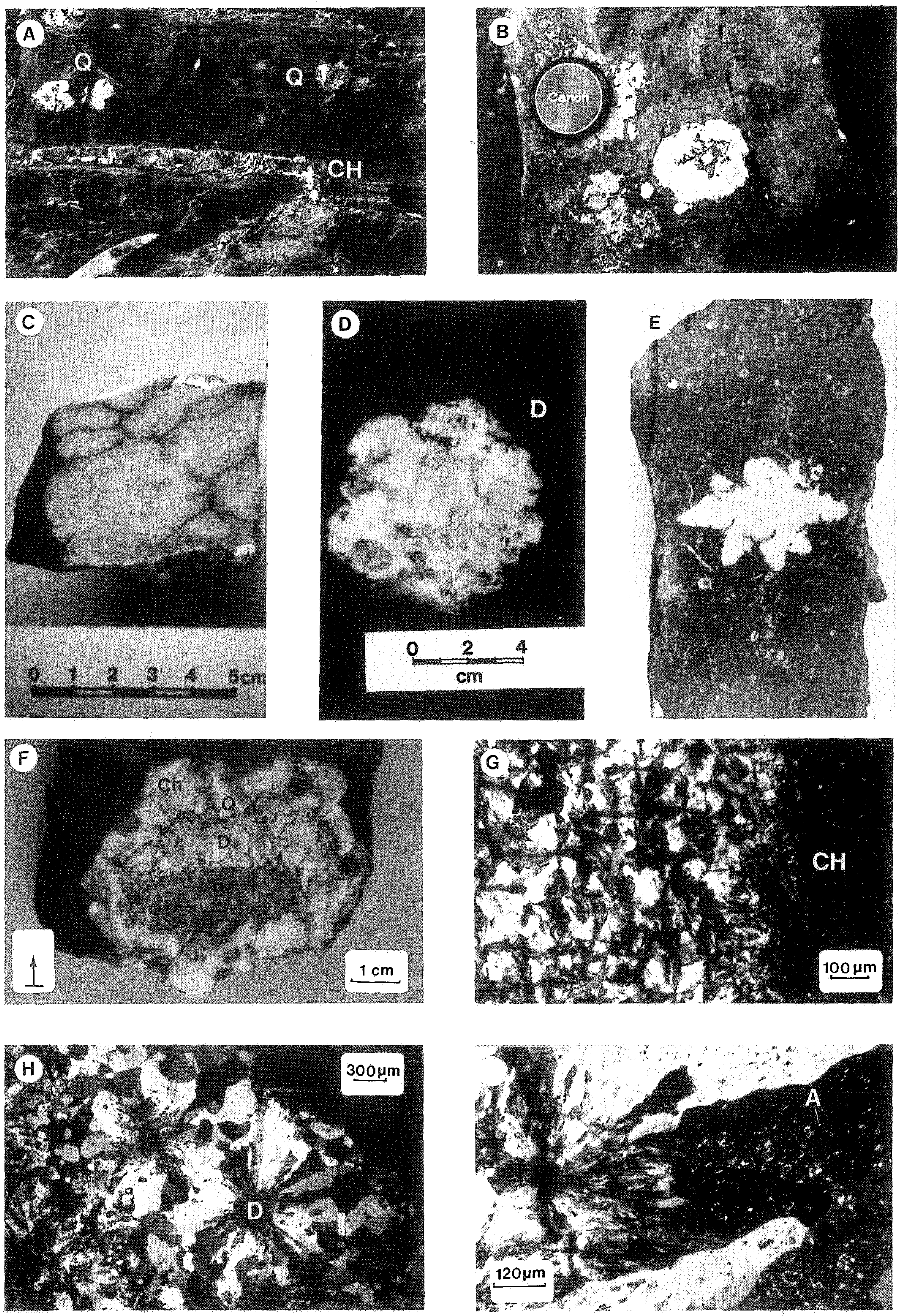

A
Q
Q
CH
B
Canon
C
0 1 2 3 4 5cm
D
D
0 2 4
cm
E
F
Ch
Q
D
Br
1 cm
G
CH
100 µm
H
300µm
D
A
120µm

PLATE 2

A. Texture 3 :
Photomicrograph of a mosaic of megaquartz grains with anhydrite inclusions (A).

B. Texture 4 :
Photomicrograph of individual euhedral megaquartz (cross-section perpendicular to the c-axis) in a dolomite matrix (D).
The anhydrite relics occur in several zones parallel to the quartz crystal faces. At the contact with the void-filling dolomite phase these crystal faces often are corroded (see arrows).

C. Texture 4 :
Photomicrograph of scattered, individual subhedral to euhedral megaquartz crystals with undulous extinction (cross-section parallel to the c-axis). The anhydrite relics occur in zones parallel to the quartz crystal faces.

D. Texture 4 :
Photomicrograph of subhedral megaquartz crystals with a typical felted texture.

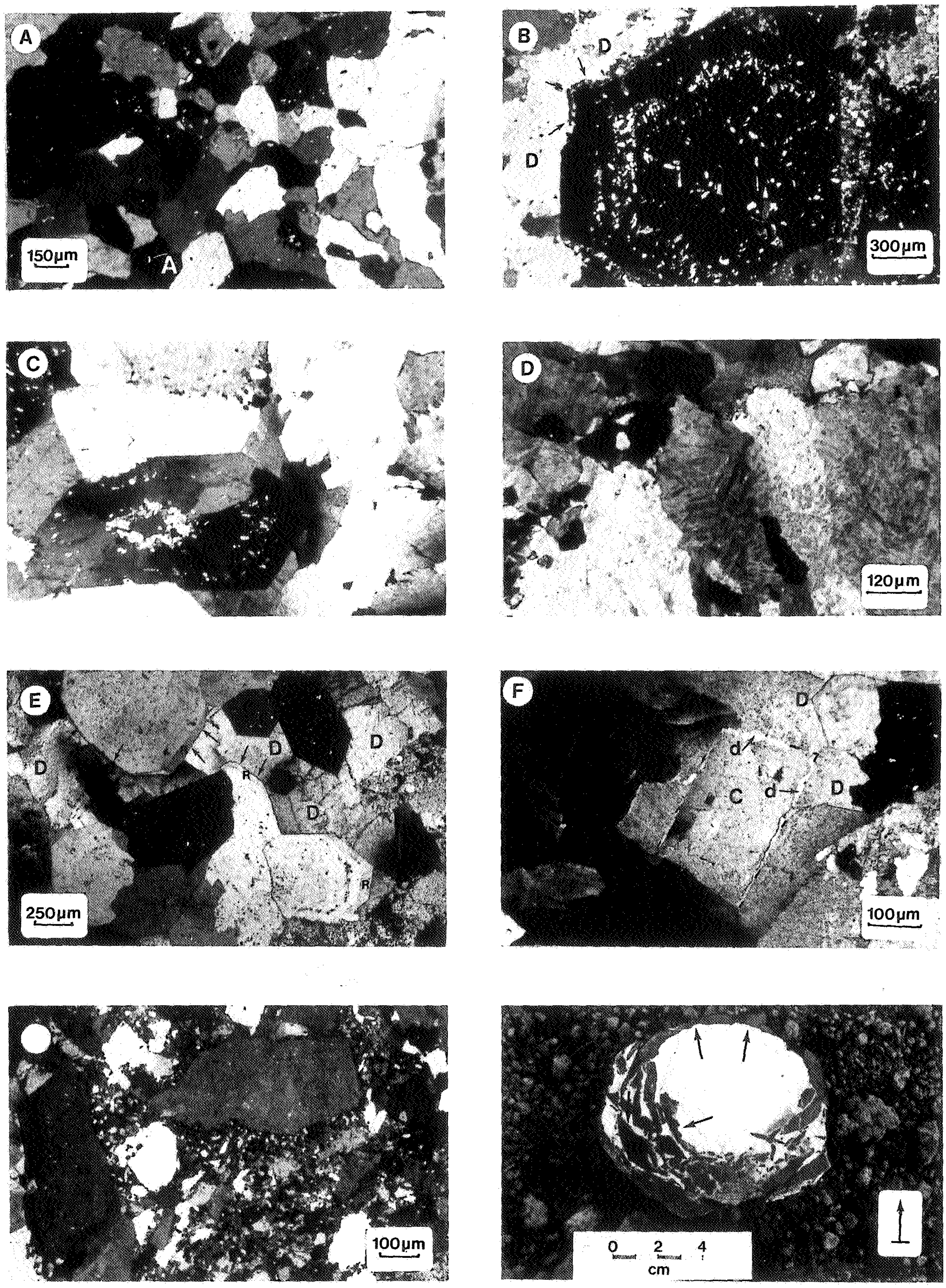
E. Texture 4 :
Photomicrograph of euhedral megaquartz crystals with secondary rim (R), free from anhydrite inclusions, in void-filling dolomite (D). At the contact with this dolomite the quartz crystal faces are often corroded (see arrows).

F. Texture 5 :
Photomicrograph of lath-shaped calcite crystals (C) in void-filling dolomite (D). Note that the outer rim of these crystals is composed of dolomite (d).

G. Texture 6 :
Breccia composed of broken megaquartz grains and fragments of different size.

H. Internally brecciated dolomite nodule. The dark colored flattened fragments are geopetally ordened. A cauliflower shape is recognisable at the upper part of the nodule as well as in some fragments (see arrows).

PLATE 2


A
150μm
A
B
D
D
300μm
C
D
120μm
E
D
D
D
D
R
R
250μm
F
D
d
C
d
D
D
100μm
100μm
0 2 4
cm