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MORPHOLOGY OF PYRITE FROM THE NANISIVIK MINE, BAFFIN ISLAND, NORTHWEST TERRITORIES

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ABSTRACT

Epitaxic overgrowths of equant crystals of pyrite on pyrite pseudomorphous after marcasite, cyclically twinned on {101}, result in unusual tabular aggregates of pyrite crystals from the Nanisivik Zn–Pb mine, Baffin Island, N.W.T. The orientation in the pseudomorphs as well as the equant crystals is: pyrite {001}[010]‖marcasite {010}[101]. The marcasite cell is in the orientation $a<c<b$ with a = 4.436, b = 5.414 and c = 3.381 Å. The equant crystals that form the tabular overgrowths exhibit the following forms, commonly in almost equal development: {001}, {011}, {111}, {021} and {211}.

Keywords: pyrite–marcasite epitaxy, pseudomorphs (pyrite after marcasite), Nanisivik mine, Baffin Island, zinc-lead deposit.

SOMMAIRE

Des surcroissances épitaxiques de cristaux équidimensionnels de pyrite sur pyrite en pseudomorphose de la marcasite, cycliquement maclée sur {101}, produisent des agrégats en tablettes peu communs de cristaux de pyrite à Nanisivik, mine de Zn–Pb sur l'île de Baffin (Territoires du Nord-Ouest). L'orientation des cristaux pseudomorphiques aussi bien que des cristaux équidimensionnels est: pyrite {001}[010]‖marcasite {010}[101]. La maille de la marcasite a l'orientation $a<c<b$ avec a = 4.436, b = 5.414 et c = 3.381 Å. Les cristaux équidimensionnels qui forment les surcroissances en tablettes montrent les formes suivantes, toutes avec à peu près la même importance: {001}, {011}, {111}, {021} et {211}.

(Traduit par la Rédaction)

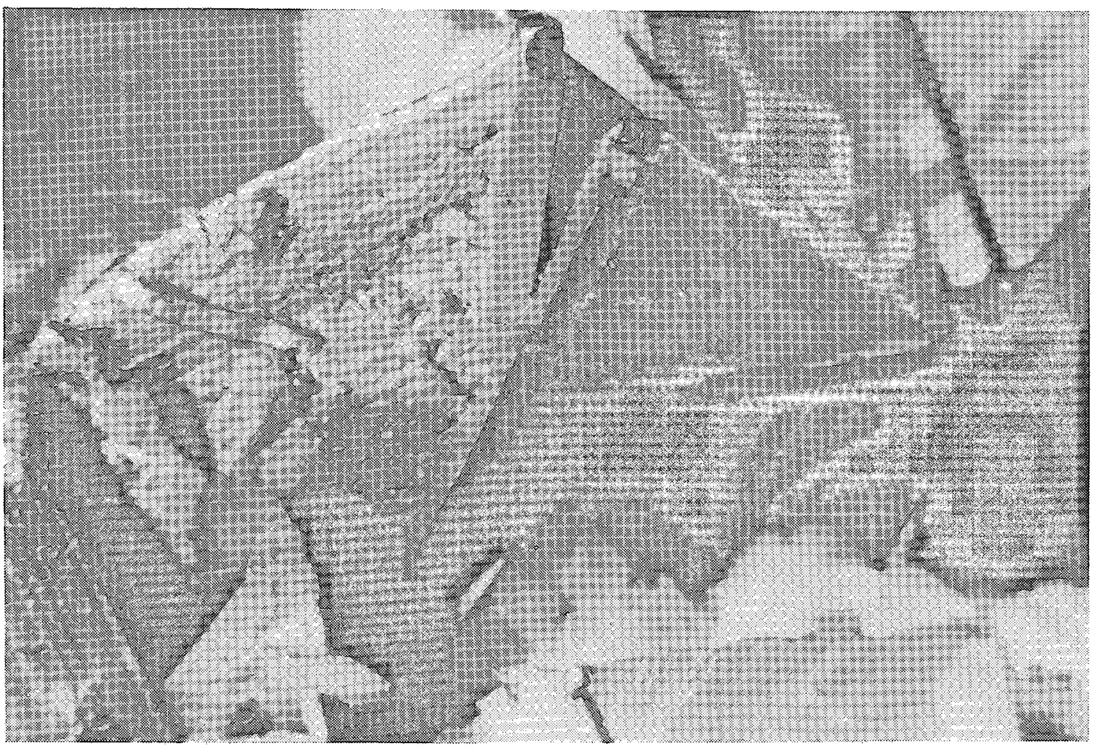

FIG. 1. Pyrite pseudomorph after marcasite twinned on {101}. Twin 7 mm across.

Mots-clés: épitaxie pyrite – marcasite, pseudomorphe (pyrite pour marcasite), mine Nanisivik, île de Baffin, gîte de Zn–Pb.

Introduction

This paper describes some of the unusual habits and aggregates of pyrite crystals from the Nanisivik mine and outlines the geological setting of the crystal-lined vugs in which they occur. Specimens from this mine were first acquired by the Royal Ontario Museum in 1978. The striking tabular groups of pyrite crystals are so different from pyrite specimens from other localities that an investigation was warranted.

General Geology of the Nanisivik Mine

The Nanisivik deposit is a carbonate-hosted, zinc-lead massive sulfide zone occurring in dolostone of the Society Cliffs Formation of middle Proterozoic age. It was described in detail by Olson (1984), Clayton & Thorpe (1982), and Jackson & Ianelli (1981).

The Main Ore Zone is lenticular in cross-section and extends 3000 metres east–west, 100 metres laterally and is 20 metres in average thickness. The Main Ore Zone is vertically connected to a lower network of tubes, pipes and stringers known as the Lower Lens.

The deposit consists mainly of pyrite pseudomorphs after marcasite, with accessory sphalerite, galena and white sparry dolomite. Several genetic models, ranging from total open-space filling to total replacement, have been proposed. Current ideas utilize a combination of the two models as follows: a small karst system within the host dolostone channeled fluids migrating from a nearby basin. Mixing of the metal-rich brines with hydrogen sulfide gas resulted in precipitation of the ore minerals, which released acids that attacked the dolostone. Repetitions of this process resulted in enlargement of this system to its present size.

Open spaces are common in the massive sulfides; they range from elongate, open fractures several centimetres wide to lens-shaped vugs up to two metres across. Well-developed crystals of the ore minerals commonly line these openings. In decreasing order of abundance the crystallized minerals are dolomite, pyrite, calcite, sphalerite, quartz, galena and chalcopyrite. Although pyrite is common throughout the

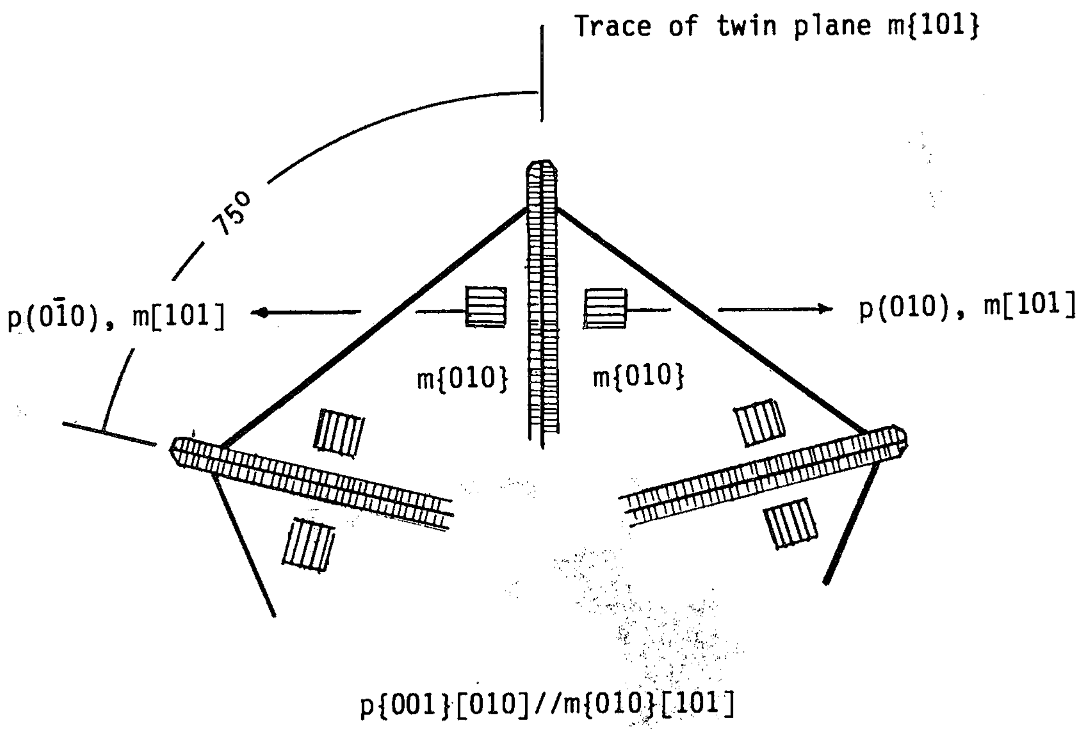

FIG. 2. Sketch of a pyritized marcasite, cyclically twinned on {101}, showing the pyrite bars along the twin planes and the orientations of the equant crystals of pyrite. Note that in the crystallographic notations, p and m refer to pyrite and marcasite.

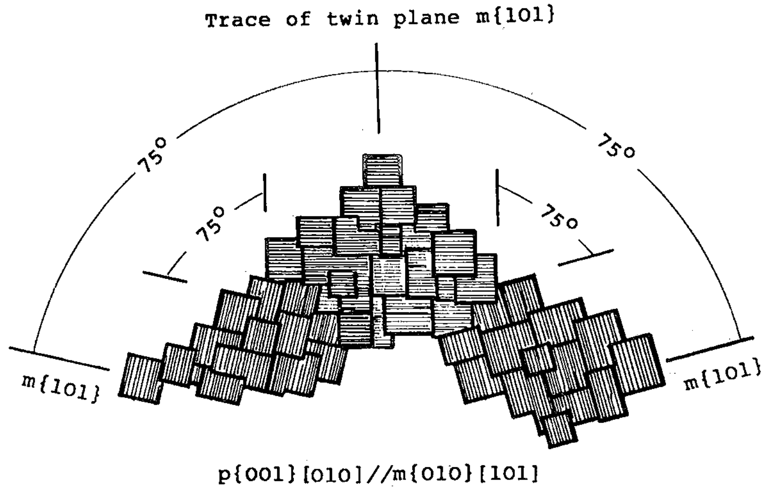

FIG. 3. Sketch showing the epitaxic overgrowths of equant crystals of pyrite obscuring a pyritized marcasite twin. Twin planes are m{101}.

deposit, most of the larger and more spectacular crystals are concentrated in cavities in the central pyrite-rich portion of the ore zone.

THE MARCASITE – PYRITE RELATIONSHIP

This study was undertaken to explain the unusual habits of the aggregates of pyrite crystals seen on many of the superb specimens from the Nanisivik mine. Some of the specimens used in this study are in the mineral collection of the Royal Ontario Museum, and others are from the collection of the late Mr. Rodney C. Staveley of Toronto. The bulk of the specimens, however, were provided by Nanisivik Mines Limited.

About 60 specimens were examined in this study in order to explain the origin of the tabular aggregates of pyrite crystals. The first clue to their origin was discovered when some exceptional twins of what appeared to be marcasite came to our attention. These specimens, which have the characteristic habit of the fiveling, cyclic twins of marcasite, are up to 7 cm in diameter, flattened on (010) with (101) as the twin plane (Fig. 1). X-ray powder-diffraction studies proved that all these apparent marcasite twins are actually pyrite pseudomorphs after marcasite. The pyrite that has replaced the marcasite is oriented so that pyrite {001}[100] is parallel to marcasite {010}[101], a common epitaxic relationship (Palache *et al.* 1944). A similar epitaxic intergrowth was noted by Fleet (1970) in his study on the marcasite–pyrite transformation. An unusual characteristic of these twins is the presence of a narrow bar of pyrite along each of the twin planes. These bars usually protrude beyond the crystal, and each has a distinct line dividing it into two parts along its length. Figures 1 and 2 show these pyrite bars and indicate that they conform to the epitaxic overgrowth relationship described above. These bars can be explained if the twin plane is a preferential site for the nucleation of the replacing crystals and the overgrowth crystals. The fine line dividing the bars lengthwise marks the boundary between the two pyrite crystals on either side of the twin plane.

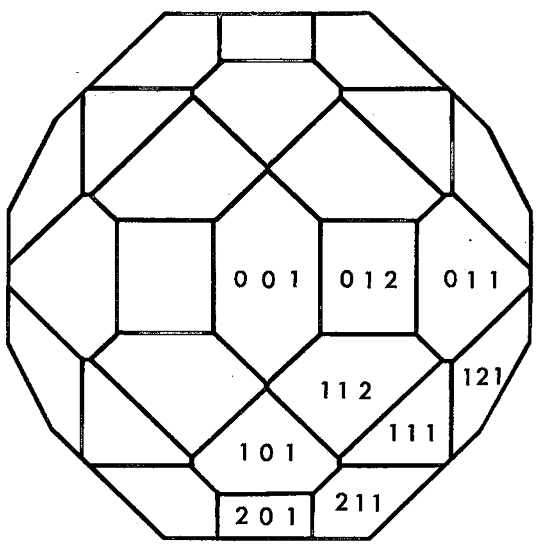

FIG. 4. Crystal drawing showing the forms {001}, {011}, {111}, {210} and {211} in nearly equal development, as seen on pyrite crystals from the Nanisivik mine.

The most spectacular of the pyrite specimens show tabular aggregates of brilliant crystals that are the result of the epitaxic overgrowth of many equant crystals of pyrite on the pyrite pseudomorphs after twinned marcasite. The angle between the twin planes of the original marcasite (now pyrite) is 74°38′. On each twin segment of the pyrite pseudomorph the overgrowths follow the general crystallographic control pyrite {001}[100]‖marcasite {010}[101], even though they appear to have two different orientations. The specific orientations are pyrite (001)[010]‖marcasite (010)[101] and pyrite (001)[0$\bar{1}$0]‖marcasite (010)[101] on either side of the twin plane (Fig. 2). An angle of about 75° is commonly noted between the cube edges of groups of oriented crystals of overgrowth pyrite even where the pyritized marcasite is completely obliterated by them. This angle was measured on several of the tabular aggregates using a contact goniometer and, although not precise, is sufficient to indicate that the tabular aggregates are the result of epitaxic overgrowths controlled by the underlying pyritized marcasite, which in turn was formed by the epitaxic replacement of the original marcasite by pyrite (Fig. 3).

Eight of the equant crystals of pyrite were selected for goniometric work in order to identify the forms. The crystals are quite complex in appearance; on many of them the forms are nearly equally developed. Measurements on the crystals revealed the following forms: cube, dodecahedron, octahedron, pyritohedron {210} and trapezohedron {211}; although diploids have been reported to occur, none were identified in this study (Fig. 4). The dodecahedron and the trapezohedron are relatively uncommon forms on pyrite crystals and are rarely seen so well developed as on these crystals. Sharp, well-developed crystals displaying these forms reach up to 1 cm in diameter. These crystals are associated with calcite, dolomite, sphalerite, galena, gypsum, and minute marcasite crystals of a later generation.

The genetic significance of the marcasite twins and of another generation of pyrite is unclear. The experimental work of Fleet (1970) indicates that the marcasite–pyrite transformation occurs at about 400°C, but the high-symmetry forms of the subsequent overgrowths suggest a lower-temperature environment.

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