MINERALOGY OF THE WEATHERING PROFILE OF A VOLCANIC BRECCIA IN THE ČESKÉ STŘEDOHOŘI Mts.

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INTRODUCTION

The investigation of Tertiary volcanic rocks of the České středohoři Mts. (in northern Bohemia) carried out between 1958—1966 was directed particularly to the study of volcanic diatremes and their fillings. The geology and mineralogy of this area was already studied in detail by J. E. HIBSCH [1926, 1934].

GEOLOGICAL SETTING AND GENETIC CONDITIONS

The young volcanics of the České středohoři Mts. are of an alkaline character and date from the Miocene to Pliocene. The bulk of volcanics belong to the first (Miocene) volcanic phase; the second, Pliocene phase was less intensive. In the intervening period of volcanic rest, the rocks were exposed to strong climatic weathering. Basic rocks were affected by montmorillonitization and the acid ones by kaolinization.

The secondary minerals studied are confined to the weathering profile of the breccia-like filling of the diatreme at the Sviňky locality near Hořenec (near Bílina spa, in the southwestern part of the České středohoří Mts.).

The diatreme is of a considerable areal extent, of about 1,000×320 metres *(Fig. 1)*, and is filled by earlier vent (volcanic) breccia and the younger massive igneous rock, that corresponds petrographically to vitreous picritic leucite basanite and occurs in a dyke form inside the diatreme.

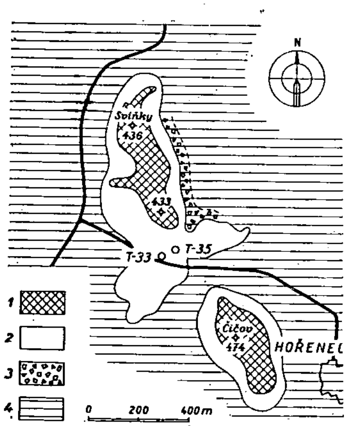

Fig. 1. Geological map of the Sviňky diatreme in the SW of the České středohoří Mts., with the location of boreholes: *1* — Massive vitreous picritic leucite basanite; *2* — vent (volcanic) breccia; *3* — crush zone of Cretaceous sediments; *4* — marlstones (Coniacian).

The vent breccia itself is composed of the fragments of picritic basaltic rock (90 per cent) altered to montmorillonite, and the fragments (xenoliths) of rocks (10 per cent) derived either from the crystalline basement (granulite, pyrope-bearing pyroxene peridotite) or from the Upper Cretaceous sedimentary complex (marlstone, fine-grained sandstone).

In the southern part of the outcrop of vent breccia (in the vicinity of T-33 and T-35 borings), solid, up to 20 cm large chert concretionary forms and xenoliths of Cretaceous sediments of about the same size weather out from the eluvium. Material for the detailed study of the clay mineral forming the substantial part of the vent breccia was taken from the borehole T-35, where the weathering profile reached to a depth of 20.70 m. In the borehole the following succession was established: clayey arable soil with basalt fragments and sporadic weathered-out concretions and xenoliths (0.20 m), brownish-yellow eluvial clay with accumulated concretions and xenoliths at the base (0.90 m); the vent breccia altered to clayey material, yellow-green in colour (to a depth of 2.50 m), yellow (to 4.20 m) and brownish-green (to 8.40 m). The brown colouration is produced evidently by goethite which at this depth was determined by X-ray analysis. The goethite pigment does not appear at lower horizons. The clay mineral proper constituting the substantial part of the rock has been determined by X-ray method as montmorillonite. Below the level of climatic weathering (deeper than 20.70 m), the breccia is greyish-blue, solid, containing carbonates — calcite and siderite — in addition to montmorillonite.

It has been ascertained that within the zone of recent weathering the primary siderite (preserved at a greater depth) is transformed into goethite, the most stable form of ferrous compounds under these conditions. The alteration of different Fe-minerals under weathering conditions is a well-known and widespread phenomenon [J. D. Dana—E. S. Dana 1951].

In the borehole T-33, from which the two chert concretions that will be described below, were taken (at a depth of 21.20 m), fossil weathering reaches 24 m under the surface. The brownish colouration by goethite is observable to a depth of 14.40 m and re-appears between 16—18.70 m.

The X-ray identification of minerals in the rocks studied was performed by Guinier method, after P. M. Wolff, in the Laboratory of the Geological Survey of Czechoslovakia, Prague. The radiation used-Cu, exposition 24 hours at 40 kV and 25 mA.

DESCRIPTION OF THE MINERALS STUDIED

From the point of view of genesis, the examined forms should be divided into chert concretions and xenoliths of Cretaceous, in part silicified sediments. In addition to various forms of SiO_2, some secondary minerals have been identified.

(A) Secondary minerals of xenoliths

The xenoliths of Cretaceous sediments studied were of two types: *(1)* Weakly silicified marlstone and *(2)* decalcified fine-grained spongolitic sandstone with muscovite and glauconite.

(1) The xenolith of weakly silicified marlstone, 8 cm in size, is slightly tinted by ferrous pigment to a distance of 1 cm under the surface. Inside the xenolith there is a lenticular cavity (2—3 cm across) lined with a continuous coating of

finely crystallized aragonite *(Pl. I/1)*. In places, spherolitic aggregates of younger clear aragonite developed, accruing round the crystallization centers to a continuous lining, filling the whole breadth of the fissure *(Pl. I/2)*.

(2) Whitish decalcified spongolitic fine-grained sandstone with muscovite and glauconite. The fissures extending from the surface into the interior of the xenolith are lined by rusty-brown fine coatings of goethite. The wider fissures (up to 2 mm) are covered by lenticular crystals in the form of low rhombohedra (—1/2R), oriented differently to the substrate *(Pl. II/1)*. The small crystals are dark-brown, opaque, with glassy lustre. Their maximum size is 1.2 mm. The general morphology of idiomorphic crystals and the characteristic rounding of rhombohedral faces indicate that they are typical forms of siderite *(Pl. II/2)*. X-ray and optical analyses, however, have identified the mineral as goethite. From this it follows that in the weathering zone goethite pseudomorphs after siderite developed.

(B) Chert concretions and their minerals

On the basis of morphology, three types of concretions may be distinguished: *1)* concretions with concentrically layered texture *(Pl. III/1)*, *2)* with massive filling and *3)* with a hollow interior *(Pl. III/2)*.

The outer zone of all concretions is transected by a network of radial cracks which open outwards, forming the characteristically grooved surface *(Pl. IV/1, IV/2)*.

1. In the chert concretions with concentrically layered structure *(Pl. III./1)*, laminae (about 1—3 mm wide) of yellow to brown compact chert alternate with softer laminae of pale yellowish colour. The compact chert laminae are cut by radial cracks *(Pl. V/ 1)*. In light-coloured soft laminae very fine-grained quartz was identified by X-ray method.

2. A chert concretion of yellow-grey colour with very typically developed radial cracks reaching to about 1.5 cm under the surface is shown in *Pl. IV/2.* At the outer margin of an open fissure, there is a group of 4 mm long clear gypsum crystals with a strongly corroded surface *(Pl. V/2)*.

Other chert concretions with dense interior are light green-grey or brown and of a typically conchoidal fracture. Radial hair-like cracks filled by earlier chalcedony and younger hyalite reach from the surface to about one third of the diameter. The concretion shown in *Pl. VI/1* has a greenish-grey unsilicified core of claystone character which may represent the centre of the nodule formation. On the outer side of the concretion, sporadical wider cracks are lined by warty coating of hyalite which passes inwards into chalcedony. In places, hyalite forms about 0.5 mm large globules *(Pl. VI/2)*.

3. Chert concretions with central cavities are yellowish to brownish-grey with a typically conchoidal fracture of the chert mass. Cavities of irregular shape *(Pl. III/2)* originated similarly as surface cracks by the drying of originally colloidal SiO_2 mass. Mn- and Fe-oxides form locally dentritic coatings on radial cracks. The cavities have again a lining of chalcedony that pass into colourless hyalite towards the surface. The total thickness of the lining is about 1 mm *(Pl. VII/1)*. The hyalite lining has a typical vitreous lustre and the index of refraction equal to 1.4485. The texture of chalcedony with hyalite lining is well visible on the photomicrograph of the transversely broken stalactite-like form *(Pl. VII/2)*. Between partly crossed nicols, the boundary between radiate chalcedony and amorphous hyalite is discernible. The filling of outer cracks in this type of concretions is analogous to that of massive concretions. Additionally, earlier calcite has been observed in this sections under the microscope.

Unlike the above described concretion, the nodule shown on *Pl. III/2* has the interior covered by finely crystalline colourless quartz which is lined by a thin coating of younger chalcedony.

The individual minerals of chert concretions were identified by optical and DEBYE—SCHERRER X-ray methods.

CONCLUSION

Within the range of fossil and recent climatic weathering of a vent breccia, a regular depth-distribution of newly formed minerals has been ascertained, both in the volcanogenic material itself and in the xenoliths of Cretaceous sediments. Beyond the reach of recent weathering, siderite is generated in the breccia and in xenoliths, altering into goethite in the superficial zone of recent weathering.

In some cases chert concretions originate around the xenoliths of Cretaceous sediments. Silicon dioxide seems to have been liberated during the conversion of the volcanogenic component of breccia into montmorillonite.

The origin of carbonates is confined to the fissures in the xenoliths of Cretaceous sediments. In chert concretions the carbonates occur quite scarcely. All forms of SiO_2 are altogether absent from the xenoliths.

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J. E. HIBSCH [1934]: Die Minerale des Böhmischen Mittelgebirges. Jena, G. Fischer.

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EXPLANATION OF THE PLATES

Pl. I. fig. 1. A halfed xenolith of weakly silicified marlstone with a lens-shaped cavity. Natural size 8 cm.
fig. 2. Spherolitic aggregates of aragonite in a lens-shaped fissure. Magn. 1:2.

Pl. II. fig. 1. Xenolith of spongolitic fine-grained sandstone with rhombohedral crystals of goethite pseudomorphs after siderite 1:1.
fig. 2. Rhombohedral crystals of goethite pseudomorphs after siderite. Magn. 1:10.

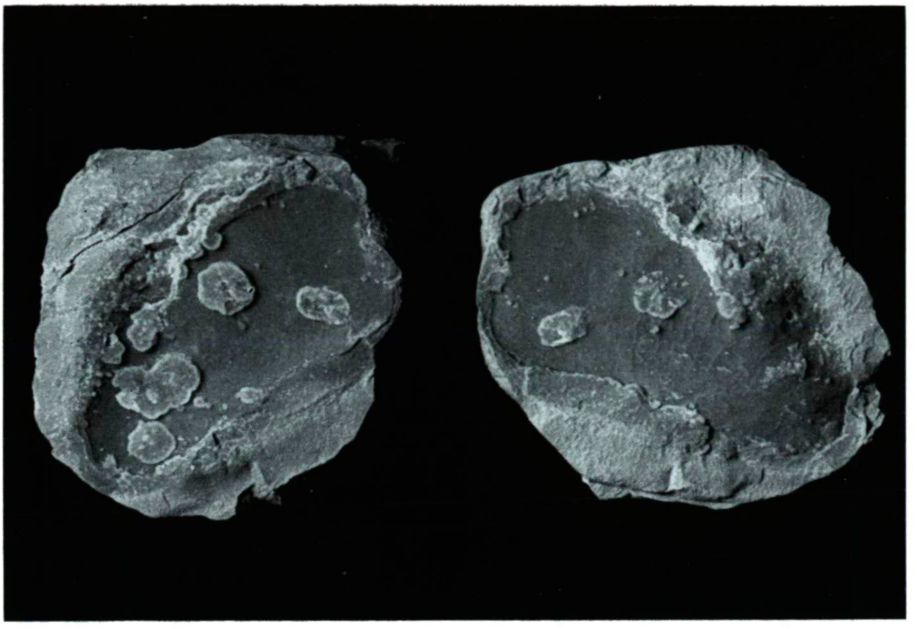
Pl. III. fig. 1. Chert Concretion with a concentrically layered texture. Natural size 11 cm.
fig. 2. Chert concretion with internal cavities lined with finely crystalline quartz. 1:1.

Pl. IV. fig. 1. Chert concretion with a typically grooved surface. Natural size 17 cm.
fig. 2. Chert concretion with a dense network of radial cracks. 1:1.

Pl. V. fig. 1. The alternation of compact chert layers with layers of softer fine-grained quartz. Radial craks are wellseen in chert layers. Magn., 1:20. (A detail from *Pl. III/1*)
fig. 2. A group of gypsum crystals in a fissure of the chert concretion shown in *Pl. IV/2.* Magn. 1:10.

Pl. VI. fig. 1. Chert concretion with unsilicified clay core. Natural size 10 cm.
fig. 2. A coating of hyalite globules on the fissure of the chert concretion shown in *Pl. VI/1.* Magn. 1:10.

Pl. VII, fig. 1. Cavity in a chert concretion with chalcedony and hyalite linings. Magn. 1:2,5.
fig. 2. A small chalcedony stalactite passing into amorphous hyalite. Partly crossed nicols. Magn. 1:50.



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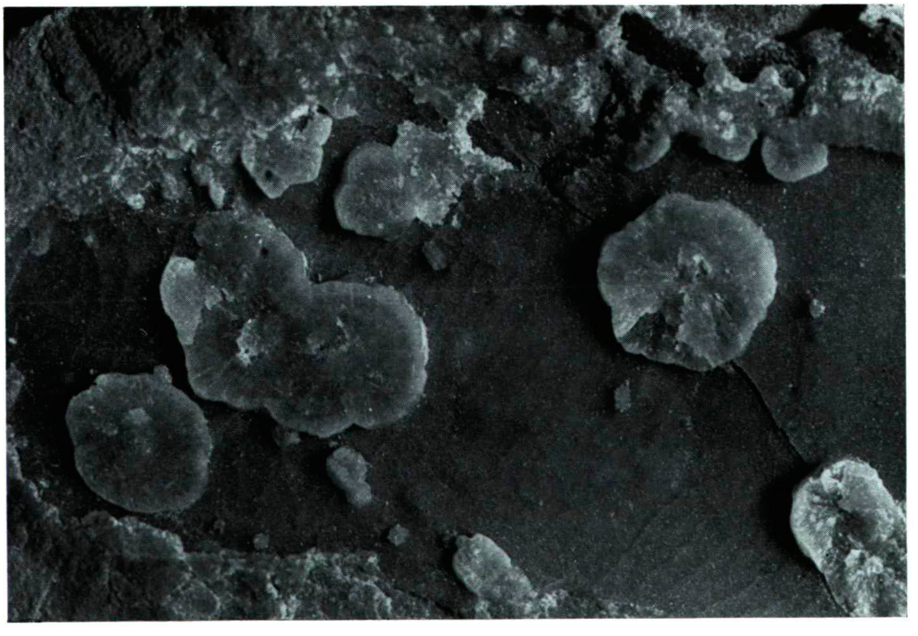

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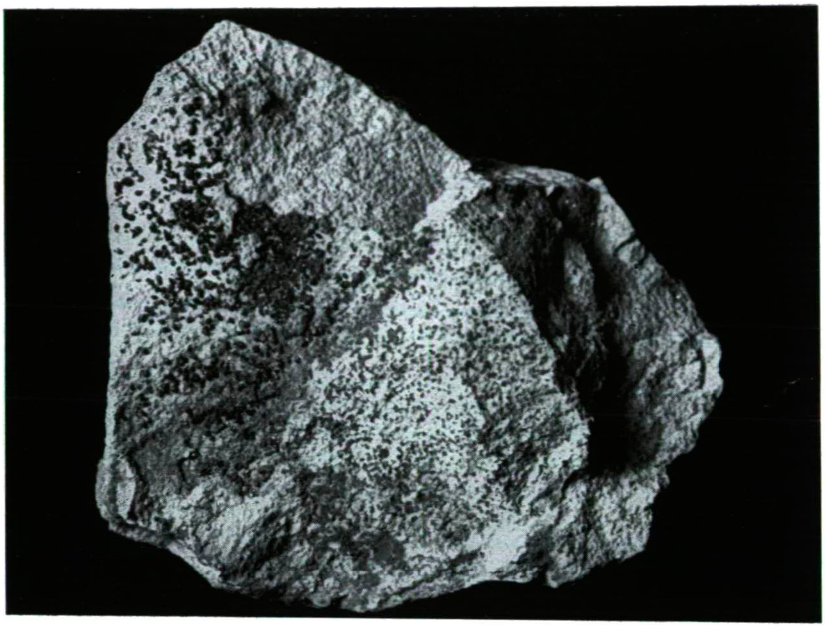

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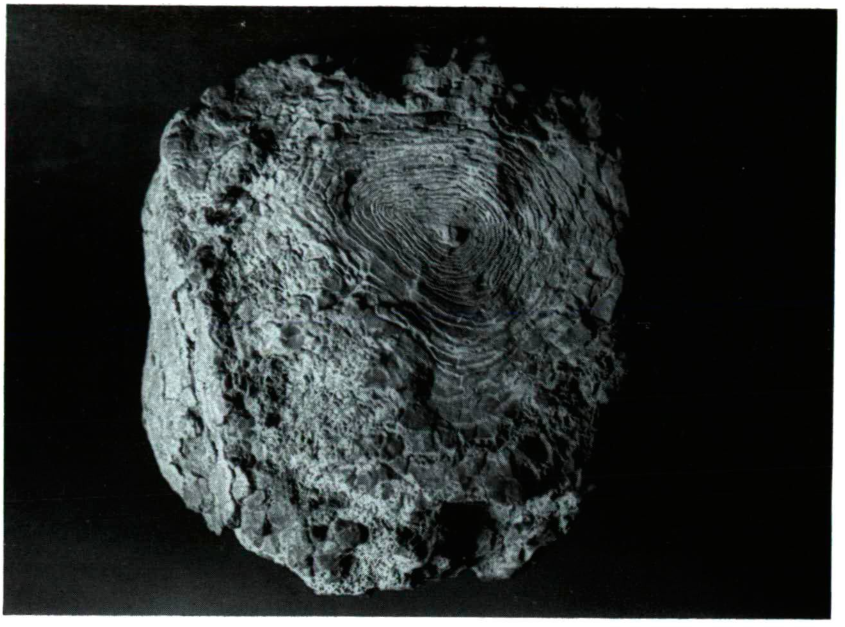

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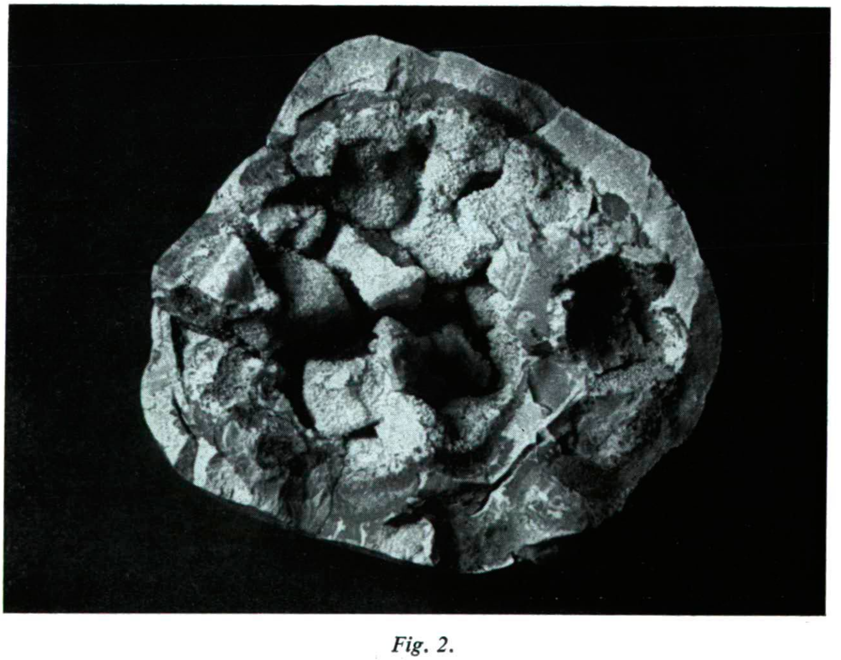

Fig. 2.

Plate IV.

Fig. 1.

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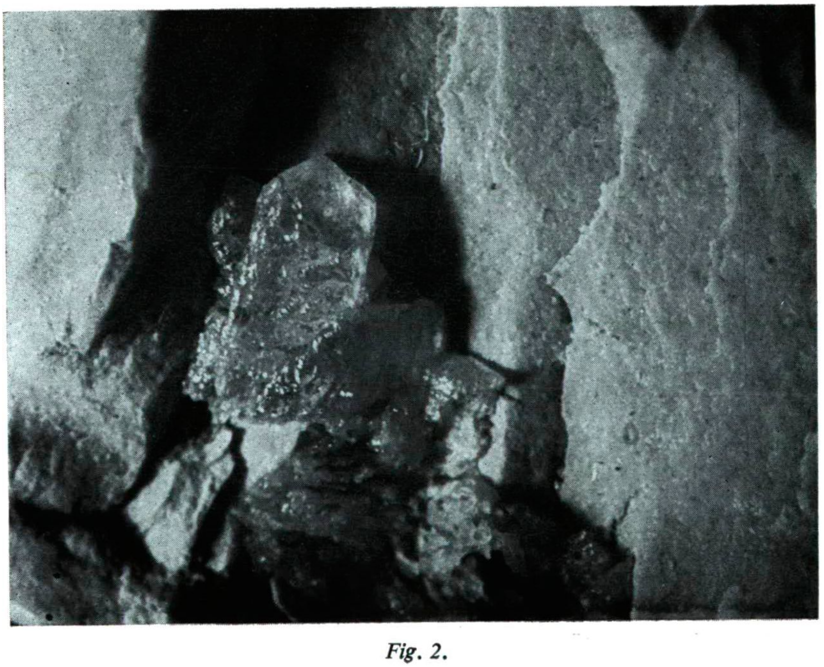

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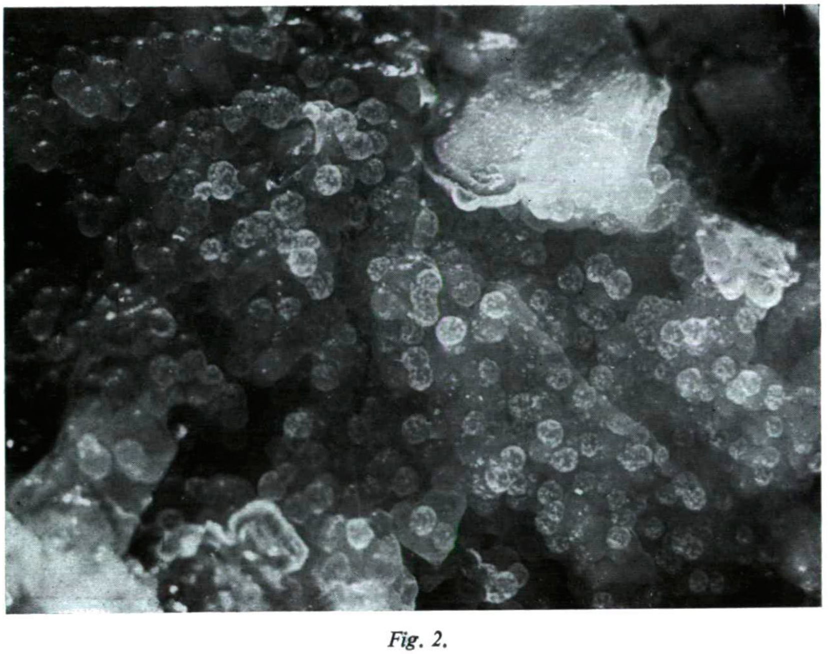

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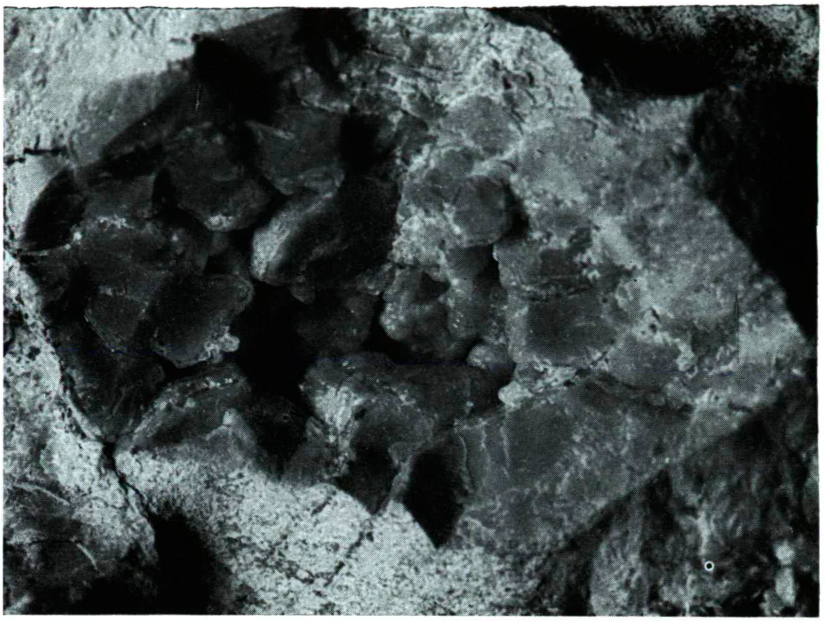

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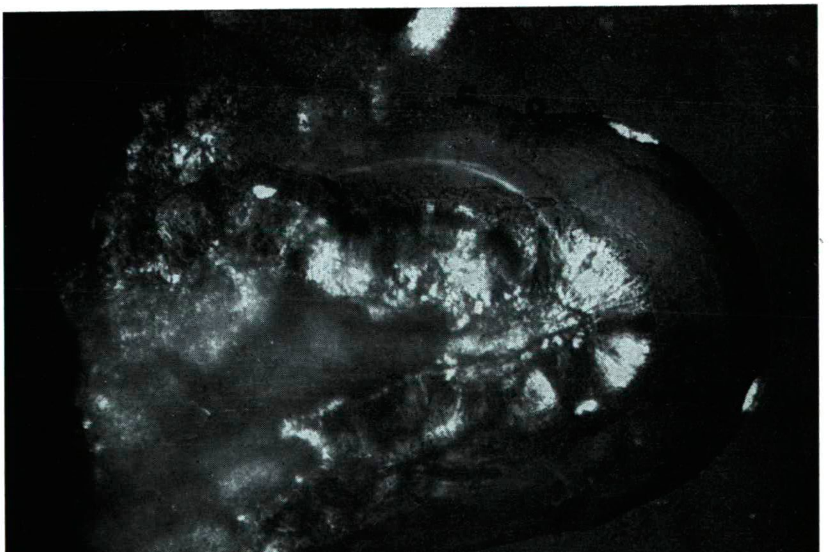

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