stibnite have been found since such compositions have been obtained artificially in thermal phase diagram studies (Takahashi, 1920).

In addition to the quantitative determinations presented in fig. 1 some full analyses of all the elements present have been made. No significant deviations from the atomic metal:sulphur ratio of 2:3 could be detected.

It is interesting to note that no Cu or Pb was found in any of the bismuthinites. These elements are likely to occur according to Padera (1956) who reported that an isomorphous series exists between aikinite ($Cu_2S.2PbS.Bi_2S_3$) and bismuthinite, leading to the rézbányite group of minerals. This series is thought to arise from the substitution of Bi in Bi_2S_3 by Pb and the simultaneous introduction of a Cu atom for every Bi atom replaced. For the present work microprobe analyses have been made of aikinite from Beresovsk (Ural) and Wittichen (Schwarzwald, Germany), and these led to compositions which were in close agreement with the usual formula for this mineral. Unfortunately no material was available of the other members of the rézbányite group (hammarite, lindströmite, and gladite) to verify their alleged relationship to bismuthinite.

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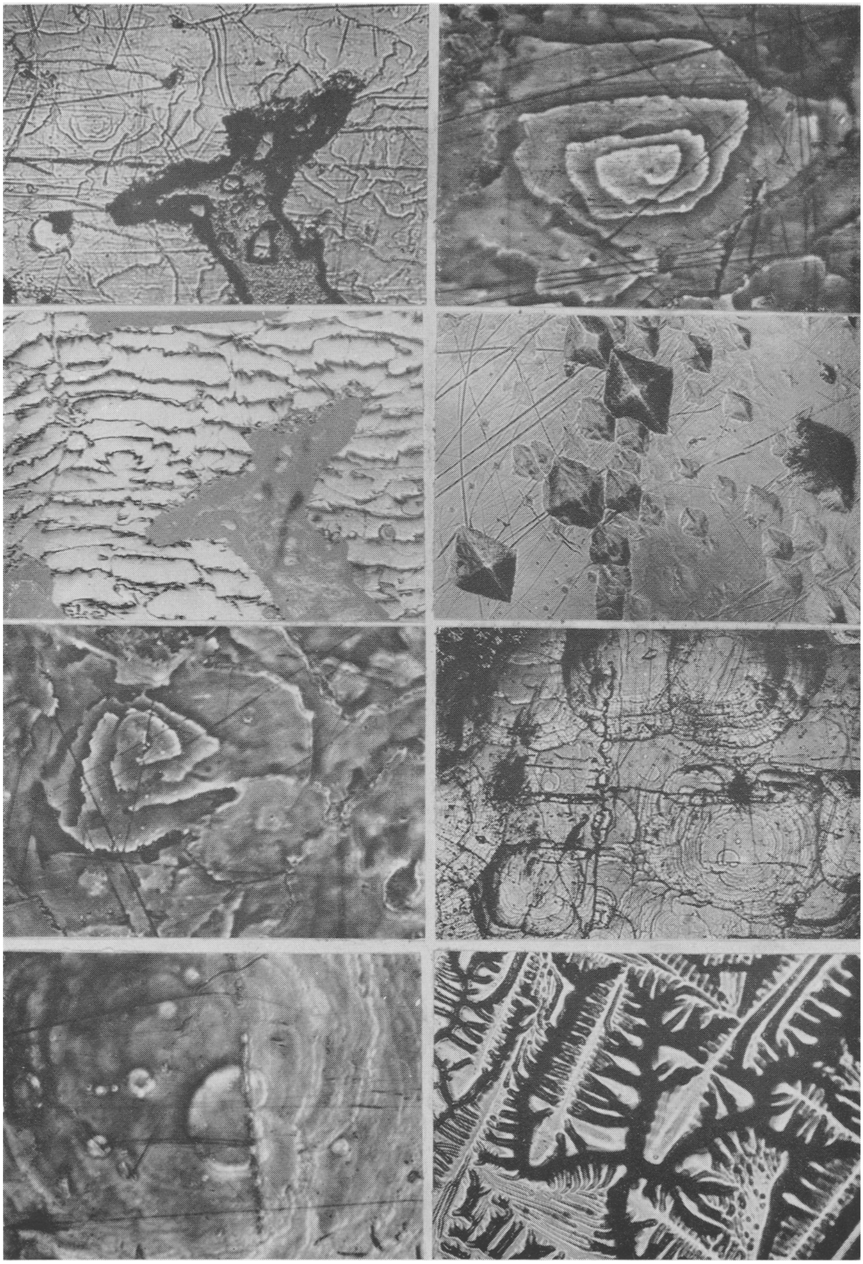
Growth spirals on baryte

Seager (1953) has reported the microstructures on different faces of many crystals including baryte from the Silverband mine, Westmorland, but did not record any spiral on the latter. We examined faces of several forms on many crystals from this mine and have succeeded in observing a few growth spirals on the planer parts of {011} faces, along with some growth hillocks. This is the first record of growth spirals on {011} faces of natural crystals of baryte.



FIGS. 1 (top left) to 8 (bottom right). For details see text.

The highly transparent natural crystals were thoroughly cleaned with dilute nitric acid and distilled water, then thin films were deposited on them. They were examined by bright-field and phase-contrast microscopy and by multiple-beam interferometry. Some typical observations are described.

Fig. 1 is a photomicrograph (×130) of anti-clockwise spiral growths on {011}. The growth layers exhibit complex forms. One spiral is shown in more detail (×450) in fig. 2, using positive phase contrast illumination. Note that the spiral has no regular shape and the edges of the growth layers are not smooth. The surface, though very rough, was examined by multiple beam interferometry (Tolansky, 1948). Fig. 3 is an interferogram of approximately the region shown in fig. 1. The uneven surface made it difficult to obtain the interferogram, and measurement of the step height was impossible. The interferogram clearly reveals the sharp steps and slightly curved upper surface of the spiral on the right and the uneven surface. This spiral was also examined by fringes of equal chromatic order, which confirmed that it was a hillock.

{001} faces of this crystal were characterized by rhombus-shaped depressions (fig. 4, ×260), which appeared to be etch pits. Some of the spiral growths found on {011} faces of another crystal are shown in fig. 5 (×450). It is noticeable that the spiral turns are not always continuous. All the spirals observed in the present work were anti-clockwise. Spirals on the top of growth hillocks are shown in figs. 6 (×48) and 7 (×130).

We also examined a number of {011} faces of $BaSO_4$ crystals grown in the laboratory by Patel and Koshy (1968). They were characterized by a dendritic pattern (fig. 8, ×64), but no spirals were observed.

Conclusion. The natural crystals of baryte may have undergone dissolution. The {011} faces of natural baryte appear to have grown by the spiral growth mechanism. Since spirals are not found on any other faces of the same crystals, it suggests that the conditions for spiral growth differ from one form to another. Since the basal pinacoid shows obvious signs of etching, the irregular spirals and growth layers on {011} may be due to the same cause. No spirals have been observed on {011} faces of crystals grown by us, but they do show dendritic growth patterns. This may occur because crystals take only a few hours to grow in the laboratory but require a much longer period in nature.

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