Note on «birds-eye» textures in some Norwegian pyrrhotite-bearing ores.

By

Per Chr. Sæbø, Thor L. Sverdrup and Harald Bjørlykke.

With 3 figures in the text.

Abstract.

Three specimens, one from Råna, Nordland County, one from Lillefjellklumpen, Grong, Nord-Trøndelag County and one from Karmøy, Rogaland County, have been examined in polished sections. They all show the typical "birds-eye" textures in the pyrrhotite, a texture not previously reported in Norwegian pyrrhotite-bearing ores. The localities are plotted on the key map, Fig. 1.

Råna.

The specimen from Råna is a weathered pyrrhotite-bearing ilmeno-norite. The rock represents a titanium-rich facies of the peridotite mass located just north of the little lake Bruvann on the western contact of the Råna norite field (Foslie, 1920). The ilmeno-norite crops out on the northern contact between the ultrabasics and the norites. The zone has been exposed to post-ore movements. The rock consists of olivine, bronzite, augite, amphibole and plagioclase in varying amounts. The primary ore minerals are pyrrhotite, pentlandite, chalcopyrite, chromite, ilmenite, and rutile. Scattered marcasite grains were isolated from the non-magnetic fractions (Franz isodynamic magnetic separator) and identified by means of X-ray powder pattern. The pyrrhotite shows the flame-like bodies of β-pyrrhotite in a matrix of α-pyrrhotite as described by Scholtz (1936). This relation is often found reversed in the ores of Råna, as already reported by Schneiderhöhn and Ramdohr (1931). The same reversed condition is also reported by Vokes (1957) from the Birtavarre ores. Polished sections show in one case remarkable examples of "birds-eye" textures due to supergene alteration as described by Schneiderhöhn and Ramdohr (1931). Marcasite starts to grow parting planes nearly $\perp$ to the (0001)

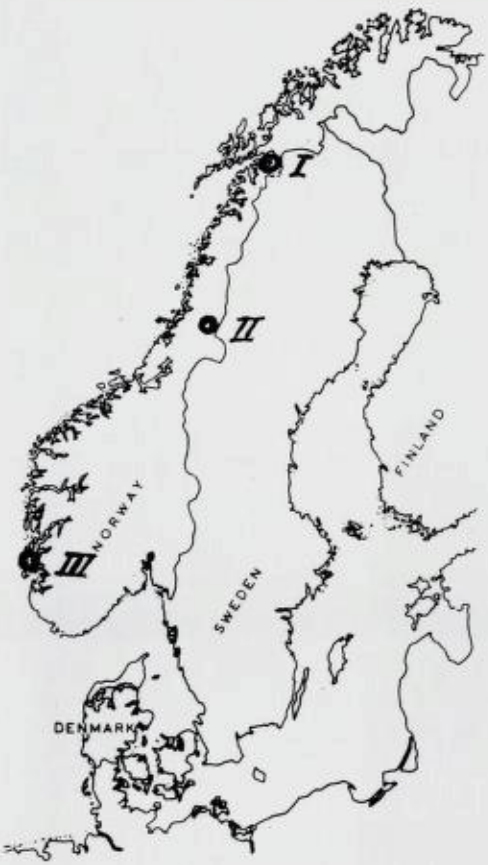

Fig. 1. Key map showing the situation of the localities.
I. Råna, Nordland County.
II. Lillefjellklumpen, Nord-Trøndelag County.
III. Karmøy, Rogaland County.

Nøkkelkart med lokalitetene.

I. Råna, Nordland.
II. Lillefjellklumpen, Nord-Trøndelag.
III. Karmøy, Rogaland.

cleavage of the pyrrhotite (translations along twin planes, according to Schneiderhöhn and Ramdohr), and occasionally along the (0001) cleavage. The periphery of the alterated zone forms an ellipsoid, the long axis of which is parallel to the parting plane. The ellipsoids may

show excellent concentric growth, the central part of which shows complete isotropy and consists of pyrite. The marcasite shows only weak anisotropy on account of the extremely small size of the mineral grains.

During the growth of the ellipsoids along the parting planes they may join and form long irregular bands along the fractures. As a consequence of the polishing of the specimen the pyrrhotite often drops out and leaves the marcasite and pyrite as ribs in the former pyrrhotite grains. The other minerals are not affected during the alteration of the pyrrhotite.

Lillefjellklumpen.

One polished section from a diamont drill core (B.h. 1, — 8.10 m) from the nickeliferous pyrrhotite-ore at Lillefjellklumpen, Grong, described by Foslie (1931), shows the "birds-eye" textures well developed.

The specimen consits of pyrite, pyrrhotite, chalcopyrite and magnetite. Secondary pyrite and marcasite are found in the altered areas of pyrrhotite.

The "birds-eyes" start to grow along broad irregular fractures in a manner much like that found in the Råna ore, but the altered areas are as a rule more nearly spheroids than ellipsoids. The "birds-eyes" are often developed only laterally along the fractures, so that only parts of the spheroids are found. (See Fig. 2.)

The "birds-eyes" show rhythmic, concentric growth and the altered areas consist mainly of pyrite. Often several altered areas grow together and form irregular patches in the pyrrhotite. The secondary sulfides of these areas tend to recrystallize and form more homogenious aggregates of marcasite. This marcasite is slightly whiter than the pyrite and shows strong anisotropy, the color shifting from bluish to reddish white.

Karmøy.

The ore samples from Karmøy comes from one of the thin pyrrhotite-beds in the greenschits in the north-eastern part of the island (Reusch, 1888). The polished section shows the "birds-eye" texture in the same manner as the Lillefjellklumpen ore sample. At the contact between the marcasite and the pyrrhotite there occurs another mineral as the first alteration product of the pyrrhotite, in a way very

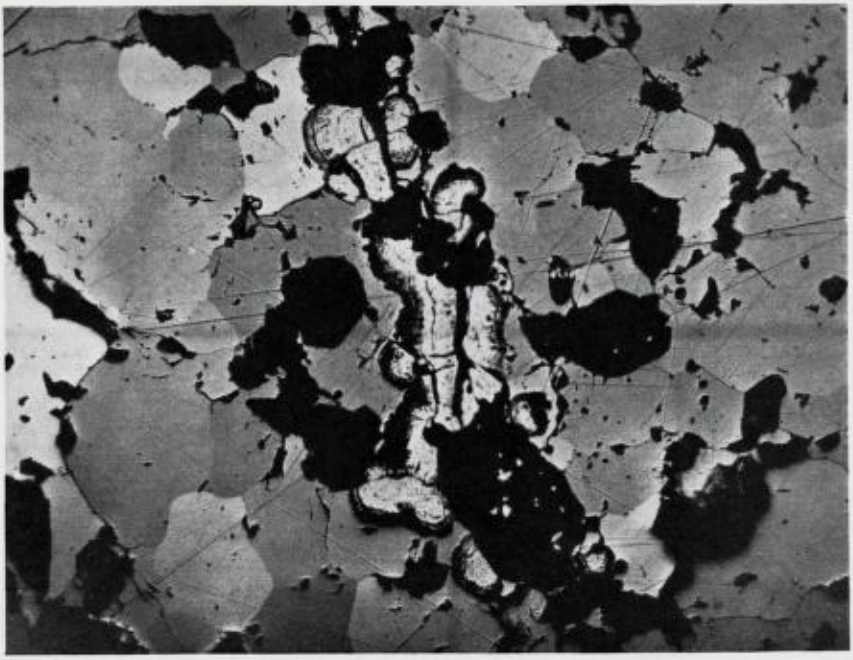

Fig. 2. Birds-eye textures in the Lillefjellklumpen ore. The altered areas in the allotriomorphic pyrrhotite consists mostly of pyrite. One nicol. ca. 150 ×.

Birds-eye teksturer i Lillefjellklumpens malm. De omvandlede områder i den allotriomorfe pyrrhotite består hovedsakelig av pyrite. En nicol. ca. 150 ×.

similar to that described by Schneiderhöhn and Ramdohr (1931) and Foslie (1950). This mineral also occurs along the (0001) cleavage in a way very similar to that described by Vokes (1957). The mineral from Karmøy is greyish, slightly blue at the immediate contact with the pyrrhotite, apparently isotropic. It developed an irregular cleavage-pattern; one of the directions is parallel to the basal cleavage of the pyrrhotite. This is well shown in Fig. 3. On account of the minute grain-size it is not possible to identify the mineral by ordinary X-ray powder methods.

The mineral reported by Schneiderhöhn and Ramdohr (1931) and Foslie (1950) is, however, strongly anisotropic. It shows many similaritites to the new rhombohedral ironsulfide smythite, Fe_3S_4, described by Erd, Evans and Richter (1957). This is supported by the optical spectrogram (Foslie, 1950), taken by Prof. I. Oftedal, of the pyrrho-

Fig. 3. Birds-eye textures in the Karmøy ore. The altered areas in the allotriomorphic pyrrhotite consist mostly of pyrite. The light coronas of the unknown mineral are well shown. One nicol. Ca. 150 ×.

Birds-eye teksturer i Karmøy malmen. De omvandlete områder i den allotriomorfe pyrrhotite består hovedsakelig av pyrite. De lyse koronaene av det ukjente mineralet vises meget tydelig. En nicol. Ca. 150 ×.

tite—marcasite associations. Iron is the only metal present, except for extremely small amounts of Mn, Ni and Co. Furthermore the two minerals, smythite and pyrrhotite are structurally closely related (Erd et al., 1957).

Recently Birks, Brooks, Adler and Milton (1959) in a very interesting paper reported a valleriite-like iron sulfide from the ore of the Machinaw Mine, Washington, previously described by Milton and Milton (1958). The iron sulphide which may be an undescribed mineral, shows, however, strong, both chemical and optical; similarities to smythite.

It is hoped that Birds and co-workers will have the opportunity to continue their important study of this ironsulfide. If this mineral

really turns out to be smythite, it would give invaluable information about the temperatures of formation of various types of sulfide-bearing ores.

The mineral from Karmøy is, however, probably not smythite. It may be a highly metastable phase of Fe_3S_4 with spinel structure. Many attempts have been made to synthesize this phase, according to Erd et al. (1957), but without any success.

The possible presence of smythite as an intermediate alteration-product along the line of sulphur-enrichment from pyrrhotite to marcasite or pyrite would make the replacement process more continuous.

Conclusion.

The "birds-eye" textures are, according to Schneiderhöhn and Ramdohr (1931) always found near the surface of the pyrrhotite-bearing ore-bodies as a very early stage of the oxidation and alteration of the ore. On account of the relatively recent glaciation of Norway only few remnants of the leached and oxidized zones are found. Therefore it may be expected that the renewed oxidation and alteration of our orebodies frequently will be traced as "birds-eyes" — and also as other alteration textures such as those reported by Foslie (1951) and Vokes (1957).

The concentric growth of the "birds-eyes" results in textures that resembles very much the so-called colloform textures in sedimentary pyrite beds (Oftedahl, 1958), but the genetic development of this texture is entirely different. Colloform textures or gel-textures in pyrrhotite-bearing ores, however, should be carefully studied to determine the genetic relations of their formation.

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Sammendrag.

En notis om de såkalte "birds-eye" teksturer i noen norske pyrrhotite-førende malmer.

Pyrrhotite-førende malm fra Råna, Nordland, Lilleklumpen, Grong, og Karmøy viser vakre eksempler på de såkalte "birds-eye" texturer i pyrrhotiten. "Birds-eyes" er mer eller mindre ovaloide, konsentrisk oppbygde områder av sekundær pyrite og marcasite, dannet ved den begynnende oksydasjon og omvandling i pyrrhotite-førende malmers utgående. Vårt land har vært utsatt for en relativt sen og kraftig iserosjon som i stor utstrekning har fjernet utlutningssonen og oksydasjonssonen over våre sulfidmalmer. Vi må derfor vente å finne "birds-eye" teksturer og også andre omvandlingsteksturer, nærmere beskrevet av Foslie (1950) og Vokes (1957), som et tegn på en begynnende oksydasjon og omvandling.

"Birds-eye"-teksturene likner meget på de såkalte kolloforme teksturer i sedimentære pyrite-malmer. Men de kolloforme teksturer eller "gel"-teksturer oppfattes som syngenetiske dannelser (Oftedahl, 1959). Finner man konsentriske teksturer i pyrrhotite-førende malmer må disse undersøkes nøye for å bringe de genetiske forhold på det rene.

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