GENESIS OF THE IRON ORE AT HSISHAN AND LEISHAN, OCHENG, HUPEH.

BY

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INTRODUCTION

The party of which the senior writer was a member after leaving the Tayeh Mines paid a visit of two days' duration to Hsishan and Leishan in the suburbs of Ochenghsien. The iron ore contained in these two hills constitutes a potential supply although hitherto unutilized. Some open-cut mining was undertaken but soon suspended with considerable ore left at dumps along the river bank and very little shipped away. Favorably located as regards communication, the deposit gives promises of profitable future exploitation. With regard to the genesis of the ore, the former belief of a contact metamorphic origin is no longer held valid. Casual examination reveals certain earmarks of a shallow-seated hydrothermal deposition, the geologic and mineralogic evidences for which it is the purpose of this paper to present. The writers take the opportunity to express due thanks to Mr. C. C. Chiang (蔣志超) for assistance in making the illustrations contained herein.

GEOLOGY

Geology in both Hsishan and Leishan is relatively simple. The exposed rocks in Hsishan (Fig. 1) beginning from the river bank and going westward are limestone, quartzite and shale striking in general northwest and dipping northeast averaging 30°-40°. The narrow belt of limestone is presumably Permo-Carboniferous and is divisible into a lower. white shaly and an upper, gray, cherty member. The gray limestone is brecciated along certain zones and many calcite and occasionally dolomite veins formed along them. Below the limestone appears a thick

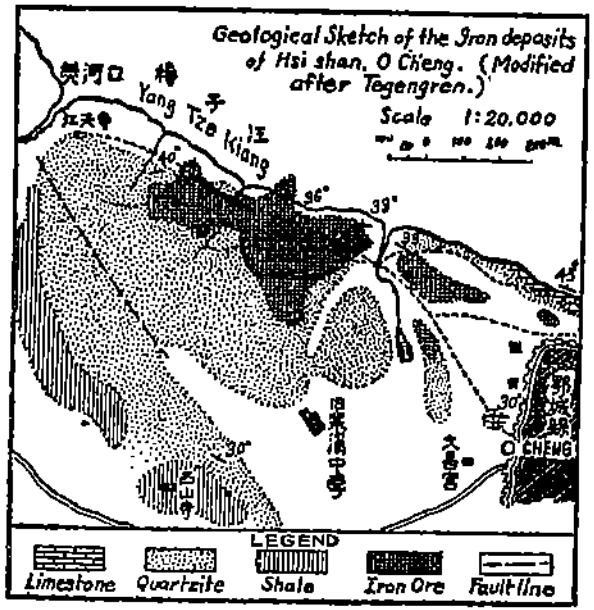
Geological Sketch of the Iron deposits of Hsi shan, O Cheng. (Modified after Tegengren.)
Scale 1:20,000
Yang Tze Kiang
O CHENG
LEGEND
Limestone
Quartzite
Shale
Iron Ore
Fault-line

Fig. 1.

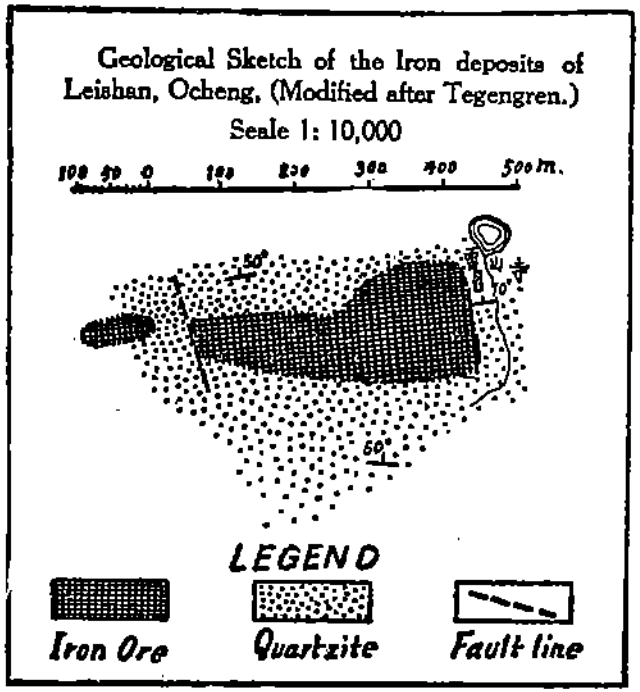
Geological Sketch of the Iron deposits of Leishan, Ocheng. (Modified after Tegengren.)
Scale 1: 10,000
100 50 0 100 200 300 400 500 m.
LEGEND
Iron Ore
Quartzite
Fault line

Fig. 2.

series of white or grayish-white quartzitic sandstone belonging to the Wutung Series. Clay shale either Wutung or a part of the Kaokiapien forms the base of the section. At Leishan, conditions are even simpler (Fig. 2) with quartzite constituting almost the whole formation except little shale near the ore. As to structure, however, there are certain complications. A fault undoubtedly occurs along the limestone river bank. Along the northern slope of Leishan there has been probably a drop forming the plain to the north. At Hsishan both folding and faulting are shown. Its northern slope generally north or northeast whereas at its southwestern part the dip is generally to the south with the summit of the hill representing the top of an anticline. At the western end of the ore body at Hsishan and both at the east and west extremeties of the ore body at Leishan, indication of movement is furnished by its abrupt termination.

The Deposit

The ore body is, in general, a tabular body with an exposed width varying from 200 to 500 feet, and dipping in the same direction as the country rocks. Its true thickness is, of course, much less as it has a dip of over 30°. The ore body occurs enclosed at the upper portion of the quartzite with Hsishan and Leishan as its two separate fields. The ore is mostly hard and compact crystalline hematite, reddish-gray or reddish-brown in color often with brecciated fragments of quartzite. Cellular and honey-combed quartz and limonite mixture forms a subordinate ore. Specularite often occurs. The iron content averages 54.3% and forms good ore. Simple mineralogically but it displays certain interesting textures.

Mineralogy

Hematite: This mineral appears in three general habits: 1. dense massive, intermixed with quartz (Fig. 3), 2. specularite plates in massive quartz or forming alternate bands with it (Fig. 4), 3, small reniform masses with an external hemi-spherical shape and internally fibrous and

concentrically banded as viewed from the side (Fig. 5). The massive intermixed hematite and quartz or aggregate of quartz and specularite

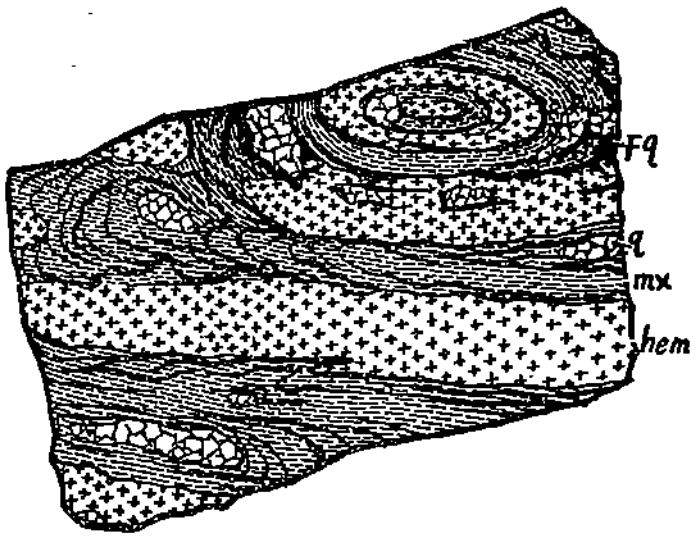

Fig. 3. Alternate bands sometimes concentric (1) hematite ore (hem) and (2) mixture of massive quartz and hematite (mx). Delicate bands of ferruginous quartz along their contact or entering the mixture (Fq). Pure quartz (q) also present. Leishan, natural size.

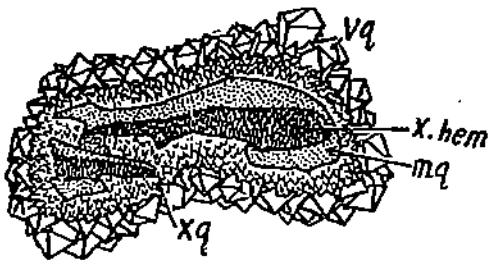

Fig. 4. Specularite (x hem) enclosed in successive layers of massive and crystalline quartz (mq & xq) forming a core on which are implanted perfect, vuggy quartz crystals (vq). Leishan, natural size.

is frequently coated by a layer of small quartz crystals and traversed by narrow ferruginous quartz bands. Vuggy cavities in ore are abundant and are lined with perfect quartz crystals. Specularite in small, thin, reddish plates, sometimes in hexagonal basal outline or as slender needles often coat massive quartz or in vuggy cavities in quartz or massive hematite. It also appears in narrow bands made up of transverse fibers. Small pseudo-pisolitic granular aggregates of hematite simulating coarse sugary texture are found in massive ore (Plate, Figs. 1, 3, 5). Often they are reniform, botryoidal with radial concentric structure (Plate, Figs. 2 & 4), and microscopically form globular nuclei with concentrically interbanded quartz gangue. Occasionally the hematitic ore shows tendency

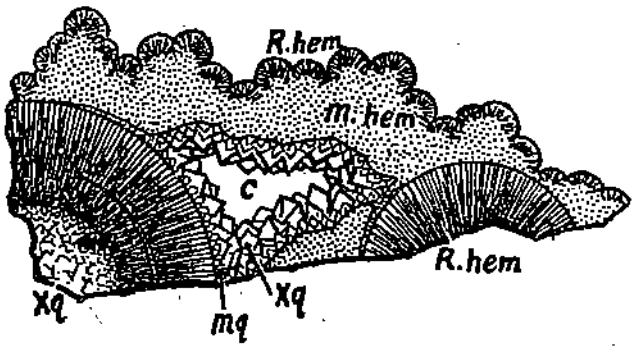

Fig. 5. Coarse and fine reniform hematite (R. hem) resting on massive hematite (m. hem) and crystalline quartz (xq) with an enclosed vug lined with quartz crystals. Reniform hematite concentric and radial, fibrous. Leishan, natural size.

towards stalactitic development. A transverse section of such stalactite shows that it is constituted in successive layers as follows: 1, outer film of limonite, 2, hematite, 3, massive quartz, 4, crystalline quartz and then a small central cavity.

Apatite: This is shown microscopically as perfect crystals or grains in siderite with interstices filled by the latter. It is seen also to be traversed by calcite crystal grains.

Quartz: Of abundant occurrence, this is either massive or crystalline. The crystals are either 1, colorless, transparent with ± rhomb

and well-developed prisms (Fig. 7), 2, pink, smoky, or yellowish ferruginous, still somewhat transparent and 3, gray, translucent showing many corrosion pits on the crystal faces. The crystals frequently show both

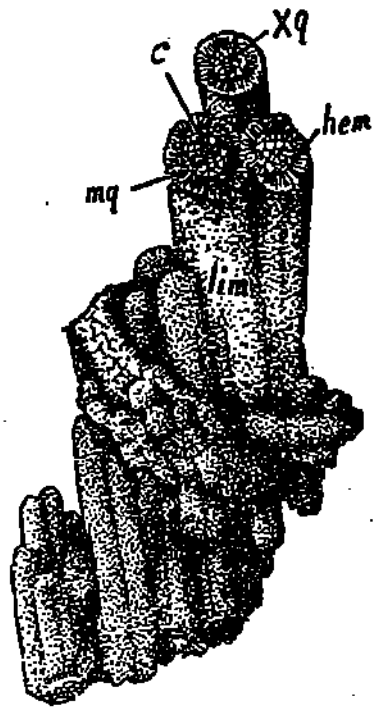

Fig. 6. Stalactitic hematite transversely constituted as
1. External film of limonite (lim).
2. Main hematite ring (crystalline plates) (hem).
3. Massive quartz (mq).
4. Quartz crystals (xq).
5. Central cavity (c).
Leishan. natural size.

terminations, in which pinkish inclusions are common. Specimens reaching 20 × 18 × 14 cm. in size may be wholly an aggregate of transparent colourless crystals surrounding massive hematite as a central core, or in smaller vugs lining massive quartz. Such specimens undoubtedly come

from large vuggy openings in the vein but they contain in themselves unfilled central portions forming what one might call a vug-in-vug texture.

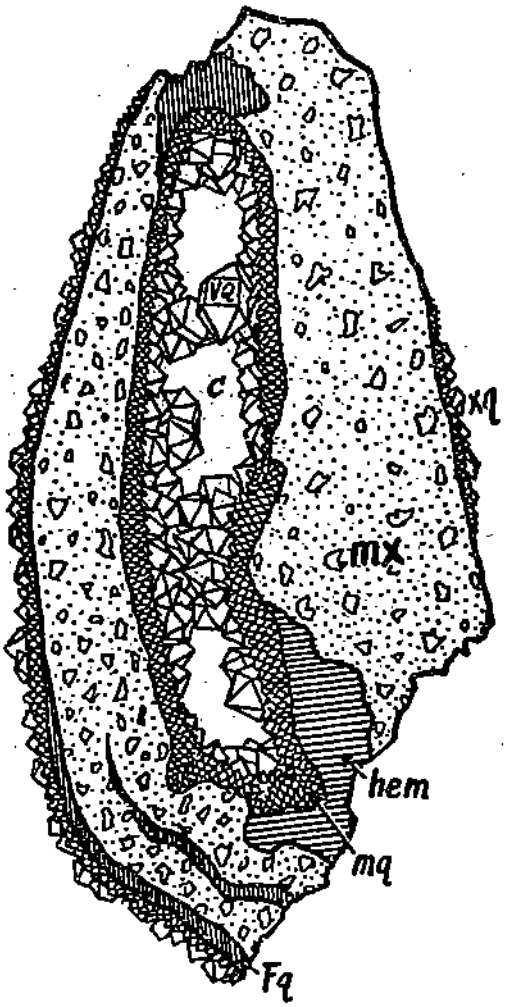

Fig. 7. Mixture of massive hematite & quartz (mx) coated by a layer of quartz crystals (xq) & containing a central vug which is lined by massive quartz (mq) and then well developed quartz crystals. C. Cavity. Ferruginous quartz bands (fq) penetrating mixture or entering along its contact with crystalline quartz. Leishan, natural size.

Massive quartz is often seen as veinlets cutting ore. A characteristic feature of low temperature deposition observed here is the honey-combed texture made up of a skeleton of reticulated plates of quartz, on the sides of which appear layers of implanted tiny quartz crystals which are in turn covered by film of limonite (Fig. 8). Equally significant is the appearance of massive and often ferruginous undulating quartz bands (Plate I, Figs. 1, 3, 5) in alternate position with mixture of ordinary colorless massive quartz and hematite or wholly in brownish quartz. Similar to the botryoidal, concentric, fibrous, or tiny pseudo-pisolitic hematite, such

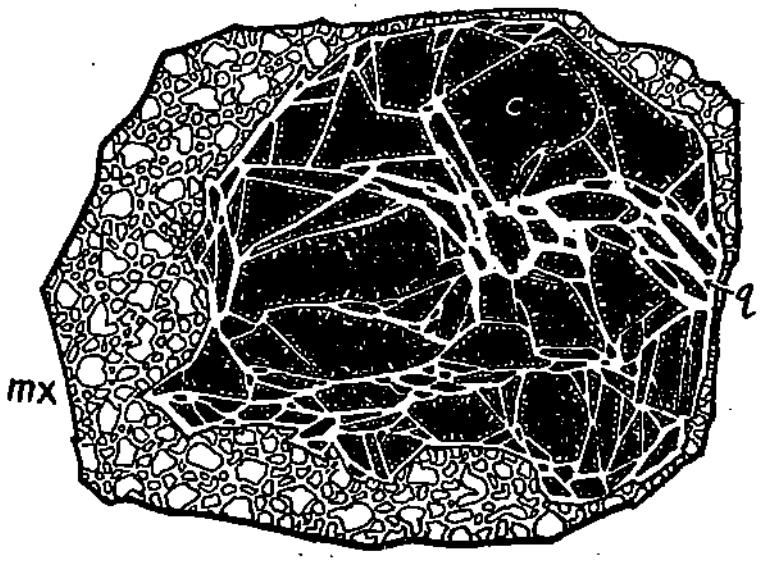

Fig. 8. Cellular, honey-combed structure with skeleton of lamellar quartz (q) plates on the sides of which are implanted tiny, translucent quartz crystals. mx, mixture of hematite and silicified product. c, cavity. Leishan, natural size.

delicate crustified ferruginous silica is a revelation of colloform banding characteristic of colloidal precipitation at low temperature and shallow depth.

Siderite: This is found sparingly as crystalline aggregates with its terminal faces surrounded by calcite which also enters along its cracks.

Calcite: This is present here in massive form as a gangue mineral with siderite.

Chalcedony: One observes this mineral as fine, delicate veinlets in calcite and siderite or along their contact as well as delicate bands between siderite and quartz (Plate I, Fig. 6).

Limonite: Present in fairly abundant amount, this is found to wrap around hematitic ore and to coat quartz crystals. It is also seen as veinlets. Limonitized ore traversed by ferruginous silica bands is a common phenomenon and limonitized skeletal silica, a typical open-texture in the oxidized zone, is frequently encountered.

Pyrolusite: This appears as powdery coatings on the already oxidized material. Commonly it encrusts chalcedony and limonite.

A general sequence of the above minerals is represented as follows beginning with the earlist; overlapping in age is naturally frequent.

massive { hematite / quartz } specularite → crystalline, vuggy quartz → siderite → apatite
massive quartz ↓
calcite→chalcedony→limonite→ pyrolusite.

GENESIS

The shallow seated hydrothermal origin of this deposit is established beyond hesitation. The following evidences are strikingly convincing.

1. Non-existence of pyrometasomatic conditions. No igneous rock is found in the immediate vicinity. The nearest exposure is a dioritic intrusion to the south, at least six or seven kilometers away. Furthermore the ore is enclosed wholly in quartzite. Contact silicate has not been found even in mere trace as such contact is nonexistent.
2. Total absence of high temperature minerals and high temperature country rock alteration.
3. Abundance in certain characteristic textures:

a. Vuggy cavities and comby fillings.
b. Fine delicate crustification.
c. Concentric, colloform banding.
d. Lammellar, skeletal structure.

In view, therefore, of the facts presented above, it is concluded that the iron deposit of Hsishan and Leishan, Ocheng, is a result of hydrothermal deposition at shallow depth *i.e.* an epithermal deposit or it may grade into Prof. Graton's newly proposed leptothermal zone.

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Explanation of Plate I

PLATE I

Fig. 1. Specularite plates or needles and undulating ferruginous quartz band (fq) and massive quartz (q) together forming a vein in hematite ore (hem); Leishan; thin section × 128.

Fig. 2. Reniform hematite (hem) in quartz gangue (q); Leishan: polished section; × 25.

Fig. 3. Pseudo-pisolitic hematite (hem) in massive quartz (q); Hsishan; thin section; × 42.

Fig. 4. Globular hematite (hem) with concentrically interbanded quartz; Leishan; polished section; × 28.

Fig. 5. Undulating ferruginous quartz band (fq) and pseudo-pisolitic hematite (hem) in massive quartz (q); Hsishan; thin section; × 32.

Fig. 6. Delicate crustification in vein material 1. Hematite ore (hem), 2. Siderite (Si) showing free rhombohedral faces, 3. Chalcedony (Cn) showing botryoidal form and concentric, colloform banding, 4. Late quartz (q) vein, 5. Limonitic veinlets (lim) in chalcedony; Hsishan; × 30.

Fig. 1.

Fig. 2.

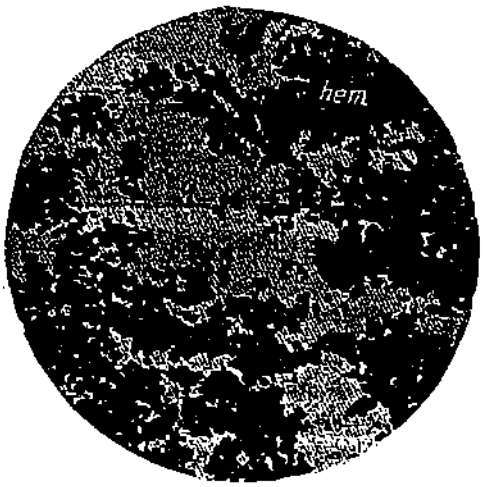

Fig. 3.

Fig. 4.

Fig. 5.

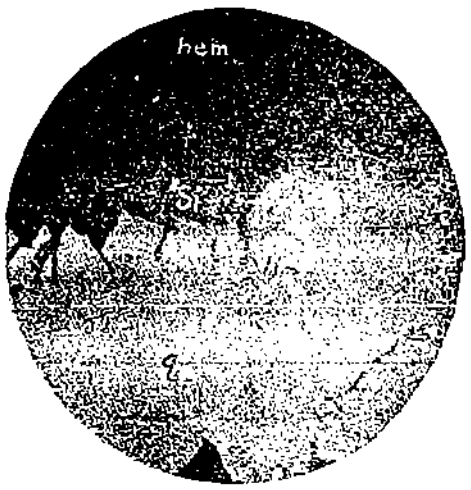

Fig. 6.