THE RHODONITE VEINS OF HSIHUTSUN, CHANGPING DISTRICT, NORTH OF PEIPING.*

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CONTENTS

Introduction

The maganese deposit of Hsihutsun was first visited by Dr. V. K. Ting[1] in 1922. During the spring of 1932 while directing students of the Geological Department of the Peking University in the field, the writer had an opportunity to study the deposit. A detailed geologic map has been prepared, but in writing this paper it has been found that field observations were still inadequate for some facts. As the writer was occupied with other works, no report in any form was written until present. It is the writer's pleasure to express his obligations to the kind assistance of Mr. S. Y. Yu and to the students who helped him in the mapping work.

* Received for publication on January, 1936.

1 V. K. Ting: The manganese deposits of Hsi Hu Tsun, Changping Hsien, Chihli, Bull. Geol. Surv. China. No. 4, 1922.

Geological Features

Hsihutsun is situated in a hilly region about 30 li from the margin of the Peiping plain and 80 li from Peiping (Fig. 1). In its vicinity one notices a wide area of granite, consisting dominantly of feldspar and mica and usually exhibiting a profoundly weathered surface (Pl. II, Fig. 1) of loose sands. On the southwest of the granite body siliceous limestone of pre-Cambrian age occurs in a narrow belt (Pl. I), trending from N. W. to S. E. and generally dipping toward S. W. at about 40°-60°. The length of the belt is only about 820 m.

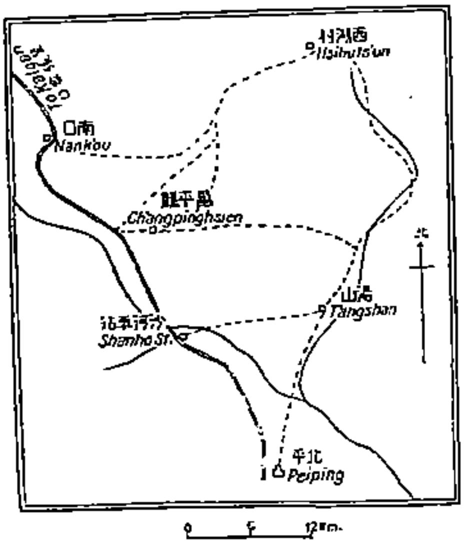

Fig. 1. A map showing the location of Hsihutsun rhodonite veins.

while its width varies from 10 to 150 m. Further, on the S. W. of the limestone there is a plagiaplite series of complicated origin. It is at the contact between the limestone and the plagiaplite series that the rhodonite veins appear. Dr. Ting formerly considered the plagiaplite series to be mainly Pre-Cambrian sandstone and a fault was drawn by him between this sandstone and the siliceous limestone. The writer cannot agree with such consideration, though the partial presence of sandstone in the plagiaplite series is not impossible.

DESCRIPTION OF INTRUSIVE IGNEOUS ROCKS.

In the plagiaplite series there are a great many dykes of varying mineralogical composition intruded in different epoches. The following only treats of a few of them. The nomenclature of the rocks is chiefly according to Prof. A. N. Winchell[1].

Before describing the plagiaplite series the main intrusion in the vicinity of Hsihutsun should be stated first. The rock as shown by handspecimens is gray in color with abundant feldspar and biotite. Under the microscope, the feldspar is composed mainly of orthoclase with a small amount of albite. The latter exhibits finely repeated twinning laminæ with a little higher refractive indices than the former. Quartz occurs only in subordinate quantity. Tabular sections of brown biotite are frequently met with, with marked pleochroism. Green hornblende is present, but partly altered to epidote. The alteration usually begins in the central part and works outward, constituting the so-called "centrifugal" replacement. Long prisms of apatite are often observed as an accessory mineral.

The rock is granular in texture and is considered as ***biotite granite***. This granite intrusion constitutes the main part of the range north of Peiping and is perhaps connected with the granite of Pataling, the longest tunnel of the Peiping-Suiyuan Railway, about 60 li northwest of Hsihutsun.

(1) *Plagiaplite*. There are numerous plagiaplite dykes on the southwest of the rhodonite veins, which may not have the same mineral composition, but only one will be mentioned here. Megascopically the rock is light-colored and fine-grained. Microscopically it is composed mainly of tabular crystals or microlites of albite in felsitic texture (Pl. III, Fig. 2). A few phenoscrysts are sometimes scattered in the microlitic groundmass, but they are subordinate in comparison with the latter.

Groundmass—It consists of albite, quartz and hornblende. *Albite*: It generally occurs in microlites. $Nm < 1.54$ but > 1.525. Optically biaxial and positive. Albite twinning distinct in some less altered crystals but mostly obscure due to alteration. The maximum extinction angle in crystals elongated

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1 A. N. Winchell: Journ. Geol. Vol. XXI, No. 3, 1913.

parallel to *a* is about 16°. Graphic intergrowth with quartz is common. Treated with mineral powder mixed with gypsum, it gives sodium flame before the blow-pipe. *Quartz*: A few quartz grains often fill the interstices of albite microlites They can be recognised in thin sections by their smooth surfaces and higher birefringence. *Hornblende*: It is only occasionally observed with marked pleochroism. Its color is green.

Phenocrysts—They are generally composed of felspar, probably orthoclase. Carlsbad twinning is sometimes visible. Refractive indices are distinctly lower than those of albite microlites. Optically biaxial and negative.

(2) *Alkali granite*. This occurs as a dyke about 80 m. S. of Heitseitzu. It consists mainly of orthoclase and quartz with some biotite in granular texture. Other accessory minerals are exceedingly rare. *Orthoclase*: Cleavage parallel to (001) usually distinct. Twinning is not observed. Mean refractive index is between 1.525 and 1.515. Optically biaxial and negative. *Quartz*: Primary and secondary quartz sections are both present. The latter are usually in small rounded grains or in a series of grains, while the former are generally in big angular fragments. *Biotite*: This occurs only as fragments with distinct basal cleavages. Parallel extinction. Pleochroism strong. In a section normal to Y, X = colorless, and Z = yellow brown. $X < Z$.

(3) *Kersantite*. This is represented by a dyke exposed on the southern slope of Heitseitzu. As shown in figures 2 and 3 the dyke transversely cuts a rhodonite vein or is included in it. Its intrusion is, thus, later than the formation of the vein. The rock is gray and porphyritic and is really a diorite porphyry. But as biotite is especially abundant, it seems better to designate it as kersantite.

Groundmass—*Albite*: It occurs in felsitic tabular crystals and constitutes the main component of the ground mass. Its mean refractive index is generally < 1.54 but > 1.525. Albite twinning is scarcely visible due to alteration. *Quartz*: A few quartz grains fill some interspaces of albite microlites but they are subordinate.

Phenocrysts—*Oligoclase-andesine* (*andeclase*): This forms the chief component of the phenocrysts. Albite twinning is common. The mean refractive index is between 1.540 and 1.550. In a section normal to X,Z ^ (001) is about 18° and the mineral is, therefore, oligoclase-andesine in a composition of about Ab[illegible]An[illegible]. Optically negative. The mineral is sometimes altered into quartz and orthoclase, resulting in a vermicular texture. *Orthoclase*: Only a few fragments are observed. As the mean refractive index is < 1.54, orthoclase can be easily distinguished from oligoclase-andesine when immersed in liquid. Carlsbad twinning occasionally present. Generally speaking, both plagioclase and

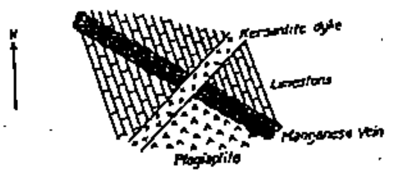

Fig. 2. A rhodonite vein cut by a kersantite dyke at Heitseitzu.

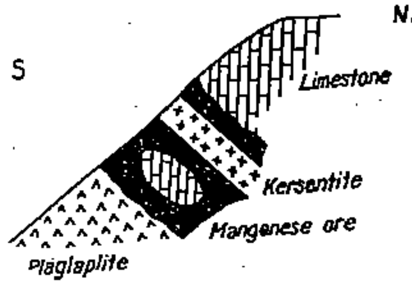

Fig. 3. Section through Heitseitzu showing the intrusion of kersantite in the rhodonite vein.

orthoclase have been much altered and mostly broken into many parallel cracks, indicating that the phenocrysts were once under great pressure before the cystallization of the goundmass. *Biotite*: This occurs abundantly. Some altered six-sided hexagonal basal section shows distinct acute bisectrix figure. In such a section, 2E=21°. Pleochroism: Y=yellow, and Z=brownish yellow. In unaltered sections, however, the optic angle is nearly equal to zero and Y=Z =deep reddish brown, X=yellow. Absorption is X < Y < Z. Some fragments are cracked and bent, while others are sometimes decomposed into a greenish substance which is nearly isotropic under crossed-nicols, and is probably chlorite. *Hornblende*: It is only represented in a few fragments. The color is bluish green with distinct pleochroism. The extinction angle ($Z \wedge C$) is about 20°.

Besides, there are numerous calcite veins (Pl. III, Fig. 3), crossing both phenocrysts and groundmass. They are probably supergene in origin

(4) *Grano-diorite*. The exact locality of the rock is not known, but it certainly occurs as a dyke in the neighborhood of Heitseitzu. Under the microscope it is granular in texture. The lime-soda-felspar is more abundant than alkali-felspars. The latter is represented by orthoclase while the former, chiefly oligoclase, is hardly discernible since subsequent alteration obliterated the twinning laminæ.

Oligoclase: The mean refractive index is above 1.525 and very near to 1.54. Albite twinning is common but usually obscure in strongly altered crysals. Optically biaxial and negative. In a section normal to X, $Z \wedge (010)$ is 86°, indicating that the composition is nearly $Ab_{76}An_{24}$.

Orthoclase. It occurs in a few fragments and can be distinguished from oligoclase by its mean refractive index which is less than 1.525 when immersed in liquid.

Biotite: It is generally in tabular fragments with marked pleochoism. X=Yellow, Y=deep yellow and Z=dark brown. Absorption is $X < Y < Z$. Z is nearly parallel to cleavage (001). The optic angle is very small though biaxial character is still clear.

Hornblende: Pleochroism distinct with X=yellow, Y=brownish green, and Z= green. Positive elongation. Optically negative. 2V=large.

Apatite: Generally in prismatic crystals or in irregular grains. Parallel extinction. Negative elongation. Refringence high. Birefringence weak.

MANGANESE VEINS

FORM OF THE VEINS

The rhodonite veins generally exist in the contact zone between the siliceous limestone and the plagiaplite series (Fig. 4) and their width varies from

0.3 m to 2 m. but is most commonly about 1 m. Seven veins may be recognised though they are possibly continuous in depth since they are arranged in the same line.

Vein I. Exposed south of Heitseitzu in contact with the alkali granite dyke (Fig. 5). It has a length of about 18 m. and a width of about 1 m.

Vein II. Situated north of vein I and separated from the latter by the dyke just mentioned. It is about 6 m. long and 1 m. wide.

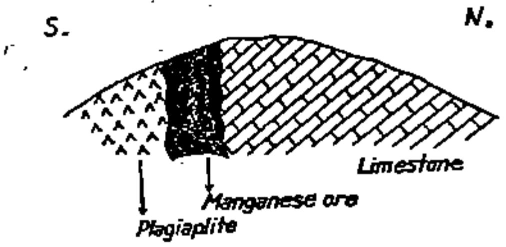

Fig. 4. Section southeast of Yikeshu, showing the occurrence of rhodonite vein between siliceous limestone and plagiaplite.

Fig. 5. Section south of Heitseitzu, showing the contact of alkali granite with manganese ore.

Vein III and IV. Exposed on the south slope of the top of Heitseitzu (Pl. II, Figs. 2 and 3). They trend in a parallel N.-S. direction and are combined into one at their northern ends. They have the same length of about 40 m. with a width varying from 0.5 to 3 m.

Vein V. This lies between Heitzeitzu and Yikeshu, with a length of about 104 m. and a width of 1-2 m.

Vein VI. Situated northwest of Toutaokou. Its length is about 300 m. and its width varies from 0.1 m. to 0.3 m.

Vein VII. Exposed at Sanchiaokou. Nearly 26 m. long and 0.3. m. wide.

DESCRIPTION OF THE MINERALS

The minerals in the veins may be generally distinguished into two groups; one is of hypogene origin or primary minerals and the other is supergene or secondary minerals. The former can only be found in depth and so far as we know it consists only of two mineral species, while the latter is mostly exposed on the surface of the veins.

Hypogene Minerals

Quartz: It is the earliest mineral in the veins. Usually occurring in a considerable quantity in certain specimens. Generally coarse-grained.

Rhodonite: It is much abundant in association with quartz and thus makes the veins a beautiful pinkish color in deep zones. In thin sections it is colorless with distinct (110) and $(1\bar{1}0)$ cleavages. Its refractive indices: N_p= 1.7174, N_m=1.728, and N_g=1.7313. In a section normal to one optic axis, Z makes about 40° with (110) and $(1\bar{1}0)$ cleavages. 2 V =80° ± as estimated from the curvature of the isogyre. The extinction angle between Z and prismatic cleavages in a section normal to Y is about 30°. Most crystals show optically positive property but a few give also negative sign. According to A. N. Winchell[1] the former should be called fowlerite and the latter rhodonite. The chemical analysis as shown below contains no zinc but a considerable amount of magnesium, while another analysis gives about 4% zinc. From a pure chemical standpoint the mineral under study does not agree in composition either with fowlerite ($Ca(Mn, Fe, Zn)_5(SiO_3)_6$?) or with rhodonite ($CaMn_5(SiO_3)_6$) and might be termed in a new name "*Hsihutsunite*". Its chemical composition, as analysed by Mr. S. C. Liang, chemist of the Geological Survey, is as follows:—

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1 A. N. Winchell: Elements of Optical Mineralogy, Part II, Sec. edition, pp. 195-196.

SiO_2	44.30%
Fe_2O_3	1.79%
Al_2O_3	0.78%
MnO	42.18%
CaO	4.31%
MgO	6.24%
Moisture	0.10%
Ignition loss	0.21%
Total	99.91%

It generally replaces quartz when it is in contact with the latter (Pl. III, fig. 1). Residual grains of quartz are not infrequently met with.

Supergene Minerals

Psilomelane: It occurs in great quantity near the outcrop of the veins. Under the microscope it shows grayish white color. Its hardness varies from high to medium. All etching reagents as suggested by C. M. Farnham[1] are negative. Colloform structure (Pl. IV, fig. 3) is distinct in some specimens. Under crossed nicols it is isotropic. Two generations of crystals can be observed: residual grains of one generation are commonly included in the other. Psilomelane veinlets are usually found in rhodonite (Pl. IV, fig. 1) or plagiaplite (Pl. IV, fig. 2) and thus replace them. The alteration of rhodonite into psilomelane generally begins with the formation of dark or black masses which are subsequently traversed by numerous psilomelane veinlets.

Manganite: This also occurs in an appreciable amount. Its presence indicates that the deposition of the supergene minerals at least partly took place in a considerable depth.

Megascopic examination: Handspecimens generally show granular, crystalline masses. Giving much water in closed tube. Hardness about 2½. Streak brownish black.

Microscopic examination: Color grayish white. Brittle when scratched with the needle. Reflecting pleochroism strong. Cleavages distinct. All etching reagents are negative. Strongly anisotropic with bluish gray and creamy white colors. Powder yellowish hrown. Generally showing intergrowth struc-

1 C. M. Farnham: Determination of the opaque minerals, 1931.

ture (Pl. IV, fig. 4). Replacement of psilomelane by manganite gashes is common. Sometimes residual grains of the former are scattered in the latter.

The chemical composition of manganite as analysed by Mr. T. T. Chang of the Geological Survey, is given below:—

Mn 47.69% (MnO_2	75.47%)
Fe	0.90%
SiO_2	0.39%
Zn	0.16%
Moisture	3.75%

Loss on ignition at 900° C for 1½ hour. 15.88% (Mainly H_2O)

Pyrolusite: It may be present but usually too little to be definitely identified in the writer's collection.

Wad: It is sometimes present in a notable amount in certain localities. Generally occurring as soft blackish earthy masses and occassionally showing cellular texture. Easily crushed into powder when touched with fingers. Mostly altered from psilomelane on its exposed surface.

Calcite: Carbonatization is the last phase of deposition occurring in the zone of the rhodonite veins. Calcite veinlets and coatings are not only frequently found in the manganese ores but also in certain dykes such as kersantite (Pl. III, Fig. 3).

The paragenesis of the hypogene and supergene minerals mentioned is summarized in the following table:—

	Hypogene	Supergene
Quartz	———	
Rhodonite	———	
Psilomelane		———
Manganite		———
Pyrolusite		———
Wad		———
Calcite		———

METASOMATIC PROCESSES OF THE COUNTRY ROCKS

The country rocks of the rhodonite veins are composed mainly of siliceous limestone and plagiaplite. The former generally shows recrystallization only. As an exception one handspecimen in the writer's collection has been found to contain some isotropic mineral showing high refractive index and being thus probably garnet which is the only silicate we found in the limestone. In connection with the alteration of plagiaplite it is exceedingly interesting to note the occurrence of a great amount of sillimanite and andalusite, minerals rarely connected with ore deposits in general. One interpretation is that such minerals are not the product of the metasomatic action of the rhodonite veins but are the result of some general metamorphism caused by other igneous rocks. It is strange, however, that these minerals are scarcely found at a distance from the contact zone of the veins. The minerals in the metasomatic rocks of plagiaplite are mentioned below in some detail.

Sillimanite: This occurs in fibres (Pl. III, fig. 4) or prismatic crystals and may be really termed fibrolites. Its mean refractive index is nearly 1.645. Cross fractures common. Parallel extinction. Positive elongation. (010) cleavage distinct in some sections. Birefringence strong. The optic sign is not easily determinable, since transverse sections are rarely obtained. In one optic normal figure, the color in the direction of the acute bisectrix is orange red while in the obtuse bisectrix it is bluish green. The acute bisectrix is, thus, the slow ray and parallel to elongation. The mineral is then positive.

Andalusite: This is represented by some rounded or irregular grains, with birefringence similar to apatite, but always gives biaxial interference figure. The optical sign is probably negative though not decisive as the interference figure is very feeble. The mean refractive index is higher than muscovite but lower than sillimanite and probably also higher than 1.60 and lower than 1.635. The mineral is provisionally assigned to andulusite though still with some doubt.

Fe-phengite: Occurs as tabular crystals with distinct (001) cleavage. Colorless in thin sections. The optic angle (2V) is very small. Optically negative. Birefringence strong.

Pyrite: This occurs only in a few grains and is partially or wholly altered into hematite.

Secondary quartz: This is characterized by its rounded forms, often replacing feldspar or muscovite. Brownish inclusions common.

Penninite: When the powder of the rock is immersed in liquids, a colorless or yellowish mineral is often found with refractive index about 1.585 and weak birefringence. Optically negative and biaxial with small optic angle. It is probably penninite.

Genesis and Economic Significance

Though there is a great variety of igneous dykes in the neighborhood of the rhodonite veins, ***plagiaplite seems to be the only rock in genetic relation with the veins***. This is shown not only by the common occurrence of plagiaplite in contact with the veins but also by the included ore body in the former as indicated in figure 6.

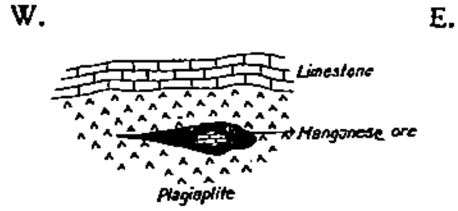


Fig. 6. Section through Heitseitzu, showing the included manganese ore and limestone in plagiaplite.

As to the physical conditions during the formation of the veins, besides the indication by the altered products in the country rock, the rhodonite itself is a high temperature mineral. ***Consequently the veins should be classified as a hypothermal type.***

Being situated near Peiping and being not far from the iron ores of Lungkuan, Chahar, their economic value is worthy of paying attention. According to the writer's observation, however, the manganese oxide ores are only superficial and should merge into manganese silicate in the depth. By rough estimation the oxide ores hardly exist 20 feet below the surface, though variations may happen in some localities. The reserve of the ore is, thus, not to be expected in great amount and its economic value becomes doubtful. On the other hand, as Peiping is the centre of precious stone industry, the rhodonite veins may be mined for the purpose of ornamental use rather than for manganese ore.

Explanation of

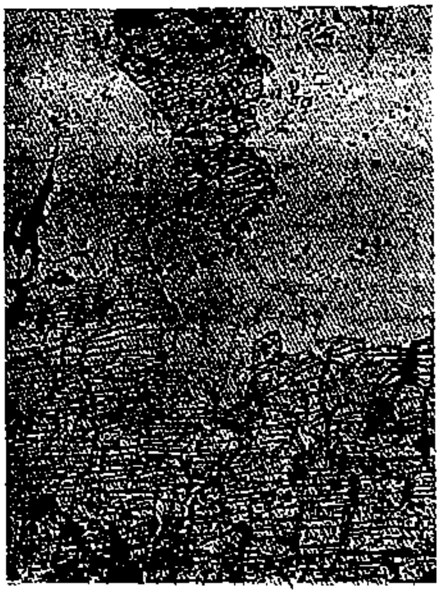
Plate II

PLATE II

Fig. 1. A distant view of Yinshan (銀山), showing the granite topography, looking north from Heitseitzu.

Fig. 2. Outcrop of manganese ore at Heitseitzu.

Fig. 3. Abandoned pits for manganese prospecting on the southern slope of Heitseitzu.



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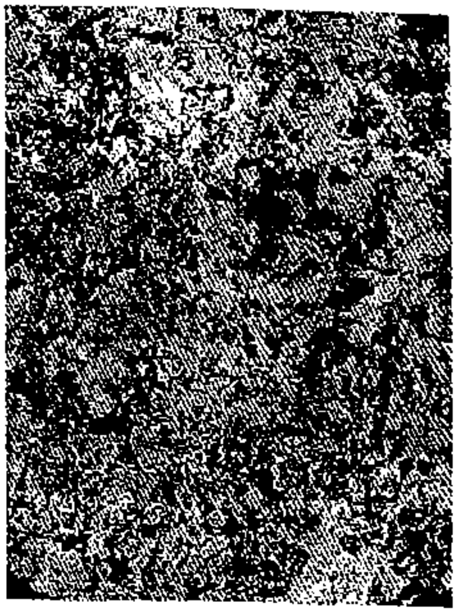

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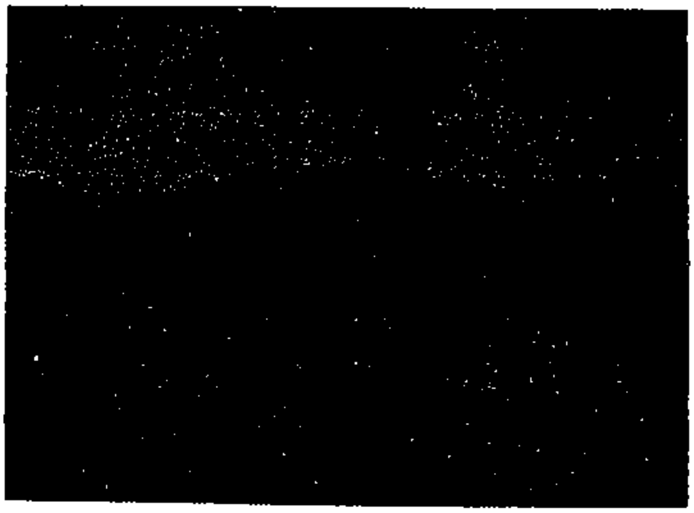

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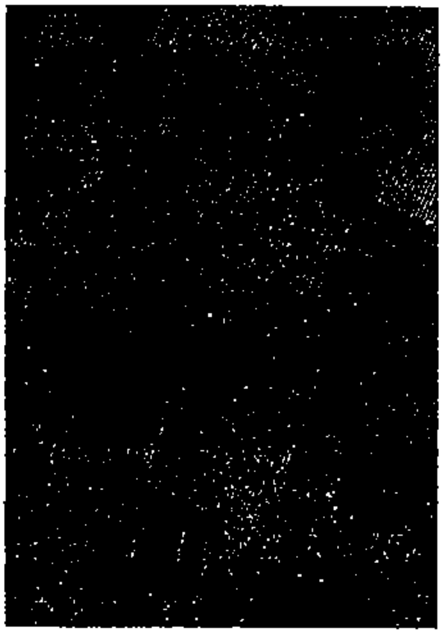

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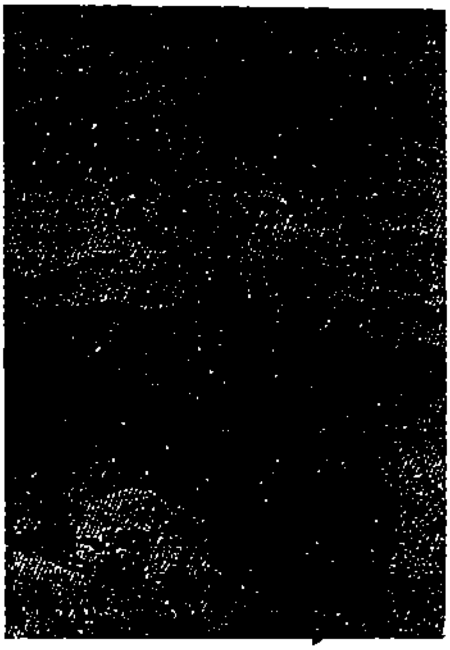

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Explanation of

Plate III

PLATE III

Fig. 1. Replacement of quartz by rhodonite. × 46, parallel nicols. Notice the residual grain of quartz included in rhodonite in the central portion of the picture.

Fig. 2. Felsitic texture of plagiaplite × 45, crossed nicols.

Fig. 3. Calcite veins in kersantite. × 46, parallel nicols.

Fig. 4. Aggregates of sillimanite fibers in plagiaplite. × 50, parallel nicols.

Explanation of Plate IV

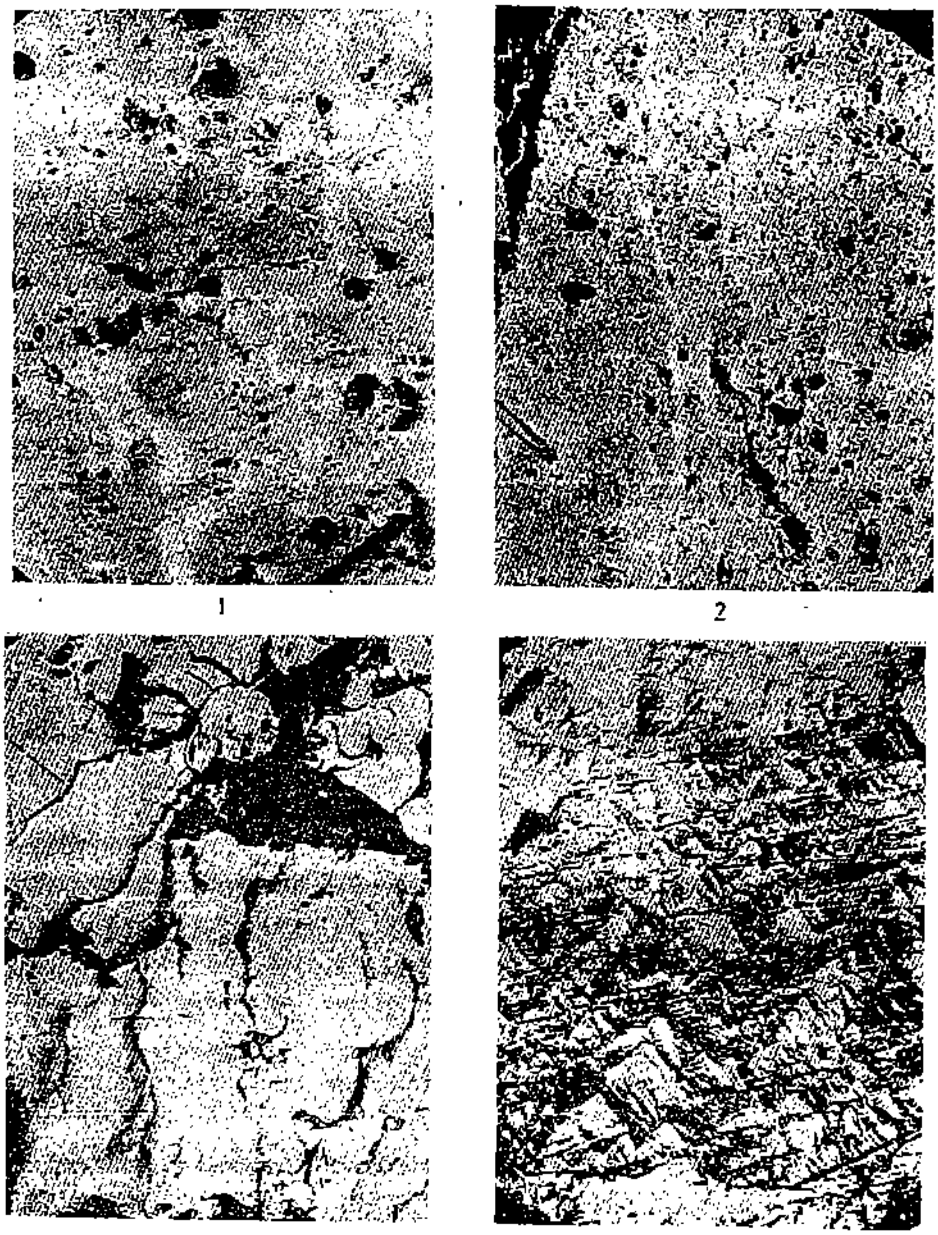
PLATE IV

Fig. 1. Psilomelane veinlets and gashes replacing rhodonite. × 150, parallel nicols.

Fig. 2. Veinlets of psilomelane in plagiaplite. × 42, parallel nicols.

Fig. 3. Colloform structure of psilomelane, × 150, parallel nicols.

Fig. 4. Intergrowth texture of manganite, × 120, crossed nicols.



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