P260-264/76 Records Copy

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26.8.76

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Winner of Award for Outstanding Export Achievement 1975

Please address all correspondence to Frewville,
In reply quote: MP1/15/8/0

25th August, 1976

The Director,
Department of Mines,
PO Box 151,
EASTWOOD, SA 5063

6737.

Attention: Mr R.B. Major

REPORT MP 204/77

YOUR REFERENCE:	Application dated 19-7-76
MATERIAL:	5 rock specimens
LOCALITY:	Mt. Gee, Mt. Painter area, SA
IDENTIFICATION:	P260-264/76
DATE RECEIVED:	21-7-76
WORK REQUIRED:	Petrographic descriptions and interpretation

Investigation and Report by: Sylvia Whitehead

Officer in Charge, Mineralogy/Petrology Section: Dr K.J. Henley

for F.R. Hartley
Director

S Whitehead

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DESCRIPTION OF MT. GEE QUARTZ-HEMATITE AND OF CONTACT BETWEEN TILLITE AND GRANITIC BRECCIA

1. INTRODUCTION

Three large specimens of Mt. Gee quartz-hematite rock, two with associated finer grained, brownish pink-stained sediments were submitted for description and suggestions concerning their origin. One specimen containing a contact between tillite and granitic breccia was submitted for determination of the nature of the contact.

2. SUMMARY AND CONCLUSION

Mt. Gee quartz-hematite rock contains specular hematite, abundant polygonal and less regular aggregates of hematite, some euhedral quartz crystals and minor monazite in a matrix now composed of intergrown quartz crystals. The shape of some hematite aggregates suggests that some iron oxide may have replaced crystals of carbonate but others may represent replaced or oxidized magnetite. Monazite occurs as separate, isolated crystals, as crystalline aggregates and as crystals included within aggregates of hematite suggesting that the monazite was intergrown with the earlier mineral which was replaced by hematite.

It is suggested that these sediments were predominantly chemical precipitates and therefore the normal rules for graded bedding would not apply. This could explain the apparently reversed graded bedding in sample P263/76 and the finer grained hematite and monazite fragments found at the base of some layers probably represent locally reworked material. These sediments were silicified very early in their history.

The associated finer grained "silty" layers do not contain more than a trace of silt-sized, clastic detrital material and are not silicified siltstone. They are probably best referred to as impure chert with the understanding that the microcrystalline quartz could have replaced another chemically precipitated mineral although no evidence was found to suggest this.

The Mt. Gee quartz-hematite rocks differ from many hematitic breccias in the Mt. Painter area in that they contain little or no clastic material derived from granitic rock, show no evidence of chlorite and contain an abundance of matrix quartz. However, they show some very significant similarities to hematitic breccias in mineral associations and textures - they all contain crystals and aggregates of specular hematite, remnants of magnetite, euhedral quartz crystals and minor monazite (some included within hematite aggregates) and it is strongly suggested that there is a genetic relationship between the Mt. Gee quartz-hematite rocks and the hematitic breccias.

Additional specimens of Mt. Gee-type, quartz-hematite rocks are described in Report MP 305/77.

3. PETROGRAPHIC DESCRIPTIONS

Samples: P260 and 261/76; TS36169, 36170

Applicant's Mark and Location:

RBM44A/76. Mount Gee Ridge, Mt. Painter Area. NFM R17/090 (95) SP (folded hematite, siltstone, quartz rock).

Hand Specimen:

Both sections were cut from the same specimen. This contains a large mass of quartz-hematite rock bordered on one surface by a band 3-4 cm thick of very fine-grained, pinkish brown rock with fine laminations defined by variations in colour. The general appearance of the fine-grained, pinkish-brown rock is that of a slightly ferruginous, finely laminated 'siltstone' in which the bedding is parallel. In the specimen submitted this fine-grained, laminated rock shows a fold or flexure over the surface of the quartz-hematite rock and this folding must have occurred when the sediment was soft. Above the fine-grained, laminated sediment there is an encrustation of typical Mt. Gee quartz in which there are traces of elongate voids.

The moderately coarse-grained, quartz-hematite rock contains some aggregates of specular hematite and a few of reddish hematite up to 5 mm in size and an abundance of much smaller hematite fragments in a mass of white quartz. In the vicinity of a small fracture or vein at the top of this mass there are some larger aggregates of hematite up to 1.5 cm in size which appear to have invaded the finer grained, pinkish-brown sediment possibly during a period of movement or deformation. In this sample there is no definite evidence of layering in the large mass of moderately coarse-grained, quartz-hematite rock.

Thin Sections:

Minerals present in the coarser grained quartz-hematite rock are as follows:-

	%
Hematite	25-30
Monazite	1-2
Primary ?quartz crystals	2-3
Secondary quartz	65-70

Minerals present in the finely banded, pinkish-brown sediment:-

	%
Quartz (secondary?)	>90
Hematite and dusty inclusions	3-5
Muscovite, sericite and clay	trace

Quartz-hematite rock:

This contains aggregates and groups of specular hematite crystals, a few patches of finer grained ochreous hematite, scattered crystals, fragments and aggregates of monazite and a few early (or primary?) euhedral crystals of quartz in a mass of later or secondary quartz which occurs as intergrown crystals with random orientation and as radiating aggregates. This late or secondary quartz contains abundant clouds and lines of minute voids and possibly dusty inclusions.

Aggregates of specular hematite vary in size but, in the area sectioned many are between 1 and 4 mm. Many of these aggregates have polygonal external shapes or partly preserved polygonal shapes clearly indicating that much of this specular hematite has replaced an earlier mineral. This cannot be identified with absolute certainty from the evidence available but there are some aggregates with shapes very similar to rhombohedral crystals of carbonate (Plate 1). In many hematite aggregates only portion of the external shape is preserved and in the interior there are varying concentrations of specular hematite crystals. Most of the remaining voids have been filled by secondary or late quartz similar to, and continuous with that now forming the matrix. Other hematite aggregates show a variety of shapes a few of which appear almost triangular in cross section and a few appear almost square. It is possible that other minerals besides carbonate were replaced by this hematite and some magnetite was very probably present (see polished section). A few of the hematite aggregates contain inclusions of monazite and most of them appear to have been partly or extensively replaced by the matrix quartz. The thin sections also contain some scattered, isolated specular hematite crystals and at least one aggregate showing parallel growth of specular hematite crystals.

Monazite occurs as crystals and crystalline aggregates and also as fragments of broken crystals up to 1 mm in size and most of these are scattered apparently at random through the secondary or late quartz matrix. A few monazite crystals are present within some of the hematite aggregates which have almost certainly replaced a pre-existing mineral and it therefore seems probable that the monazite was also included within this earlier mineral.

Thin section 36171 (cut from the quartz-hematite rock at a distance of over over 10 cm below the fine-grained sediment) contains one elongate and possibly slightly contorted mass over 4 mm long composed almost entirely of intergrown monazite crystals. At one end of this aggregate this crystalline mass appears to have been overlain by, or grade into some very turbid, fine-grained material heavily stained by iron oxide and as this appears to have a refractive index similar to that of the coarser grained monazite. It could represent a later stage in the growth of this monazite aggregate. This aggregate is now surrounded and locally penetrated by the late or secondary quartz. This textural evidence shows that at least some and possibly all of the monazite crystallized within this rock and some has been fractured by subsequent movement. Where it is in contact with hematite it appears to have crystallized before the hematite. This monazite is indistinguishable from that found in many other hematite-bearing breccias in the Mt. Painter area.

There are a few euhedral crystals of clear quartz 0.5 to 1 mm in size and some of these are surrounded by a thin, optically continuous overgrowth which is intergrown with the matrix quartz. Very few of these quartz crystals are in contact with hematite but in thin section 36171 some hematite has crystallized against one of these quartz crystals.

Thin section 36171 (P261A - several centimetres from contact with the finely banded rock) contains one area 5 x 7 mm in size in which moderately coarse-grained quartz is now intergrown with very turbid microcrystalline quartz and the shape of some grain boundaries indicates that this microcrystalline quartz has replaced an earlier mineral. The general texture of this intergrowth is similar to that of quartz and feldspar or quartz and chloritized feldspar noted in lithic clasts in some of the hematitic and granitic breccias and it is tentatively suggested that this also represents a lithic clast which has been silicified. No other similar areas were found in the sections from this specimen.

The matrix consists of intergrown quartz crystals most of which are between 0.1 and 0.5 mm in size but in a few places there are aggregates of radiating quartz crystals up to 1 mm long. This quartz is slightly turbid due to the presence of clouds of minute voids and possibly traces of dark material and some of these outline relict textures in the form of small prismatic or acicular crystals which occur generally along the centre of elongate quartz crystals forming the radiating aggregates. This quartz fills all interstices between crystals and aggregates of hematite and monazite and it has also penetrated within aggregates of hematite crystals and along fractures in monazite. Clearly this matrix quartz crystallized after there had been some movement within this hematite-bearing rock and it was the last mineral to crystallize. Whether or not it replaced an earlier matrix cannot be decided from the available evidence but the general texture suggests silicification.

Polished Section:

This contains scattered crystals and fragments of specular hematite, some aggregates of similar hematite showing parallel growth but which have been deformed and some aggregates with polygonal outline composed of finer grained specular hematite. In some aggregates interstices between the larger hematite crystals contain finer grained hematite which may be of a latter generation. Very few of the large specular hematite crystals contain minute inclusions of pyrite and of magnetite.

There are also angular clasts now composed of ochreous hematite and although there are traces of relict textures these cannot be recognized with certainty. Some may have replaced carbonate but a chloritic mineral is also a possibilty.

Finely banded sediment: (Plate 2)

This consists largely of intergrown quartz crystals similar to but much finer grained than those forming the matrix of the hematite-bearing rock and these are stained by varying concentrations of orange, brown and red iron oxide pigment. There are also scattered, very small flakes of specular hematite generally less than 0.1 mm long and a few microns thick. There are a few patches of very fine-grained sericitic material, a few very small grains of zircon? and possibly a few minute fragments of monazite? The layering noted in the hand specimen is due to varying concentrations of reddish-brown iron oxide staining in the quartz which appears to have crystallized across and replaced the original sediment or precipitate.

There are a few small quartz veins cutting the rock at a high angle to the layering and these are distinguished mainly by their lack of orange to brown staining. One of these veins contains minor amounts of very fine-grained hematite which occurs discontinuously along the centre of the vein and there are also a few small voids.

Contact between the hematite-bearing rock and the finely layered sediment is irregular in that some crystals and aggregates of hematite project above the general level of the contact. Quartz now forming the bulk of the layered sediment is continuous with that forming the matrix of the hematite-bearing rock the only distinction being a change in the grain size and no evidence can be found for a time break between the crystallization of quartz in the hematite-bearing rock and that of the finer grained quartz now forming the bulk of the layered sediment. This is almost certainly secondary quartz and any earlier features which may have been important in distinguishing the type of contact have apparently been obliterated.

Near the outer surface of the layered sediment the fine-grained quartz stained by iron oxide passes into coarser grained quartz showing subparallel growth which forms a layer or encrustation over the surface. There are in fact two thin layers of this quartz showing parallel growth interspersed with a thin layer of the finer grained, orange-stained quartz just below the final layer of larger quartz crystals which are up to 1 cm long.

Summary:

The quartz-hematite rock contains crystals and fragments of specular hematite and monazite and also aggregates of hematite which have replaced some earlier minerals almost certainly including some carbonate and magnetite It is possible that ochreous hematite present in some fragments may have replaced a chloritic mineral. There is evidence of fracturing and deformation in this material before crystallization of the abundant matrix quartz and it is very probably although not absolutely certain that this matrix quartz has replaced an earlier matrix.

The overlying, finely layered sediment is composed of quartz which is similar to and continuous with that forming the matrix of the quartz-hematite rock differing from it only in grain size and in the orange to brown iron oxide staining. This appears to be a silicified fine-grained sediment and it was deformed before it was silicified.

Overlying the fine-grained sediment there is a layer of quartz crystals very similar to typical Mt. Gee quartz and this also is continuous with the finer grained quartz which has replaced the layered sediment. (Plate 2)

Sample: P262/76; TS36172; PS24980

Applicant's Mark and Location:

RBM44A/76. Mount Gee Ridge, Mt. Painter Area. NFM R17/090 (95) SP (folded hematite, siltstone, quartz rock).

Hand Specimen:

A siliceous rock with a repeated series of layers, Assuming the sample is right way up there are layers containing specular hematite and quartz which are immediately overlain by fine-grained, brownish-pink impure 'chert' similar to that described in the previous sample and this 'chert' is then in sharp contact with an overlying "layer" composed of late quartz some of which shows radiating structures. At the top of this quartz there is then another layer of quartz-hematite rock overlain by brownish-pink, impure 'chert'. In a few places moderately large aggregates of specular hematite occur in the pink 'chert' and also in the quartz showing radiating structures.

Thin and Polished Sections:

The hematite-bearing layer included in the section contains loose aggregates of specular hematite crystals, a few euhedral quartz crystals and a few crystals and fragments of monazite in a matrix which is now composed of intergrown quartz crystals very similar to those described for sample P260-61/76. Hematite aggregates in this sample differ from many of those noted in sample P260-261/76 in that they show no evidence of having replaced earlier crystals but in polished section a few of the larger hematite crystals contain minute inclusions or remnants of magnetite and also a few small relict textures of another mineral? across which the hematite appears to have crystallized (Plate 3b). One hematite crystal included in the polished section contains a very small inclusion of pyrite. This is similar to sample P160-161/76 in that textural relationships suggest that the monazite crystallized before the hematite.

Towards the top of this layer concentrations of hematite occur along an undulating surface, the origin of which remains obscure and below this the secondary quartz occurs in radiating aggregates many of which appear to have grown out from this undulating surface. At present this structure can only be described and no satisfactory explanation for its origin can be suggested. (Plate 3a)

Immediately above this undulating surface the hematite-bearing rock passes into the finer grained silicified 'silt' or chert which is indistinguishable from that in sample P261/76. It is composed of a mosaic of quartz crystals which are stained with varying concentrations of extremely fine-grained iron oxide. A few aggregates of specular hematite and moderately coarse-grained quartz project up into this layer.

The overlying, coarser grained quartz is very similar to the typical Mt. Gee quartz but does contain some zones which are turbid due to the presence of clouds of minute cavities and there are also a few relict textures of fine prismatic or acicular crystals generally in the centre of a quartz crystal in a radiating aggregate. In some layers in this quartz there are voids lined with projecting quartz crystals.

Conclusion:

This is clearly related to sample P260-261/76 in origin and history and it is considered possible that much of this was originally a chemically precipitated sediment which has been subsequently silicified.

Sample: P263/76; TS36173; PS24981

Applicant's Mark and Location:

RBM44C/76. North-east Mount Gee Prospect, near Mount Gee 79A.
NFM R17/090 (95) SP. Hematite-quartz rock with "reverse graded bedding".

Hand Specimen:

The rock contains aggregates of specular hematite, crystals of specular hematite and some aggregates of reddish ochreous hematite in a matrix of white quartz in which there are numerous voids or vugs lined with small quartz crystals. The size of the hematite aggregates varies and in the specimen submitted there appears to be a thick layer (12 cm) in which the size of hematite aggregates near the base averages about 1 mm and these become progressively larger towards the top of the layer where there are some hematite aggregates 1 cm across. This variation is not always regular and there are a few large aggregates 5 cm from the top of the layer. The variation in size of these hematite aggregates gives the impression of reverse graded bedding however, as this is clearly not a normal clastic sediment normal rules concerning graded bedding cannot apply. It is more probable that this hematite has replaced crystals which have grown in a chemically precipitated sediment and the size of these crystals could well be larger near the top of any such layer.

Thin and Polished Sections:

This quartz-hematite rock is very similar to that described for sample P260-261/76. (Plate 4b)

It contains crystals and fragments of specular hematite, aggregates of specular hematite which have clearly replaced earlier, polygonal crystals, a few euhedral crystals of clear quartz and a few crystals and fragments of monazite. These are scattered through a matrix composed of late or secondary quartz which is clouded with minute voids and has clearly been the last mineral to crystallize. As in sample P260-261/76 some of the aggregates of specular hematite have external shapes suggesting that this hematite replaced rhombohedral crystals of carbonate but there are other polygonal aggregates in which the shape of the former crystal cannot be determined with certainty. It is these aggregates of hematite some of which have probably replaced carbonate which vary in size in different parts of this thick layer and give the impression of graded bedding. Many of these aggregates are porous and have been invaded by the matrix quartz. (Plate 4b)

Monazite fragments and euhedral crystals of clear quartz are similar to those noted in other samples and the section contains one aggregate of monazite crystals almost completely enclosed by one of the clear quartz crystals. This monazite contains some small fluid inclusions which could be suitable for fluid inclusion study to determine the temperature of crystallization. The clear quartz crystals are surrounded by zones of optically continuous overgrowths of turbid quartz which is intergrown with the matrix quartz.

The thin section was cut to include the "coarse-grained" top of one layer and the "fine-grained" base of the next layer. The "coarse-grained" top portion of the layer contains numerous large aggregates of specular hematite several millimetres in size and very few separate crystals of hematite. It contains some monazite and clear quartz crystals and also one patch of pink-stained microcrystalline clay? The "finer grained" base of the succeeding layer contains abundant small fragments of specular hematite crystals and fewer crystalline aggregates but this concentration of small fragments of specular hematite occurs only over a distance of approximately 5 mm. Above this most of the hematite occurs in crystalline aggregates which vary in size.

Examination of the polished section does not given any further useful information. Most of the hematite does not contain visible or recognizable inclusions and only a few of the larger crystals contain minute inclusions of magnetite and a few contain minute inclusions of pyrite.

Conclusion:

This is essentially very similar to quartz-hematite rock in sample P260-261/76 and has clearly had a similar origin and history. The apparent graded bedding is due to variations in the size of aggregates of specular hematite and the thin section shows that this hematite has almost certainly replaced crystals of an earlier mineral some of which were probably carbonate. As this crystallized from a chemical precipitate and not a clastic sediment the normal rules of graded bedding cannot apply and it is quite possible that larger crystals could be formed near the top of a layer formed by chemical precipitation. The zone containing small fragments of specular hematite at the base of the thick layer could represent reworked material derived from a chemically precipitated sediment.

Sample: P264/76; TS36446

Applicant's Mark and Location:

RBM71A/76. Mount Gee Prospect. NFM R17/090 (48) SP. Contact between tillite and granitic breccia.

Hand Specimen:

The sample contains a fairly straight contact between a purple conglomeratic rock very similar to tillite and a paler coloured, granitic breccia. The purple tillite contains several well rounded pebbles and cobbles and one or two similar rounded pebbles can be seen in the granitic breccia.
On one surface there is a flat or tabular pebble possibly 2 cm long which is embedded in the tillite but also projects into the granitic breccia. The slice of rock which was sectioned also shows an irregular patch of purple tillite within the granitic breccia.

Thin Section:

The tillite contains poorly sorted, rounded and subrounded quartz grains generally less than 1 mm in size, a few rounded lithic grains composed mainly of sericite (possibly schist) and some lithic grains composed of fine-grained quartz and sericite or mica. There are also a few turbid grains which could have been derived from acid volcanic rock and some grains of microcrystalline quartz or of fine-grained quartzite. In the area included in the thin section the tillite also contains a large, angular fragment composed predominantly of coarse-grained microcline and another composed of intergrown quartz and microcline. The matrix of this tillite is very fine-grained and is composed largely of sericitic material stained by minute particles of red iron oxide. There is also some fine-grained quartz. This tillite does not show any evidence of metamorphism and the rounded grains and pebbles do not show any evidence of deformation. There is no recognizable foliation in the matrix. Where elongate grains are present either of quartz or fine-grained schist most of these are almost parallel to the contact with the granitic breccia. The orientation of these elongate grains probably indicates the direction of bedding.

The granitic breccia is composed of a confused mass of coarse-grained quartz and microcline with some recognizable clasts composed of intergrown quartz and microcline with and without small patches of sericite or fine-grained muscovite which may have replaced plagioclase. In one of these coarse-grained clasts some of the microcline contains groups of opaque, magnetite or martite crystals. There are patches of intergrown quartz crystals probably cementing some of the clasts but distinction between clasts and matrix is not readily recognizable. In one area there are some fractured fragments of apatite and also irregular patches of leucoxene.

The contact between the tillite and the granitic breccia is slightly irregular and in places the tillite appears to have penetrated between clasts of coarse-grained microcline and quartz. Some of these clasts in the granitic breccia appear to be at least partly embedded in the tillite. There is no evidence to suggest fracturing or shearing along this contact but, over a short distance there is a small quartz vein in the granitic breccia adjacent to the contact.

Conclusion:

No evidence was found to suggest that this is a fractured, faulted or sheared contact and almost certainly the tillite was soft when these two rock types came into contact. Preferred orientation of elongate grains and fragments in the tillite parallel to the contact suggests that this contact is parallel to the bedding in the tillite and therefore a sedimentary contact is possible. It is not clear why secondary or cementing quartz should be relatively abundant in the granitic breccia but absent from the tillite but this may be due to differring porosity.

It is possible that the large angular fragment composed of coarse-grained microcline found in the tillite is related to coarse-grained, microcline-rich clasts in the breccia and this would support the suggestion of a sedimentary contact, however, the origin of these coarse-grained microcline clasts cannot be determined with certainty.

PLATE 1

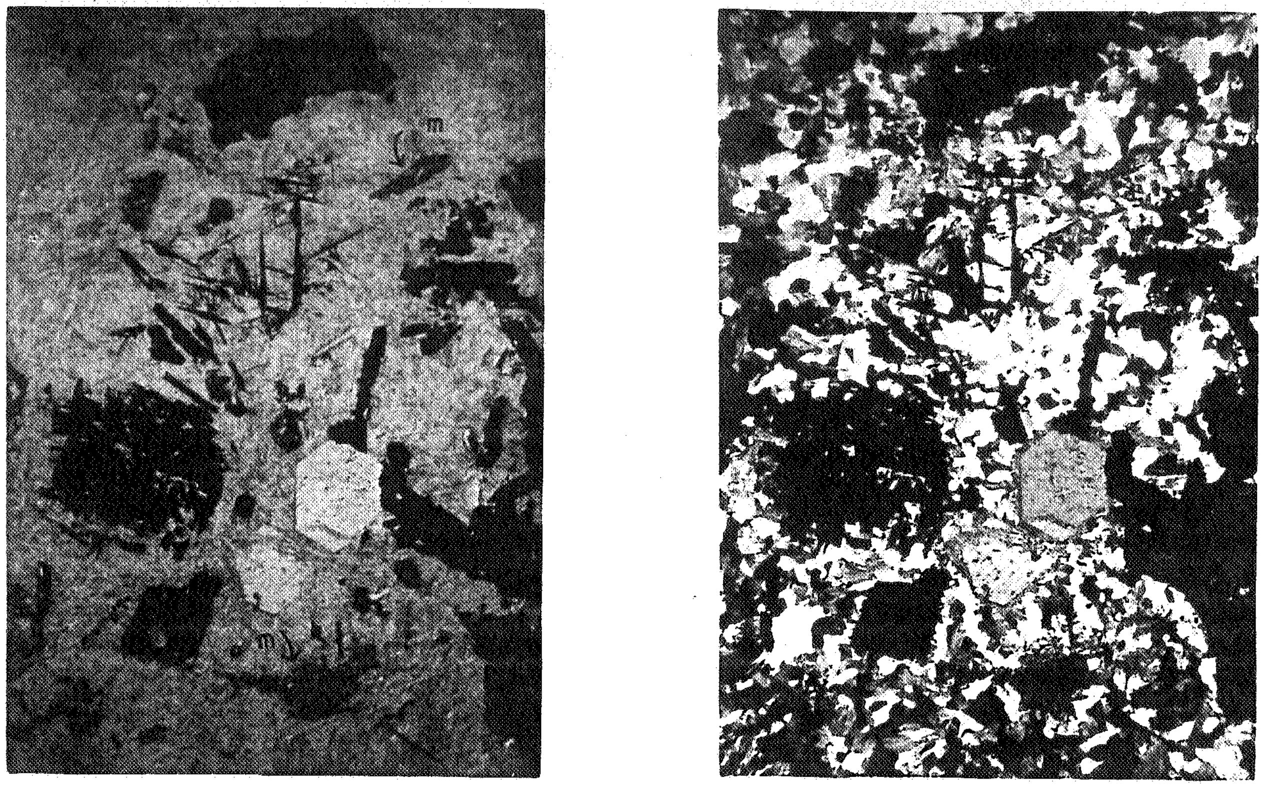
Samples P160-161/76

a. & b. TS36171 (P261/76 10 cm below contact with fine-grained sediment). Crossed nicols on right.

This shows aggregates of hematite (black), a few isolated crystals of specular hematite, euhedral quartz crystals (lower centre) and some monazite (M) in a matrix composed of intergrown quartz crystals. This matrix quartz has also penetrated the hematite aggregates.

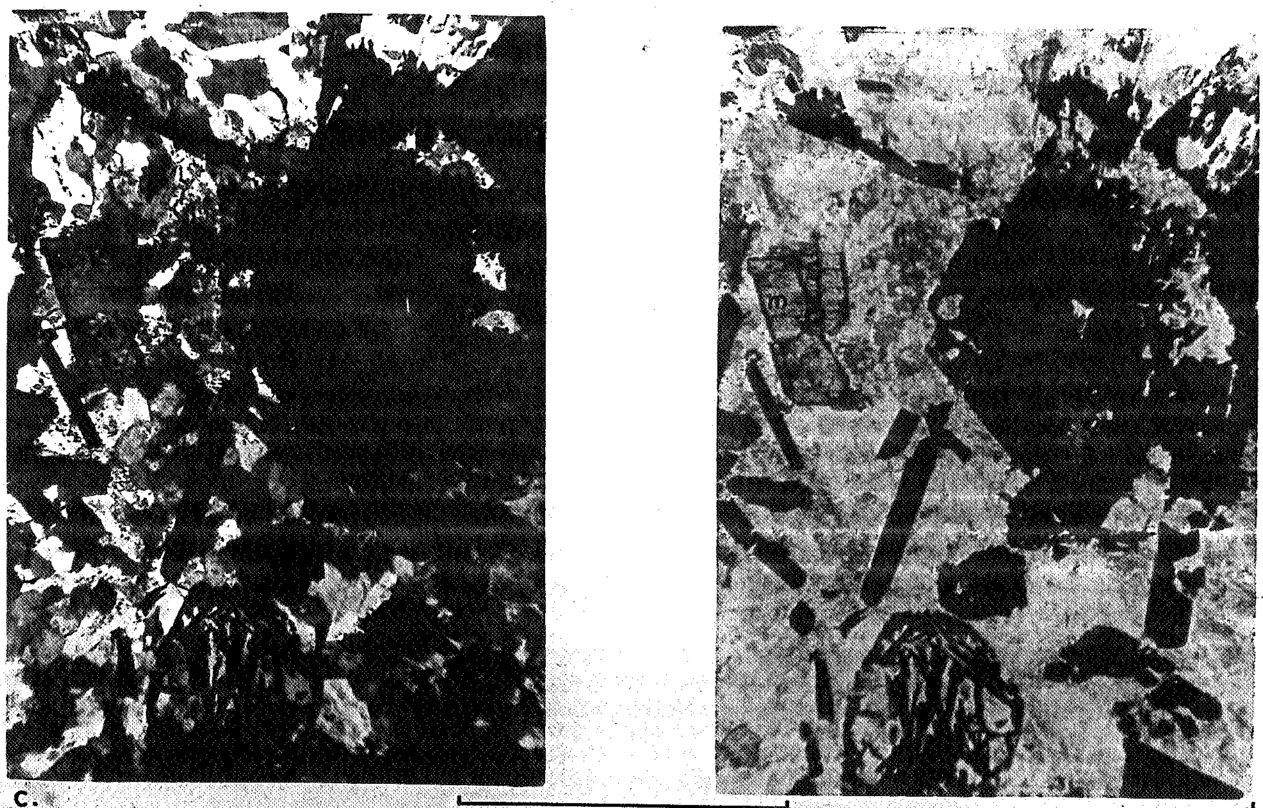
c. & d. TS36169 (P260/76 near contact with fine-grained sediment). Crossed nicols on left.

This zone shows some isolated specular hematite crystals some aggregates of hematite and one crystalline aggregate of monazite (grey in d) in a matrix of intergrown quartz crystals. The external shape of one hematite aggregate suggests that the hematite may have replaced carbonate.



a. 1mm b.

PLATE 1



c. 1 mm d.

PLATE 2

Sample P260/76

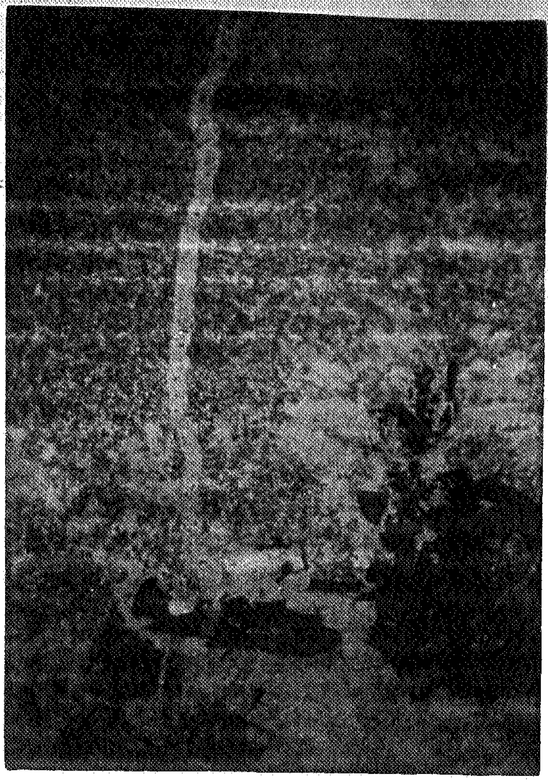
& b. TS36169 (P260/76). Crossed nicols on right.

Contact between coarse-grained, quartz-hematite rock and the overlying, finely laminated impure chert described in field notes as 'silty' layer. This chert does not contain relict silt-sized clastic detrital material but it is possible that the micro-crystalline quartz could have replaced an earlier chemical precipitate. The vein is of clear quartz unstained by the iron oxide present in the brownish pink chert.

& d. TS36170 (P260/76). Crossed nicols on right.

Transition from laminated, brownish pink-stained chert (above) to clear Mt. Gee-type quartz which encrusts the specimen (bottom). (The photographs are reversed in relation to a. & b.)

These textures suggest that the quartz crystallized early in the history of these sediments.

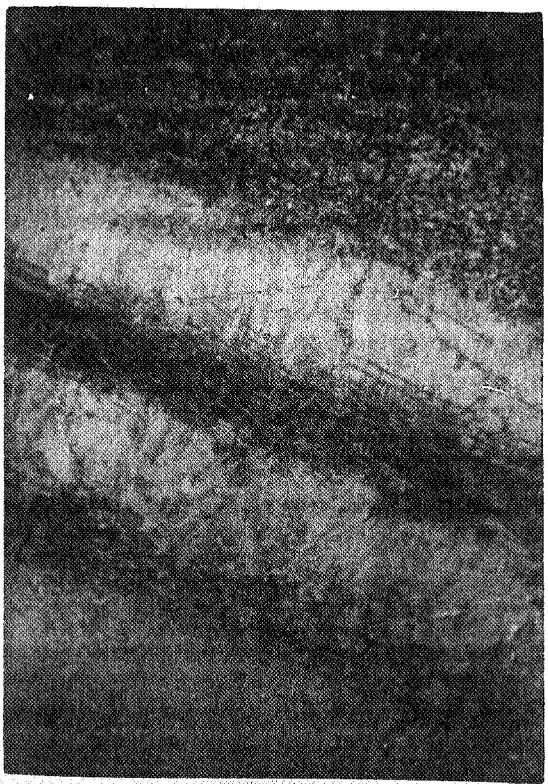


a.

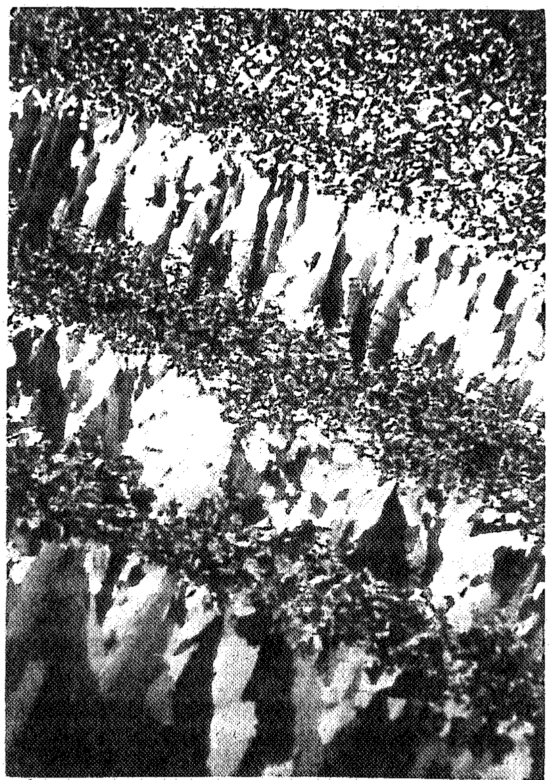
b.

1mm

PLATE 2



c.



d.

PLATE 3

Sample P262/76

TS26172

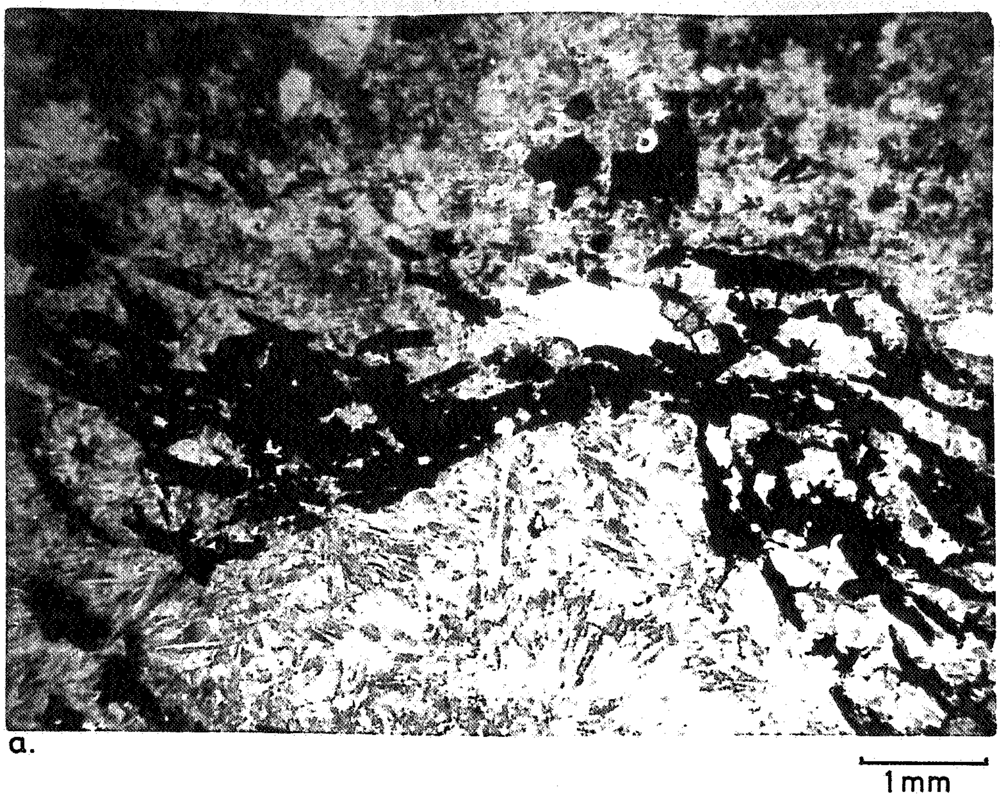
Contact between underlying layer of quartz-hematite rock and an overlying layer of impure ferruginous, pink-stained 'chert'.

Irregularities and undulations in the surface of quartz at the top of the quartz-hematite layer contain accummulations of apparently reworked fragments of hematite and monazite which are then overlain by the chert.

Fine, acicular relict textures are visible in some of the underlying quartz.

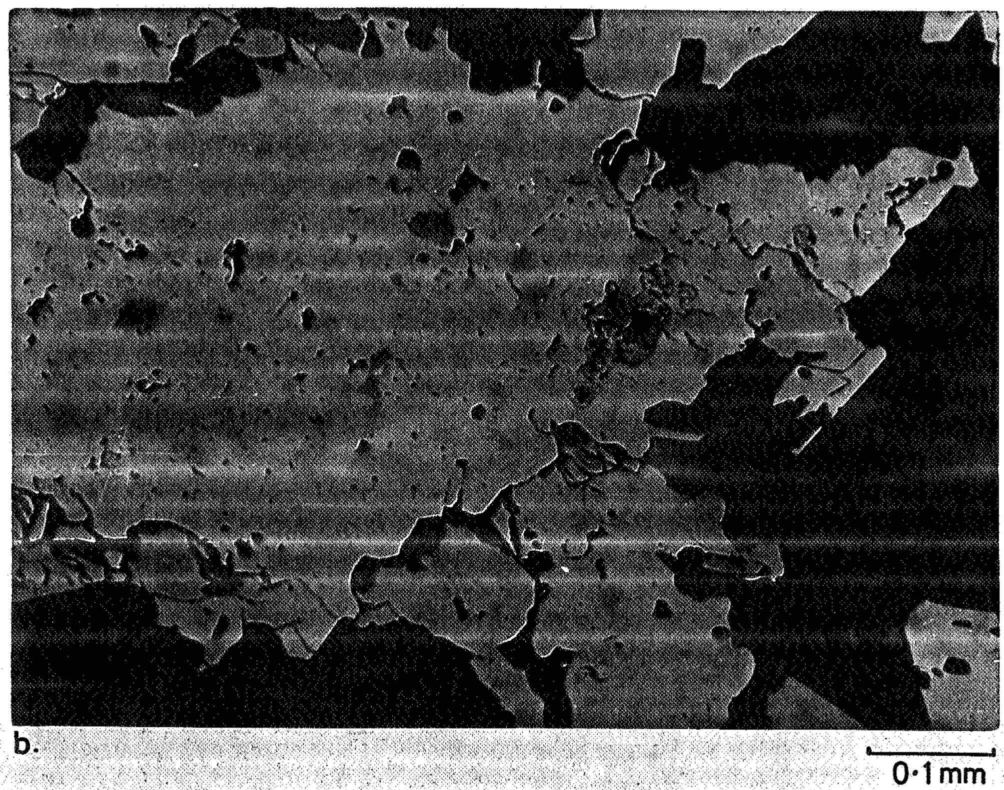
PS24980

Some of the hematite in quartz-hematite layers contains a few small remnants of magnetite (darker grey - just left of centre). Unidentified relict textures are also visible in some of the hematite (right of centre).



a.

PLATE 3



b.

PLATE 4

Sample P263/76, TS36173

a. General view of the base of the thick layer. This zone contains small fragments of reworked hematite, quartz and monazite. Above this there are larger aggregates of hematite which have replaced crystals of a mineral formed in a chemically precipitated sediment. Because much of this layer probably contained minerals which crystallized from a chemical precipitate the normal rules of graded bedding would not necessarily apply.

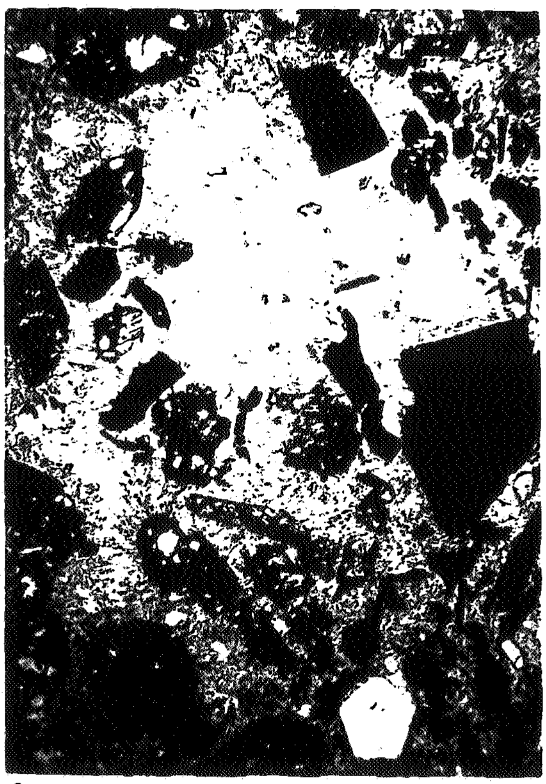
b. A former polygonal crystal which is now outlined by hematite and has been invaded and replaced by the matrix quartz (crossed nicols).

c. & d. General view of quartz-hematite rock containing aggregates of hematite, isolated crystals of hematite and euhedral quartz crystals in a matrix composed of intergrown quartz crystals.

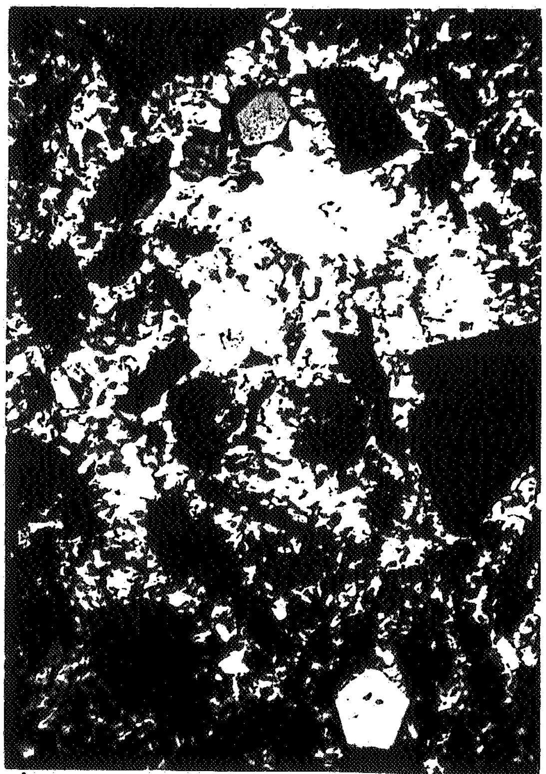
a. 1mm

b. 1mm

PLATE 4



c.



d.

1mm