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THE HEMATITE SHALE AT TENNANT CREEK

by

W. Oldershaw

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SUMMARY

The quartz-magnetite reefs at Tennant Creek are usually associated with a distinctive marker horizon called the Hematite Shale. Their relationships were mapped in detail in the Hammerjack-Skipper area and their petrography and content of trace elements was compared. The Hematite Shale appears to be a bedded iron deposit and is probably favourable for replacement by quartz-magnetite reefs when intersected by mineralised shears.

INTRODUCTION

The Hematite Shale is a distinctive silty shale containing thin crenulate beds of iron oxide less than 2 mm. thick (see plate II a & b). It ranges from 3 to 20 ft. in thickness and in some places there are two or three beds separated by beds of typical Warramunga greywackes and shales 3 to 4 ft. thick. The Hematite Shale is a hard silicified rock with a characteristic blocky mode of weathering. In places it contains disseminated pseudomorphs after magnetite octahedra.

The auriferous quartz-magnetite reefs at Tennant Creek usually occur close to the Hematite Shale. The Hematite Shale may merely be any thin bedded silty greywacke which has been selectively enriched by iron in the proximity of quartz-magnetite reefs. On the other hand, the beds of iron in the Hematite Shale may be primary. Therefore the Hematite Shale could be used as a marker horizon and its close association with the quartz-magnetite reefs suggests that it is a favourable horizon for the emplacement of Quartz-magnetite reefs.

The Hematite Shale and the quartz-magnetite reefs are well exposed in the Hammerjack-Skipper area (see plate 1) two miles south west of Tennant Creek. Structurally the Hammerjack-Skipper area consists of two major anticlinoria en echelon; the western one, in the Skipper area, plunging gently westwards and the eastern one, in the Hammerjack area, plunging gently eastwards at angles of up to twenty degrees. The dominant rock types are moderately folded greywackes, from one to four feet thick, dipping at angles up to forty degrees.

Although the greywackes and structures throughout the Hammerjack-Skipper area seem uniform, the quartz-magnetite reefs have a selective distribution: they occur only in the eastern two miles and the western mile of the area. Moreover they invariably occur close to the Hematite Shale which is similarly restricted to the extremities of the area. The quartz-magnetite reefs contain several gold mines; Hammerjack (recorded production 5,500 oz.); Mount Samuel (4,000 oz.), Westward Ho (700 oz.) and Skipper Extended (4,000 oz.).

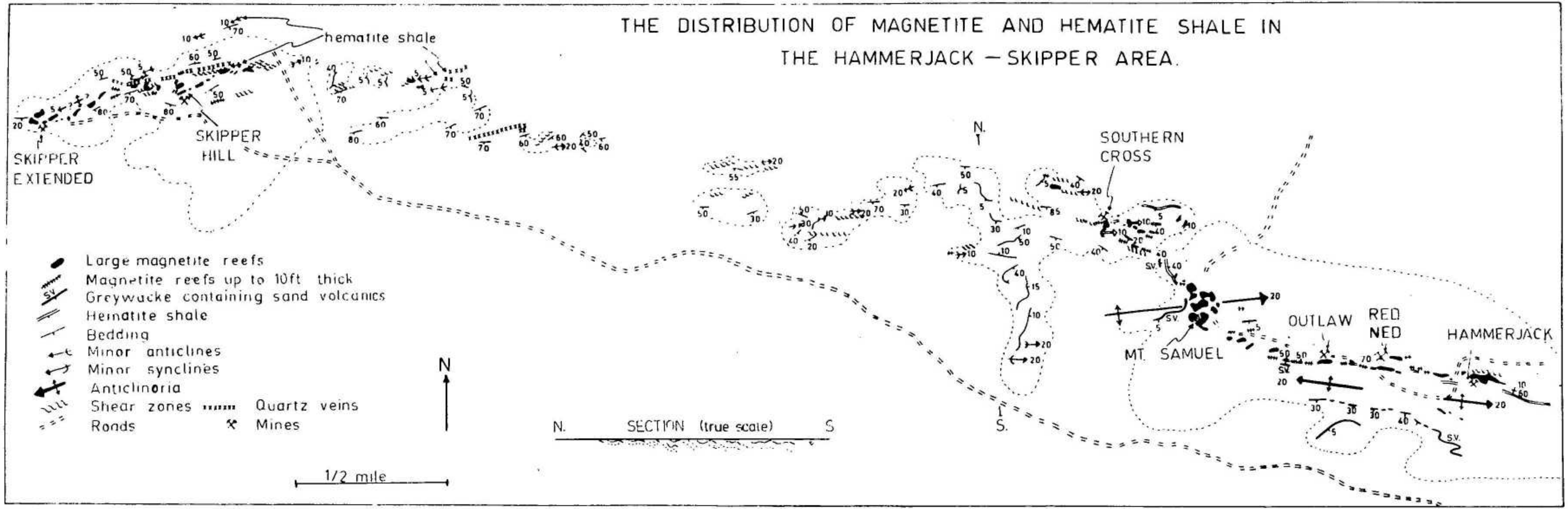
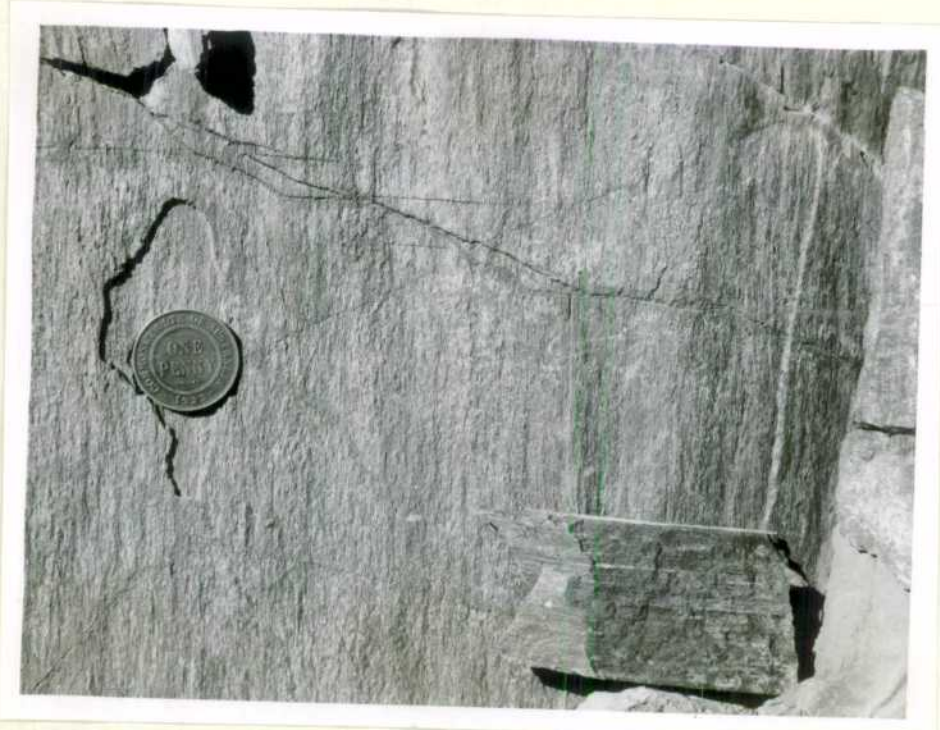

THE DISTRIBUTION OF MAGNETITE AND HEMATITE SHALE IN THE HAMMERJACK — SKIPPER AREA.
hematite shale
SKIPPER EXTENDED
SKIPPER HILL
SOUTHERN CROSS
MT. SAMUEL
OUTLAW
RED NED
HAMMERJACK
N.
S.
N
Large magnetite reefs
Magnetite reefs up to 10ft thick
Greywacke containing sand volcanics
Hematite shale
Bedding
Minor anticlines
Minor synclines
Anticlinoria
Shear zones
Quartz veins
Roads
Mines
N. SECTION (true scale) S
1/2 mile

PLATE II

a. Typical Hematite Shale. From the Big Ben Mine. Note regularity of the layering.



b. Bedding plane surface of Hematite Shale showing pronounced lineation produced by the intersection of the bedding and the axial plane cleavage.

THE HAMMERJACK-SKIPPER AREA

(a) The Greywackes

The greywackes in the Hammerjack-Skipper area vary both in lithology and in the thickness of individual beds. Some are coarse-grained grits showing graded bedding; others are laminated siltstones. A few beds, one to two feet thick, of black carbonaceous shale, were found on Skipper Hill.

There are two marker horizons; the first, the Hematite Shale, consists of alternating laminae of brown or black amorphous hematite and laminae of chert or silicified shale. The second marker horizon consists of two or three contiguous beds of graded greywacke whose top surfaces are crowded with small sand volcanoes. A few of the greywackes contain small irregular tubular concretions up to three inches long and a quarter of an inch across which may be infilled worm tubes. Several beds contain numerous round siliceous concretions up to one inch across.

Three exposures of micro-current bedding were found in thin siltstone beds at the tops of graded greywackes; the foresets all dipped westwards. Many of the greywackes have flute casts on their bottom surfaces. These flute-casts are always orientated east-west parallel to the strike. This, together with the evidence of current bedding, suggests that the turbidity currents depositing the greywackes were flowing from east to west along the axis of the postulated Warramunga Geosyncline.

(b) The Hammerjack Area

(i) Structure

The Hammerjack area consists of two anticlinoria en echelon. The Mount Samuel anticlinorium plunges gently eastwards and is delineated by the beds with sand volcanoes. The Hammerjack anticlinorium plunges gently westwards near Mount Samuel and gently eastwards at the Hammerjack. The beds of sand volcanoes are almost continuous along the southern flanks of both anticlinoria but are exposed at only one place along the northern flanks.

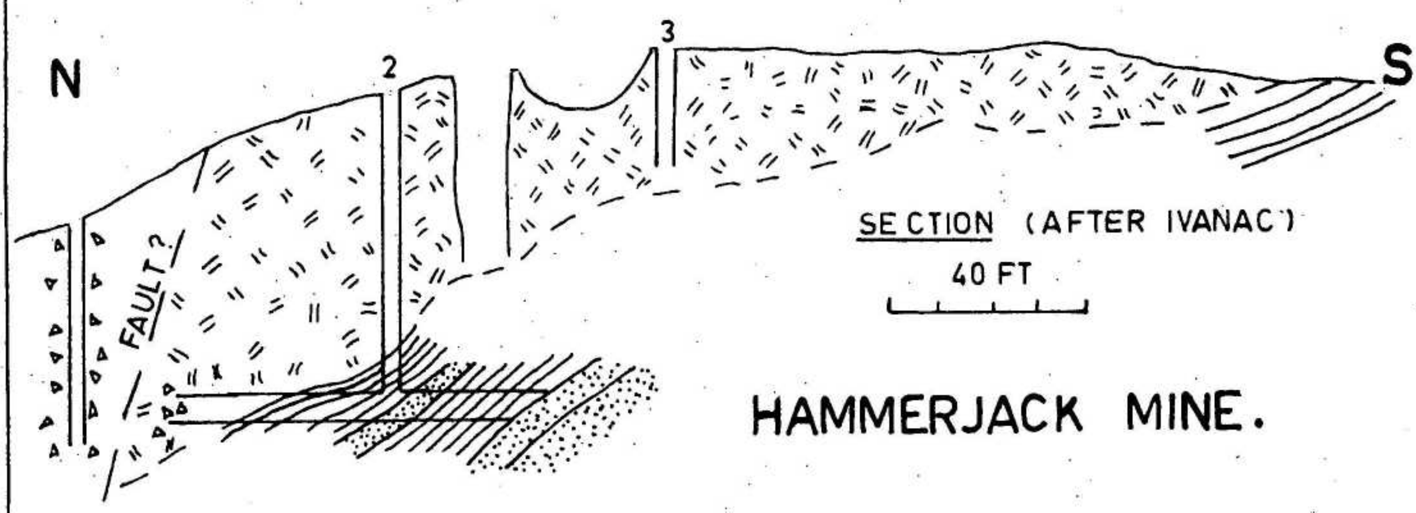
The Hematite Shale forms the more distinctive marker horizon and appears twenty to forty feet stratigraphically above the beds of sand volcanoes. Although the Hematite Shale has been traced one and a half miles from the Hammerjack to the Southern Cross mine, it has only been found on the northern flanks of the two anticlinoria. The southern flanks of the anticlinoria dip more gently than the northern and so the outcrop of the hematite shale along the southern flanks would be further away from the beds of sand volcanoes and may be hidden under the bulldust. On the other hand, the juxtaposition of the Hematite Shale and the beds of sand volcanoes along the northern flanks of the anticlinoria may be due to strike faults. The presence of such a strike fault or shear plane would explain the line of small hematite lenses up to ten feet thick which occurs along the outcrop of the Hematite Shale between the Hammerjack and Mount Samuel.

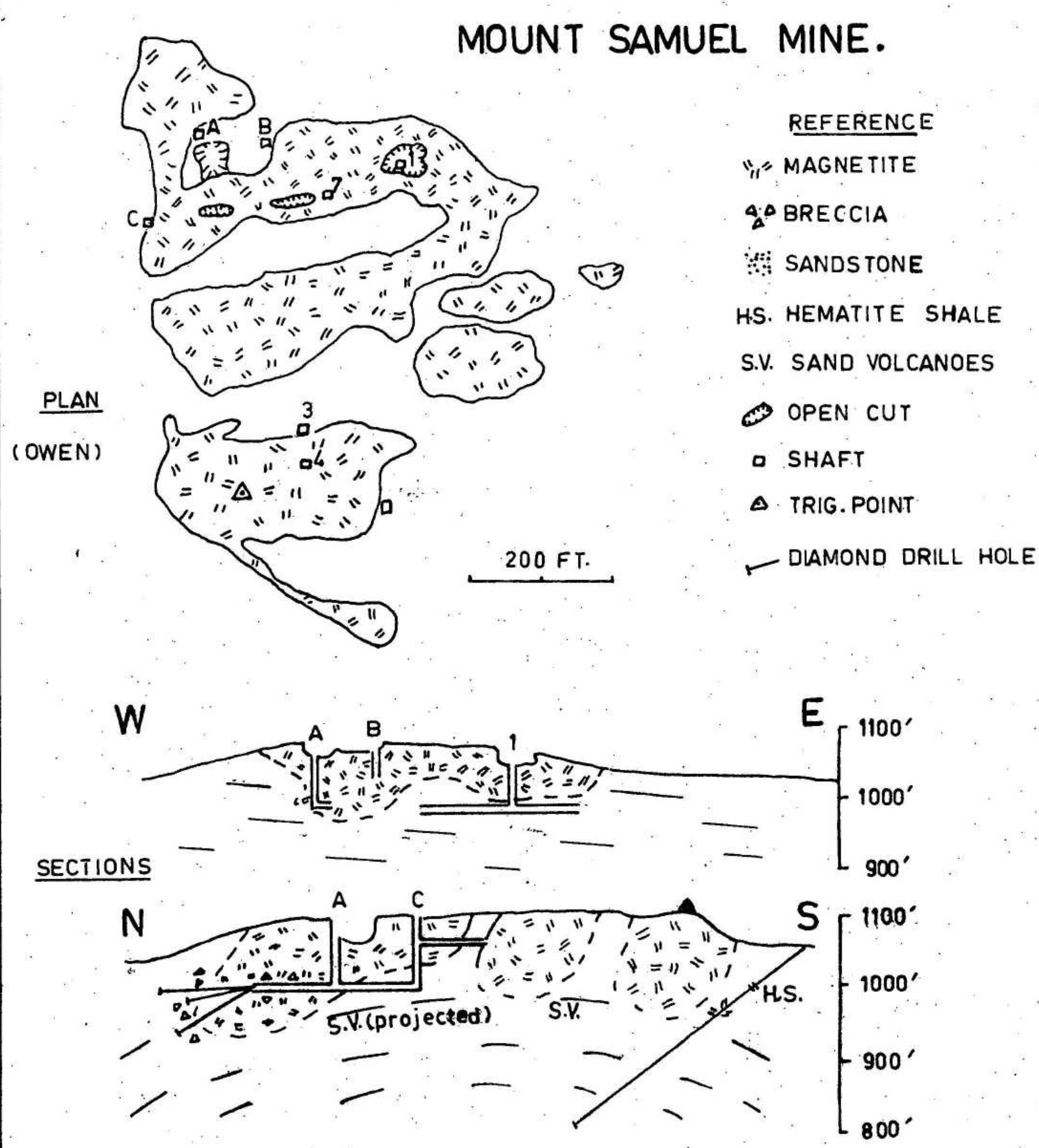
(ii) The Quartz-Magnetite Reefs.

The cliffs to the west of Mount Samuel cut across a gently folded anticlinorium which plunges eastwards at ten degrees (see plate 1). The strata exposed under the Mount Samuel quartz-magnetite masses are sub-horizontal (see plate 3). Although the quartz-magnetite masses are 200 yds across, all the bore holes and shafts sunk into them show that they are only about 90 feet thick. Therefore the quartz-magnetite appears to be in the form of a flat sheet conformable to the structure of the enclosing sediments. Although the nearby Hematite Shale cannot be traced into the magnetite, both appear to be at, or near, the same stratigraphic horizon.

At the Hammerjack Mine the quartz-magnetite reef occurs close to the hematite shale and appears to be emplaced on the northern limb of an anticline plunging gently eastwards. It can be seen in the mine workings that the base of the reef dips northwards parallel to the bedding of the underlying sediments (see plate 3). Three shafts, just to the north of the reef, show that the northern margin is a vertical or steeply dipping fault breccia. Therefore the reef appears to be a conformable sheet of quartz-magnetite which has been cut off along its northern boundary by a steep east-west fault (probably an extension of the fault postulated along the hematite shale outcrop). The position and the extent of the faulted-off block of magnetite to the north of the fault is of interest for it may contain ore-shoots as rich as those of the Hammerjack itself.

At the Southern Cross mine two lines of vertical magnetite reefs, six to ten feet thick, intersect (see photo plate V). A shaft sunk in the large magnetite lens which developed at this intersection appears to have passed through the magnetite; the underlying shales yielded 650 tons of gold ore averaging 9 dwt. This reef may therefore be only a flat lens, but the two lines of smaller reefs appear to be vertical though they may only extend a short distance downwards. The hematite shale is exposed over the whole of the flat-topped mesa as a gently undulating sheet containing numerous minor folds and puckers plunging east at 10 degrees. This is the most westerly exposure of hematite shale in the area and it is also the most westerly occurrence of any large quartz-magnetite reef. A small reef of quartz-magnetite was found in sub-horizontal strata a quarter of a mile to the west; but an adit driven in from the hillside to intersect this reef at a depth of a few feet passed under it showing that the quartz-magnetite is only a small lens conformable to the surrounding structure. A small symmetrical anticline to the west plunges 10° to 090 (see plate V). Its northern limb is cut by a vertical crush zone, ten feet thick, in which large blocks (three feet across) of micaceous hematite were found.


N
S
2
3
FAULT ?
SECTION (AFTER IVANAC)
40 FT
HAMMERJACK MINE.


MOUNT SAMUEL MINE.
REFERENCE
MAGNETITE
BRECCIA
SANDSTONE
H.S. HEMATITE SHALE
S.V. SAND VOLCANOES
OPEN CUT
SHAFT
TRIG. POINT
DIAMOND DRILL HOLE
A
B
C
1
7
3
4
PLAN
(OWEN)
200 FT.
W
E
1100′
1000′
900′
SECTIONS
N
S
S.V. (projected)
S.V.
H.S.
1100′
1000′
900′
800′

(c) Skipper Area.

(i) Structure

In the Skipper area the line of hills decreases in height and fades out westwards under the sand and gravel covered plain so that exposures are not as good as in the Hammerjack area. The Skipper area appears to consist of an anticlinorium which plunges gently westwards (see plate 4). An asymmetrical anticline exposed just to the west of Skipper Hill has a vertical southern limb while the northern limb dips at 50° (plate VI). There are numerous shear zones trending 080°. Three small outcrops of hematite shale were found on the northern limb of the postulated anticlinorium and a few sand volcanoes were found on one greywacke bed close to the hematite shale.

(ii) Quartz-Magnetite Reefs

A small patch of hematite shale rubble was found a mile to the east of Skipper Hill close to the easternmost quartz-magnetite mass of the Skipper Group. The quartz-magnetite occurs in a vertical shear zone in the core of a symmetrical anticline which plunges westwards at 5°. The quartz-magnetite is a vertical lens which pitches westwards at 5° and widens upwards from one foot thick at its lowest exposure to twenty feet thick fifty feet higher.

The quartz magnetite reefs at the Skipper have curvilinear cuspate outcrops which appear to follow the trend of the bedding round the noses of gently westward plunging anticlines (see Plate VI) and plates I and 4). There are three such cuspate groups of quartz-magnetite reefs each of which could be due to the intersection of a series of vertical shears trending 70-80° with a favourable horizon folded into a westward plunging asymmetrical anticline with a steep southern limb. One such anticline was found just to the west of Skipper Hill (see above). The occurrence of three such areas suggests either three favourable horizons or the repetition of one such horizon by faulting. If these assumptions are correct it may be that the long linear quartz-magnetite reefs (Plate VI) extend to some depth whereas the nodal masses are mainly flat-lying lenses. One of the quartz-magnetite reefs at Skipper Hill contains drusy cavities (sp. 149419) lined with micaceous hematite and bipyramidal quartz crystals, the later being the characteristic habit of high temperature quartz formed at over 573°C.

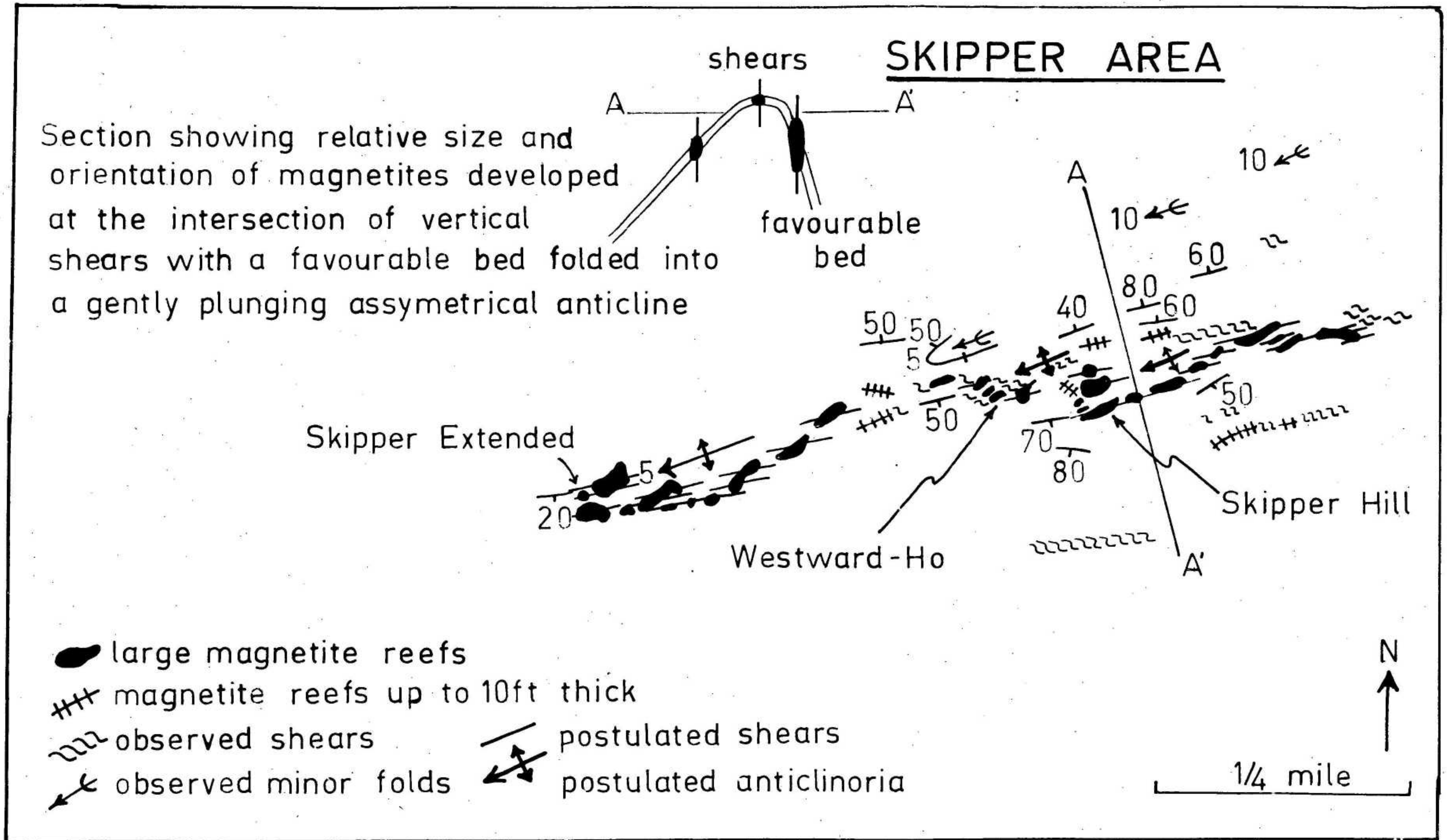
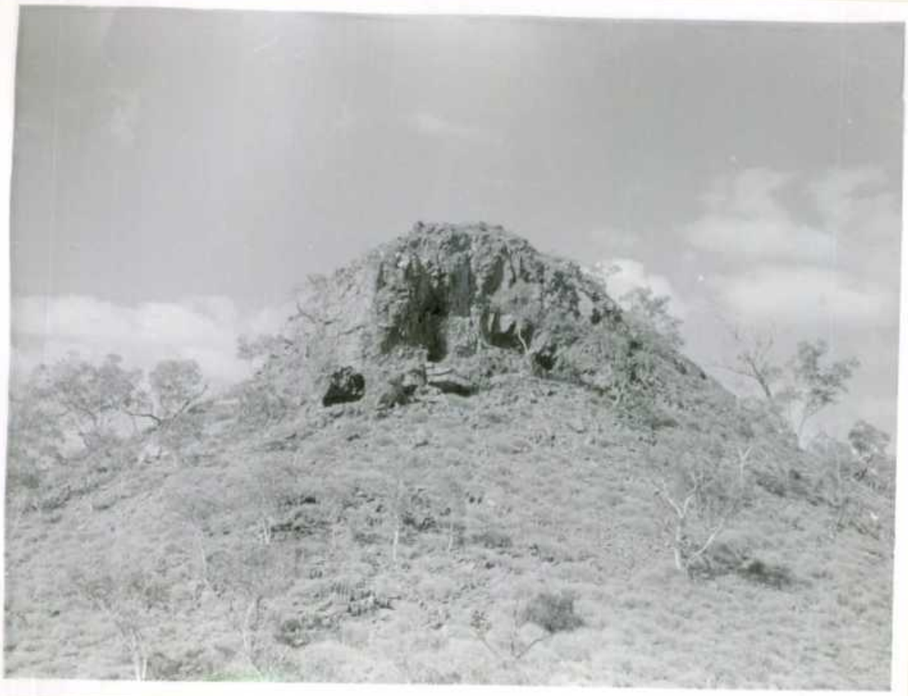

SKIPPER AREA
shears
A
A'
Section showing relative size and orientation of magnetites developed at the intersection of vertical shears with a favourable bed folded into a gently plunging assymetrical anticline
favourable bed
10
10
60
80
60
40
50
50
5
50
50
70
80
5
20
Skipper Extended
Westward-Ho
Skipper Hill
large magnetite reefs
magnetite reefs up to 10ft thick
observed shears
observed minor folds
postulated shears
postulated anticlinoria
N
1/4 mile

PLATE V

View eastwards from Mount Samuel along the Mount Samuel-Hammerjack line of quartz magnetite reefs. Eldorado Mine in the distance.

Looking west from Mt. Samuel. The two lines of vertical quartz-magnetite reefs intersect at the Southern Cross Mine.



Symmetrical anticline plunging east at 10° half a mile west of Mt. Samuel. The northern limb is cut by a vertical shear in which blocks of magnetite occur.

PLATE VI

Looking east along the Skipper quartz-magnetite reef towards Mount Samuel.

An asymmetrical anticline plunging gently westwards just to the north of the Westward Ho Mine.

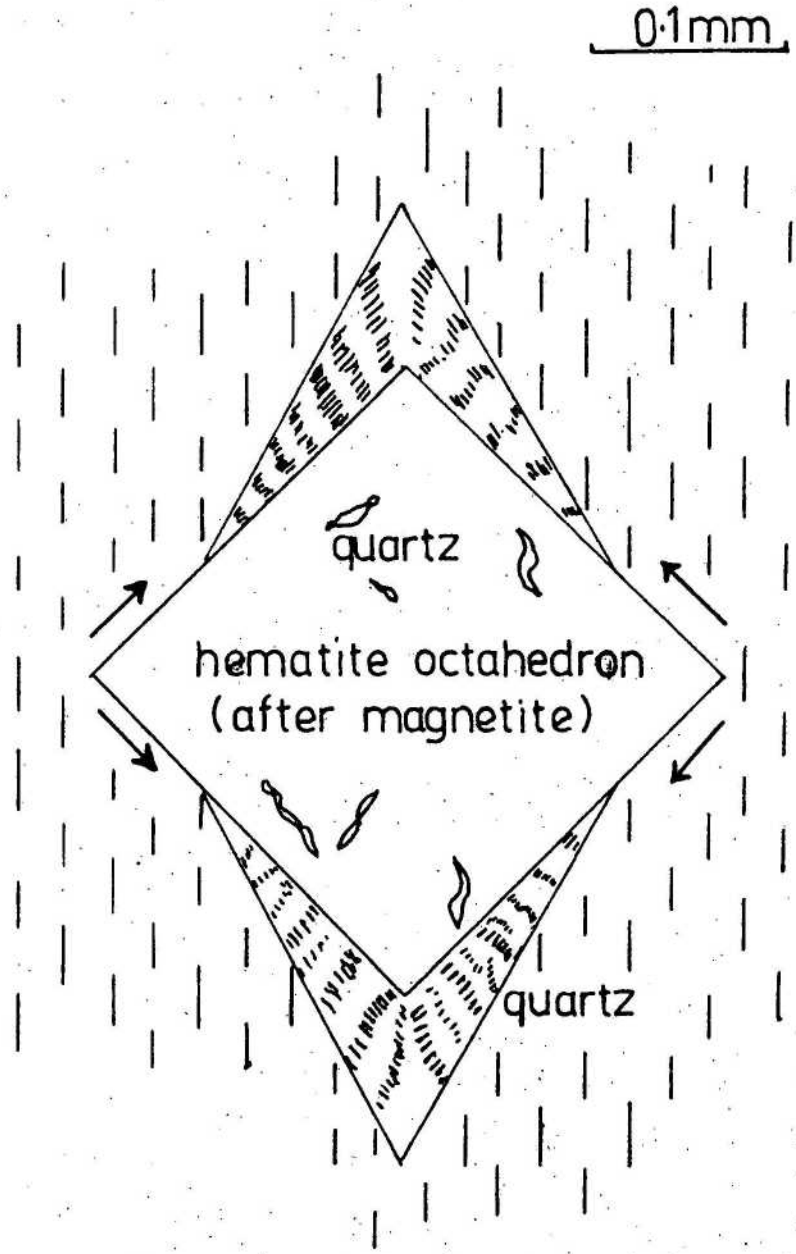


FIG. 1. Fractured octahedron of hematite after magnetite set in well foliated and cleaved sericitic siltstone.

PETROGRAPHY

Type Specimen of the Hematite Shale from Eldorado (sp. 196410)

It is a hard, blocky, silicified rock composed of alternating layers, usually less than 2 mm thick, of black and brown iron oxide and yellowish-buff siltstone and shale. The bedding appears very constant but is minutely crenulate, and there is a well marked cleavage and associated bedding/cleavage intersection lineation.

Under the microscope the rock is seen to consist of crenulate layers of black hematite and layers of silty shale. There is a well marked mineral foliation parallel to the axial plane cleavage, and the rock is packed with octahedra of hematite after magnetite, which form about 7% of the rock.

The sedimentary layers consist of siltstone, silty shale, and shale. Some of the silty layers appear to be graded, having a bottom zone of angular and sub-angular quartz grains up to 0.05 mm. across which passes up into a zone of minute quartz grains which, with increasing sericite, grades up into sericite shale. The silty shale layers consist of minute quartz granules set in a matrix of sericite flakes. These layers have a pronounced foliation parallel to the cleavage. The quartz grains are elongated, and the sericite flakes mostly extinguish parallel to the cleavage.

The layers of iron oxide range from barely visible bands up to layers 2 mm. thick. They are very persistent and even the thinnest layers extend across the thin-section. The layers, however, are very crenulate and often zigzag sharply. Limonite-staining extends outwards from the hematite layers into the neighbouring siltstone. Some of the thin bands consist of a single layer of minute granules of black iron oxide. The thicker layers consist of solid black hematite. Some layers consist of aggregated granules of hematite. The layers occur singly, in groups of a dozen of more, and in mixed groups of thick layers with several thin layers on either side of them. There appears to be no systematic alternation of the layers. The cleavage is not so prominent in the hematite layers as in the siltstone layers.

The hematite octahedra (after magnetite) range up to 0.3 mm. across. They do not seem to be concentrated in either the iron rich or iron poor layers and form about 7% of the rock. They are usually well shaped, though many of them are fractured. Most of them have small triangular areas of quartz along the faces normal, or at high angles, to the foliation of the enclosing sediment. At first sight the octahedra look as though they have been rotated and the resulting spaces along the octahedral boundaries filled with quartz. However the direction of rotation, supposing it to be such, is not constant. The sediments appear to have been compressed around the pre-existing magnetite octahedra and to have slipped or ridden up along the octahedral faces thus forming triangular voids which were later filled with minute quartz crystals growing normal to the octahedral faces. This shows that there was a pronounced period of movement after the formation of the magnetite octahedra.

Using the ore microscope it was seen that the octahedra of hematite after magnetite consist of a mosiac of several interlocking crystals of Hematite. W.M.B.R. suggests that the magnetite was retrogressively metamorphosed to hematite. However, the magnetite reefs in the area have been converted to hematite above the water table by normal weathering.

The grains of hematite in the hematite layers are so minute as to be beyond the resolving powers of the microscope. This may reflect the original grainsize of the layers or it may be a result of recrystallisation by weathering or metamorphism.

The degree of crenulation of the iron oxide layers and siltstone and shaly layers appears to be inversely proportional to the thickness of the layers. The very thin bands of minute iron oxide granules are much more crenulate than the 3 mm. thick layers of siltstone, yet all the layers are roughly concordant. The well marked mineral foliation is parallel to the axial planes of the crenulations and appears to be an axial plane cleavage. This foliation has a symmetrical orientation to the quartz fringes round the magnetite octahedra, and was probably formed at the time of the deformation of the octahedra. Therefore it would appear that the same movements were responsible for the crenulation of the strata, the development of the axial plane foliation, and the distortion of the magnetite octahedra and that they were later than the development of the magnetite octahedra. Yet the magnetite reefs at Tennant Creek were emplaced after the main period of folding.

There are two modes of occurrence of hematite in the Hematite Shale:-

(i) Hematite layers,

(ii) pseudomorphs of magnetite octahedra.

This suggests that there are two modes of origin. The magnetite octahedra are secondary and were formed from introduced iron or redistributed primary iron. The hematite layers are most probably primary for they alternate with layers of siltstone and shale and faithfully follow the crenulations of the adjacent beds. They are neither transgressive nor discontinuous.

C.S.I.R.O. Mineragraphic Rept. 626 contains a description of a "chlorite magnetite schist" from Peko Mine similar to a chlorite magnetite schist from Eldorado whose weathered outcrop is "thought to be" "a strikingly finely banded red and dark brown rock" which might be the Hematite Shale. The report mentions the constant association of the chlorite schist with bodies of magnetite and suggests that there may be a genetic relationship between them. The fresh chlorite schist is a "strongly cleaved, soft, blackish green rock which rubs to a light green mud on grinding. The rock consists of lenses of: massive chlorite, chlorite containing silt size quartz grains, chlorite slate and chlorite rich greywacke." It is "extraordinarily rich in ferrous iron", and it is suggested that it may be an altered basaltic ash. However, it seems very unlikely that such a chlorite schist composed of lenticles of various rocks could develop (even by weathering) the extremely finely laminated crenulate structure characteristic of the Hematite Shale.

The Hematite Shale is probably a bedded iron ore. It is considered that, during an early stage of mild metamorphism, part of the iron was redistributed to form magnetite octahedra. This was followed by a period of folding which gave the rock an axial plane foliation, distorted the magnetite octahedra, and retrogressively changed them to hematite. The final stage was the development of limonite staining around and within the layers of hematite.

Other Specimens of Hematite Shale.

The type Hematite Shale from Eldorado is a finely banded silicified siltstone containing bands of hematite and scattered, octahedral pseudomorphs of hematite after magnetite. The bedding is markedly crenulate and there is a pronounced axial plane cleavage. This bed of Hematite Shale can be traced continuously for three miles along the strike from Eldorado to Southern Cross Mine.

The Hematite Shale at Big Ben (sp. 149436) is similar to the type specimen. It consists of thin (less than 2 mm.) interbedded layers of hematite and sericitic siltstone which have been folded into minute drag folds (amplitude less than 3 mm.) overturned the same way. There has been some tectonic thinning and thickening and there is a well marked axial plane foliation. The magnetite occurs not as octahedra but as stretched and broken lenses conformable with the bedding; tension gashes in the lenses have been filled with quartz.

Sp. 97935 from near the Burnt Shirt Mine does not contain any magnetite octahedra or lenses. There appears to have been much redistribution of the iron in the rock, for the sericite flakes are extensively limonite stained and the thin-section is much darker than normal. The hematite layers are not very homogeneous, being quite irregular and often splitting into two, probably due to secondary solution and redistribution of the iron during metamorphism or weathering. The layers are very tightly folded - almost isoclinally in places - and there is a well marked axial plane cleavage.

Close to a small magnetite reef emplaced in the crest of a minor anticline in the Hematite Shale near the Southern Cross mine the Hematite Shale appears to pass into a breccia consisting of fragments of iron-impregnated siltstone (not banded) set in a matrix of micaceous hematite. The magnetite reef itself contains some finely laminated magnetite which looks like completely replaced Hematite Shale. A finely banded sooty blue-black hematite from Metallic Hill may also be Hematite Shale which has been almost completely replaced by iron oxide except for a few relict bands of siltstone. The rock contains hematite pseudomorphs after magnetite octahedra and transverse veins of magnetite or hematite.

Many other colour-banded laminated siltstones have been identified as Hematite Shale, but they do not contain any layers of solid hematite nor in many cases are the beds markedly crenulate. The colour-banding appears to be due to the varying content of limonite granules and stains in the different layers. These laminated siltstones differ from the contiguous greywackes in containing magnetite octahedra which form up to 10% of the rock. They may also be richer in hematite and limonite.

One example is the probable Hematite Shale (149463) from Town Hill near the Wheal Doria magnetite reef. The rock consists of layers of fine-grained sericitic siltstone with a few bands of coarser-grained siltstone. The bedding is markedly crenulate and there is a pronounced axial plane foliation. The colour banding is due to lines and layers of limonite granules and stains and hematite grains parallel to the bedding. The rock contains up to 10% of magnetite octahedra most of which show pressure fringes of quartz along the faces more or less normal to the foliation. The limonite banding emphasises the original bedding and could be due to re-distribution of scattered primary iron, or perhaps secondary introduced iron, during metamorphism or even weathering. Some limonite occurs along the cleavage.

TRACE ELEMENTS IN THE HEMATITE FROM THE HEMATITE SHALE AND FROM THE WEATHERED PARTS OF THE QUARTZ-MAGNETITE REEFS.

Specimens of the hematite layers and the hematite pseudomorphs after magnetite octahedra in the Hematite Shale together with specimens of the quartz-magnetite reefs were spectrochemically analysed by A.D. Haldane to determine from the trace elements if the iron in both rocks is consanguineous. All the specimens were collected from surface outcrops, so the effects of surface leaching if any should be similar in all the specimens.

Assuming the hematite in the Hematite Shale to have been introduced from the nearby quartz-magnetite reefs then both should contain the same suite of trace elements. If on the other hand, the hematite in the Hematite Shale shows a different suite of trace elements then separate origins are indicated. Furthermore a comparison between the trace elements found in the hematite layers and the magnetite octahedra of the Hematite Shale should show whether the magnetite octahedra were introduced from the quartz-magnetite reefs or were formed by the redistribution of the primary iron in the Hematite Shale.

Three specimens of the Hematite Shale were crushed and pure samples of hematite separated out on a "Superpanner". Sp 4545 contained only hematite pseudomorphs of the magnetite octahedra, Sp 97935 contained only layers of hematite, whereas Sp 196410 (the type specimen) contained both octahedra and layers. Sp.s 52, 52A were taken from the Mt. Samuel quartz-magnetite reef and Sp 149419 was taken from the Skipper Hill quartz-magnetite reef. The latter reef contained drusy cavities lined with high-temp. quartz and micaceous hematite.

As can be seen from the table of results below, the magnetite octahedra and the hematite layers from the Hematite Shale contain substantially the same trace elements but they differ markedly from the quartz-magnetite reefs. The Hematite Shale contains Cr and Mn which are absent from the quartz-magnetite reef samples, while only the latter contain Bi, W, Ge. The Bi and W content of the reefs is significant as they are regarded as typical epithermal elements and no trace of them was found in the Hematite Shale. An unexpected feature is the purity of the magnetite from the reefs. Although the specimens were taken from reefs which contained rich shoots of gold with traces of silver and also veins of copper ore, the samples of magnetite tested contained very little or none of these metals (e.g. up to 2 ppm Cu).

It can be concluded from these preliminary results that the iron oxides in the Hematite Shale and the quartz-magnetite reefs are from two different sources. Further the iron oxide in the Hematite Shale is most probably syngenetic while that of the quartz-magnetic reefs is epigenetic. The magnetite octahedra in the Hematite Shale were apparently formed by redistribution of the primary iron in the shale during a period of mild metamorphism.

SPECROCHEMICAL ANALYSES

SP.	52A	Magnetite reef from Mt. Samuel Tennant Creek
	52B	" " " " " " "
	149419	Magnetite reef from Skipper mine Tennant Creek
	4545	Hematite Shale, Magnetite octahedra
	97935	Hematite Shale, Hematite layers.
	196410	Hematite Shale, Octahedra and layers mixed.

Fe, Al, Si, Ti, present in all samples.

	Magnetite Reef			Hematite Shale		
	52A,	52B,	149419	4545	97935,	196410
K	3	2	3	5	4	3
Ca	4	4	5	4	4	4
Sr	0	0	2	1	1	0
Ba	0	0	0	3	0	0
Ag	0	0	0	3	0	0
Cu	6	7	6 - 2 ppm	7	6	5
Pb	2	2	2	3	4	2
Sn	3	4	1	3	1	2
Bi	3	5	0	0	0	0
In	2	0	2	0	2	1
Cr	0	0	0	5	3	4
V	0	1	3	2	2	3
Mn	0	0	0	2	7	2
Co	0	1	0	1	1	1
Ni	1	2	2	2	3	2
W	4	1	3	0	0	0
Mo	5	5	4	2	1	2
Ge	1	1	0	0	0	0
	Bi, W, Ge, Mo			Cr, Mn, (Ba), (Ag)		

The numbers are the relative intensities for a given element and are comparable between samples but are not comparable between the different elements.

CONCLUSION

Although the Hematite Shale usually occurs close to the quartz-magnetite reefs the trace element analyses show that neither the hematite layers or magnetite octahedra in the shale were derived from the reefs. The iron layers in the Hematite Shale appear to be primary for they closely follow the bedding of the shale. The hematite has not been introduced along favourable horizons because the hematite layers follow isoclinal folds and detached limbs and nowhere follow thrusts or the axial plane cleavage or cross from one bed to another or bifurcate.

The octahedra of magnetite in the Hematite Shale are obviously secondary. They were probably formed during a period of mild metamorphism of the shale. They were later deformed and recrystallised by movements which produced the crenulations and the axial plane foliation of the shale.

The Hematite Shale is a distinctive marker horizon and has been traced continuously for four miles eastwards along the strike from the Southern Cross mine past the Hammerjack mine to the Cats Whiskers mine. It has been found elsewhere in the goldfield and has been traced for various distances along the strike.

The close association of the quartz-magnetite reefs with such a syngenetic iron deposit is unusual. The Hematite Shale may be a "favourable horizon" which is easily replaced by quartz-magnetite reefs when intersected by a mineralised shear, or it may be close to such a horizon. The shape and extent of the quartz-magnetite masses appear to depend on the attitude of the Hematite Shale relative to the mineralised shear and to mainly follow the structure of the Hematite Shale.

This close association of quartz-magnetite and hematite shale provides a means of delineating other areas favourable for the occurrence of large masses of quartz-magnetite. Also the structure of buried parts of exposed quartz-magnetite reefs can be predicted by a study of the local bedding/shearing relationships.

Even more important is that if the structure of the nearby hematite shale is known, the shape and attitude of a buried mass of magnetite detected by a magnetometer can be predicted. Calculations can be made based on these postulated shapes of the magnetite mass, instead of the conventional sphere, and checked with the observed anomaly to determine the depth and size of the magnetite mass.

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