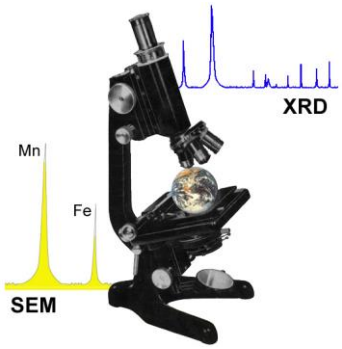

Roger Townend and Associates
Consulting Mineralogists

Unit 4, 40 Irvine drive, Malaga Western Australia 6062
Phone: (08) 9248 1674 Fax: (08) 9248 1502
email: rogertownend@westnet.com.au

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BLIGH RESOURCES LTD,

84 PITT STREET

SYDNEY

NEW SOUTH WALES 2000

Our reference 23302

MINERALOGICAL EXAMINATION OF FOUR ROCK SAMPLES BY OPTICAL/SEM/XRD METHODS WITH REFERENCE TO MANGANESE.

Roger Townend

Correspondence to Box 3129, Malaga D.C. WA 6945
ACN 069 920 476 ABN 92 076 109 663

SAMPLE BC 11 12001

ROCK SPECIMEN fine grained black rock with pink carbonate veins (7.5%Mn 4.1%Fe)

POLISHED THIN SECTION./XRD/SEM

CARBONATE	MAJOR
QUARTZ	ACCESSORY
POTASH FELDSPAR	ACCESSORY
MUSCOVITE	TRACE
PYROLUSITE	ACCESSORY
CRYPTOMELANE/ROMANECHITE ?	ACCESSORY
GOETHITE	ACCESSORY
VEINS	
CARBONATE	

CLASSIFIED AS A SILICEOUS FERRUGINOUS LIMESTONE CONTAINING MANGANESE OXIDES.

The dominant lithology is a fine-grained calcite that is obscured by the extent of the oxide impregnation particularly goethite.

Silicates are confined to fine-grained sporadic quartz, potash feldspar and fine muscovite within the carbonate matrix. There are areas of low carbonate composed of quartz and mica with elevated manganese, some iron and barium. There are sporadic calcite veins

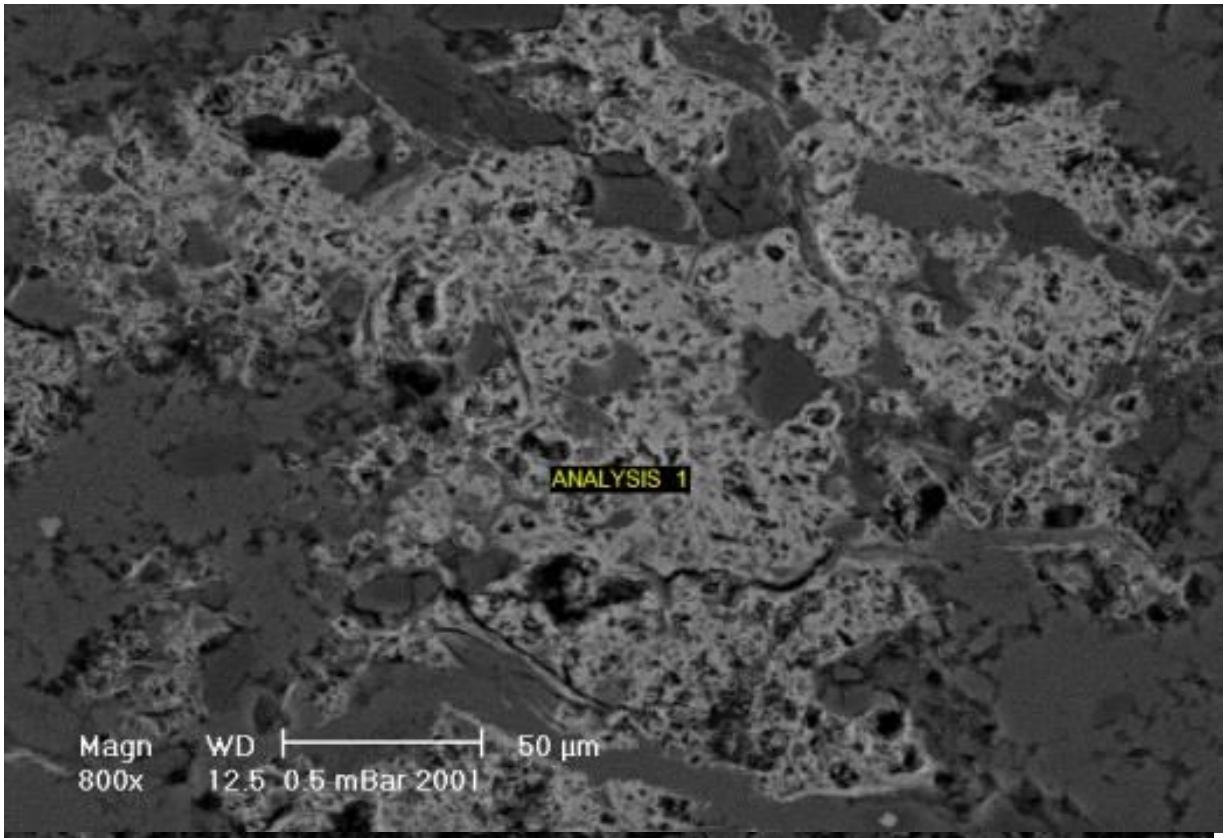
MANGANESE ORES

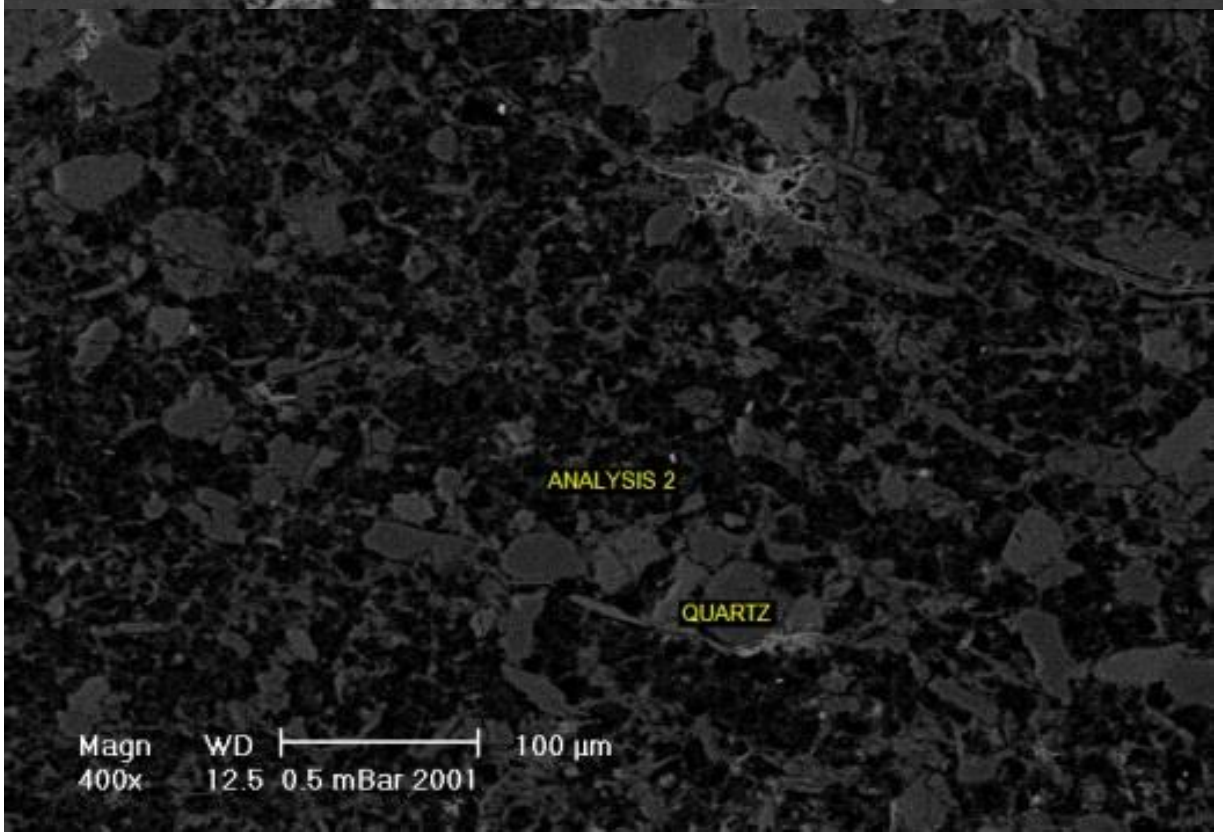
The manganese oxide group is present as loose networks sporadically throughout the ferruginous calcite matrix. The most extensive examples reached 500 µ.

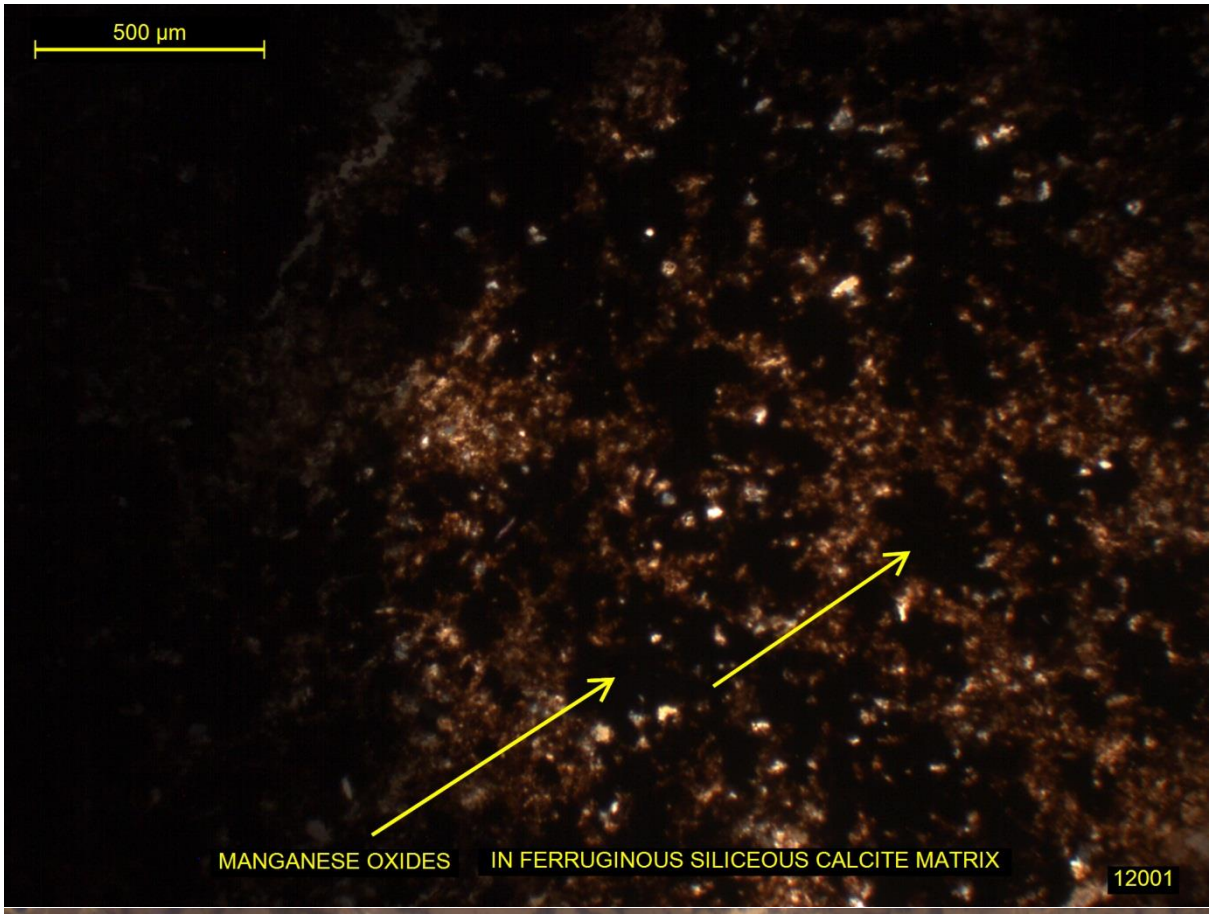
Examination by XRD identified pyrolusite. Examination by SEM/EDS indicated the presence of potassium and barium manganese oxides as shown in analysis AI below. The common forms of these oxides, as found in some of the other samples, cryptomelane and romanechite, not detected by the XRD scan.

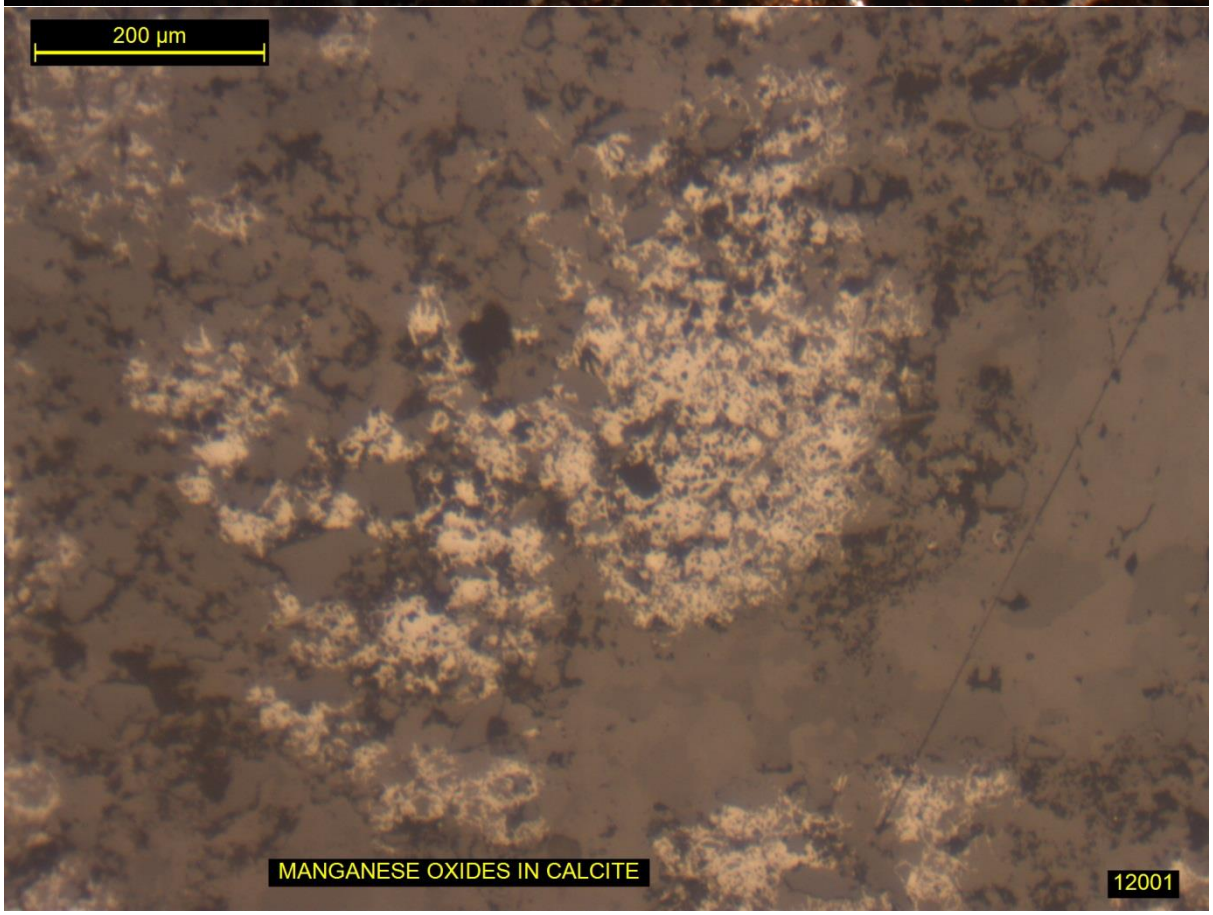
SEM/EDS ANALYSES (see SEM images)

WT%	A1	A2
MgO		3%
Al2O3		13.4%
SiO2		56.4%
K2O	5.1%	5.3%
CaO		1.2%
BaO	4.4%	2.2%
MnO	85.8%	14.2%
FeO	4.7%	4.3%


ANALYSIS 1
Magn WD 50 µm
800x 12.5 0.5 mBar 2001


ANALYSIS 2
QUARTZ
Magn WD 100 µm
400x 12.5 0.5 mBar 2001


500 µm
MANGANESE OXIDES
IN FERRUGINOUS SILICEOUS CALCITE MATRIX
12001


200 µm
MANGANESE OXIDES IN CALCITE
12001

SAMPLE BC 11 12002

ROCK SPECIMEN pale orange fine-grained carbonate with bands and patches of black oxide . (20.1% Mn 19.7 %Fe)

POLISHED THIN SECTION/XRD/SEM

CALCITE	DOMINANT TO MINOR
QUARTZ	ACCESSORY
MICA	ACCESSORY
CRYPTOMELANE	ACCESSORY
ROMANECHITE	ACCESSORY
GOETHITE	MINOR
VEINS	
CARBONATE	DOMINANT
BARITE	ACCESSORY TO TRACE

CLASSIFIED AS LIMESTONE HOSTING MANGANESE OXIDES WITH NUMEROUS CALCITE VEINS.

The limestone slide is about 50% composed of a high density of oxides , and 50% of a low density oxides.

The low density area contains extensive earthy goethite impregnation, with sporadic 100-200 µ patches of manganese oxides. The high density areas are major goethite and manganese oxides . .

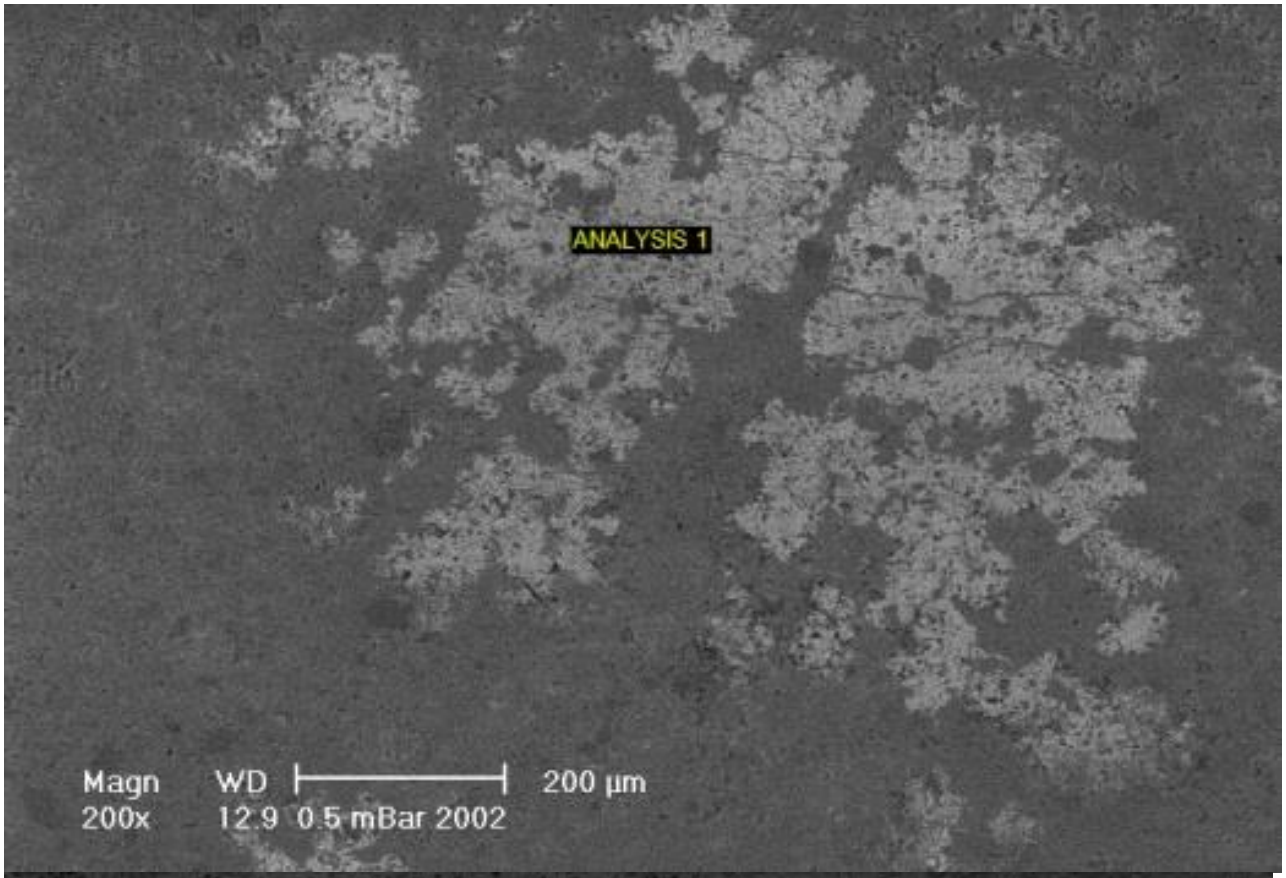
There are several generations of carbonate veins and some contain concentrations of barite.

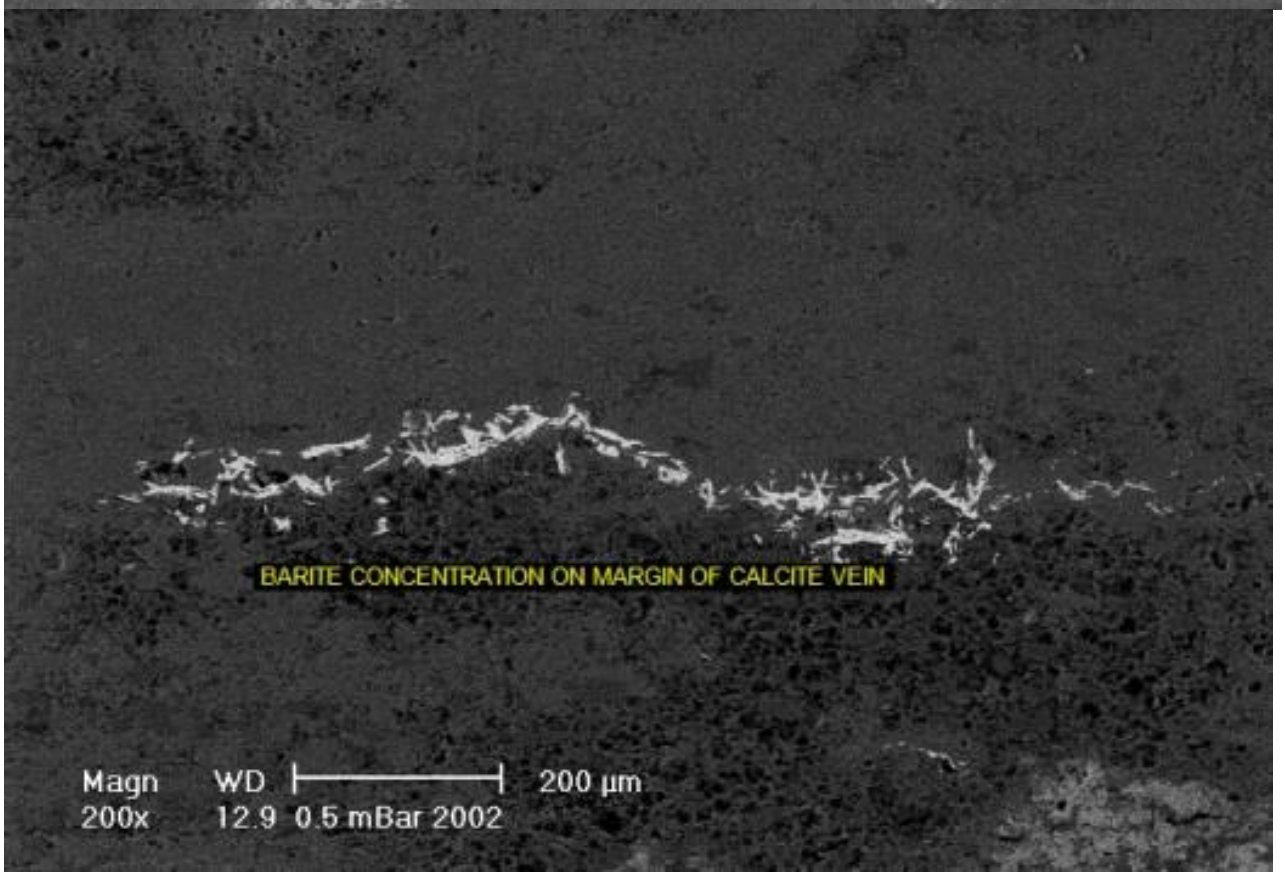
MANGANESE ORES

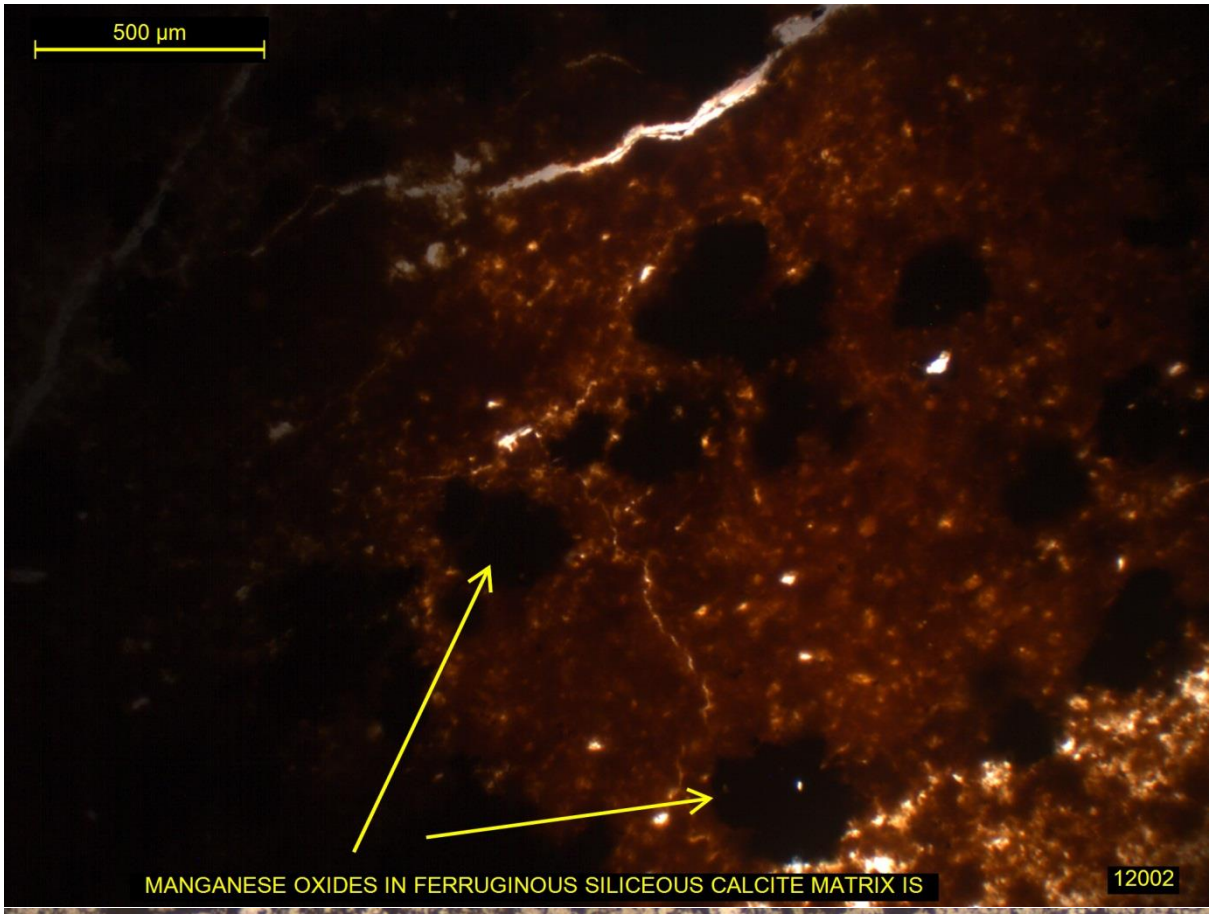
The manganese oxides are present as irregular patches to 500 µ within the ferruginous and siliceous calcite matrix. The XRD analysis identified cryptomelane and romanechite, which appear to be finely intergrown as suggested by the analysis below.

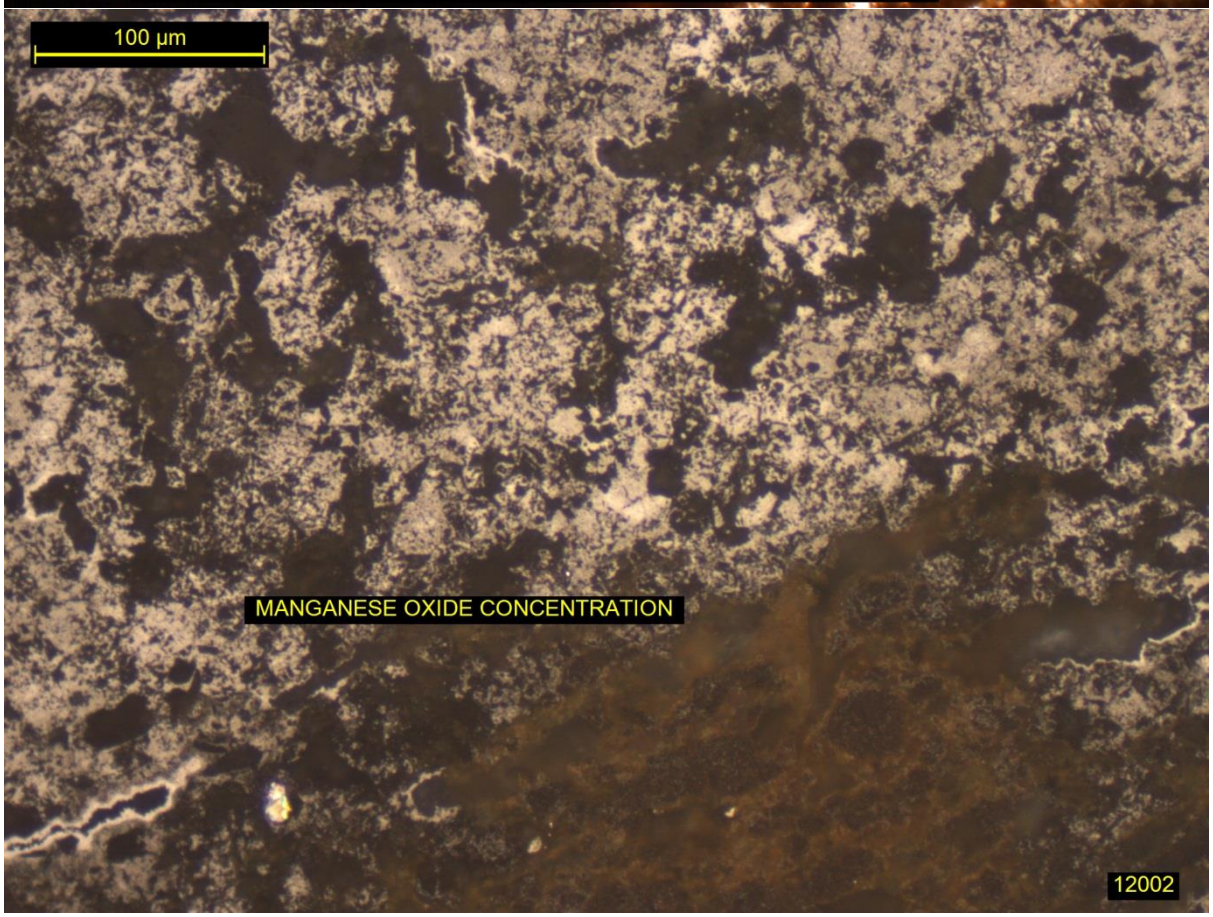
SEM/EDS analysis (see SEM image)

Wt%	
K2O	2.3
BaO	15.2
MnO	70.9
FeO	11.6


ANALYSIS 1
Magn WD 200 µm
200x 12.9 0.5 mBar 2002


BARITE CONCENTRATION ON MARGIN OF CALCITE VEIN
Magn WD 200 µm
200x 12.9 0.5 mBar 2002


500 µm
MANGANESE OXIDES IN FERRUGINOUS SILICEOUS CALCITE MATRIX IS
12002


100 µm
MANGANESE OXIDE CONCENTRATION
12002

SAMPLE BC 11 12004

ROCK SPECIMEN black massive manganese oxide with white carbonate veins (20%Mn 19.7%Fe)

POLISHED THIN SECTION/XRD/SEM

CALCITE	MINOR
QUARTZ	ACCESSORY
MICA	ACCESSORY
CRYPTOMELANE	MINOR
ROMANECHITE	MINOR
GOETHITE	MAJOR
VEINS	
CARBONATE	

CLASSIFIED AS A BANDED IRON MANGANESE OXIDE MINERALISED LIMESTONE

Within the fine oxide/carbonate matrix there is a centimetre length lens of predominantly goethite and fine quartz. Quartz otherwise was only identified by SEM or XRD.

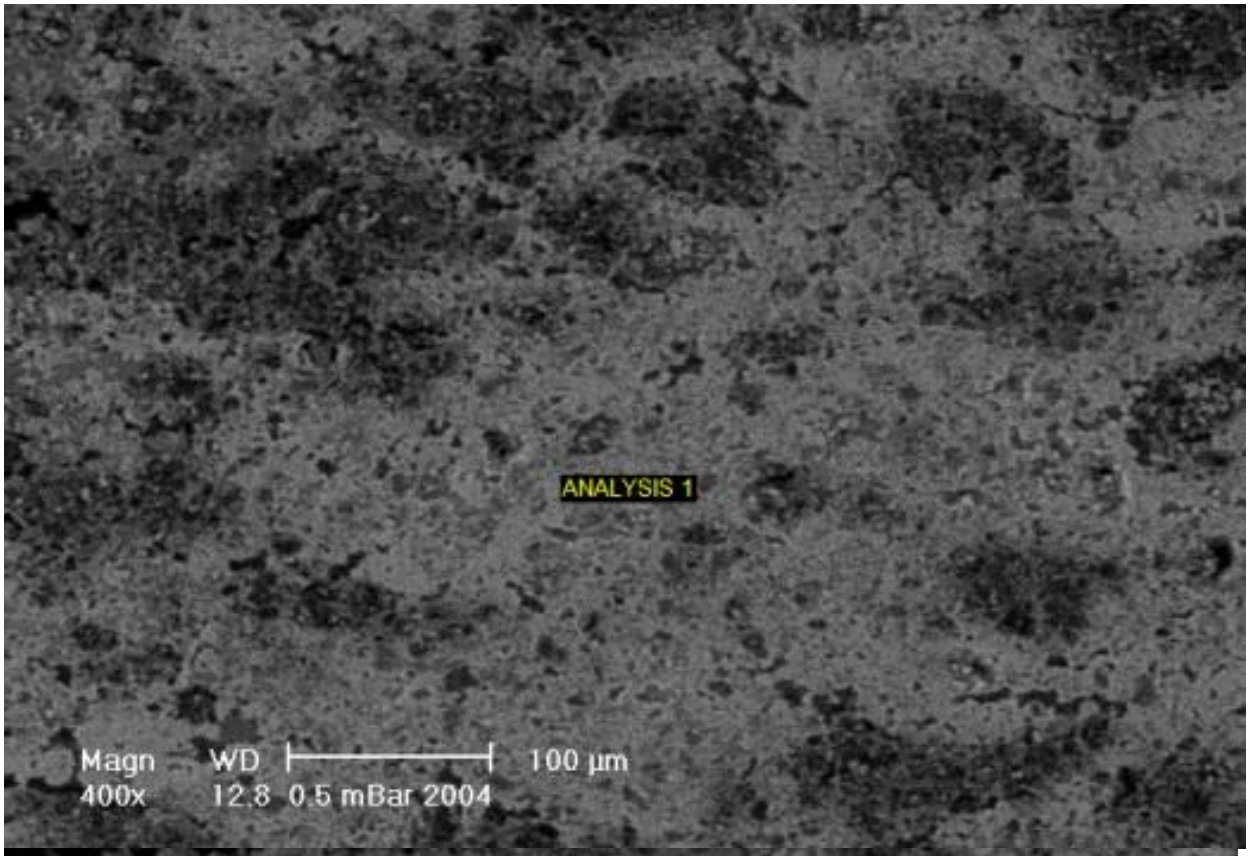
There are occasional discontinuous calcite veins through the oxides. Goethite appears to be present within the manganese rich and manganese poor areas of the matrix.

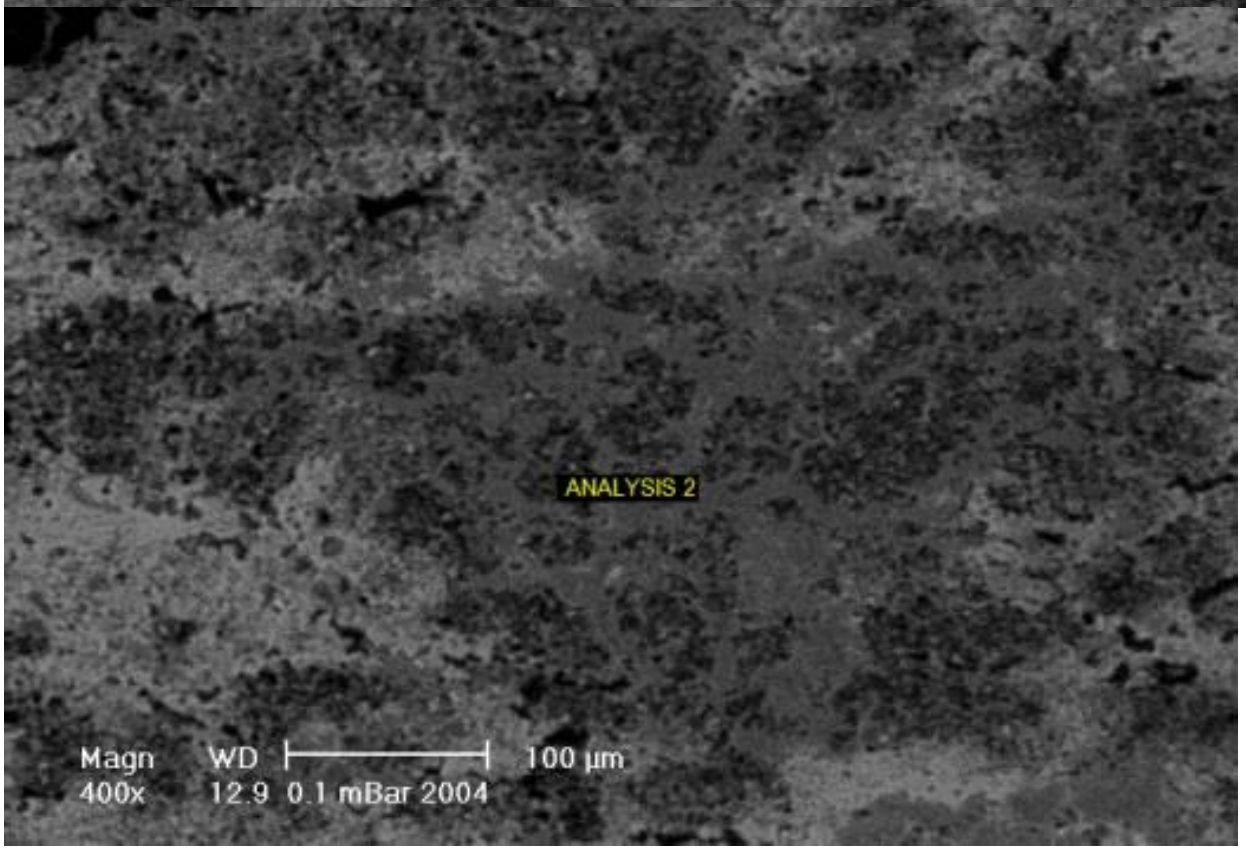
MANGANESE ORES

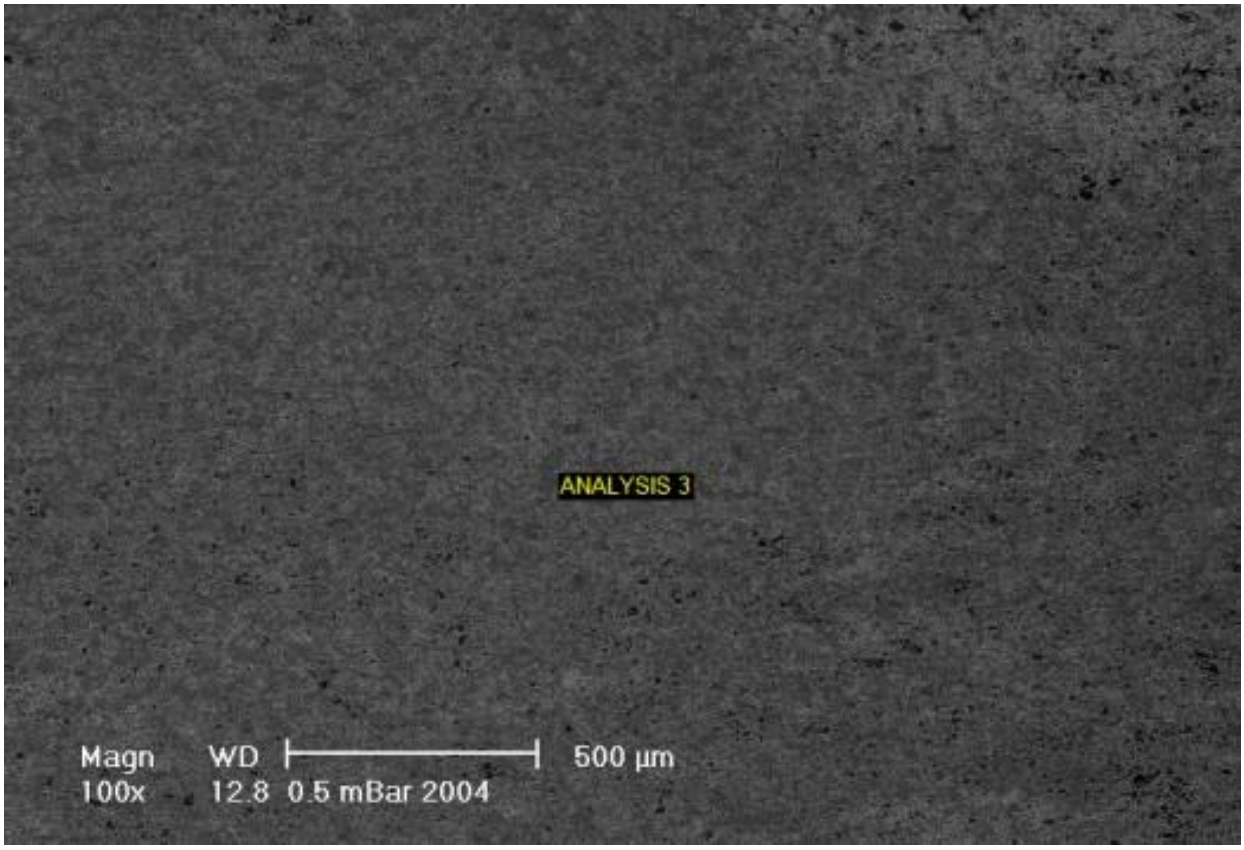
The manganese ores identified (XRD/SEM) occur as areas of dominant pervasive microcrystalline material, (analysis 1). varying to patches within complex areas of barium free manganese oxides with calcite and silicates, (analyses 2 and 3). As for the previous sample, the manganese oxides appear finely intergrown.

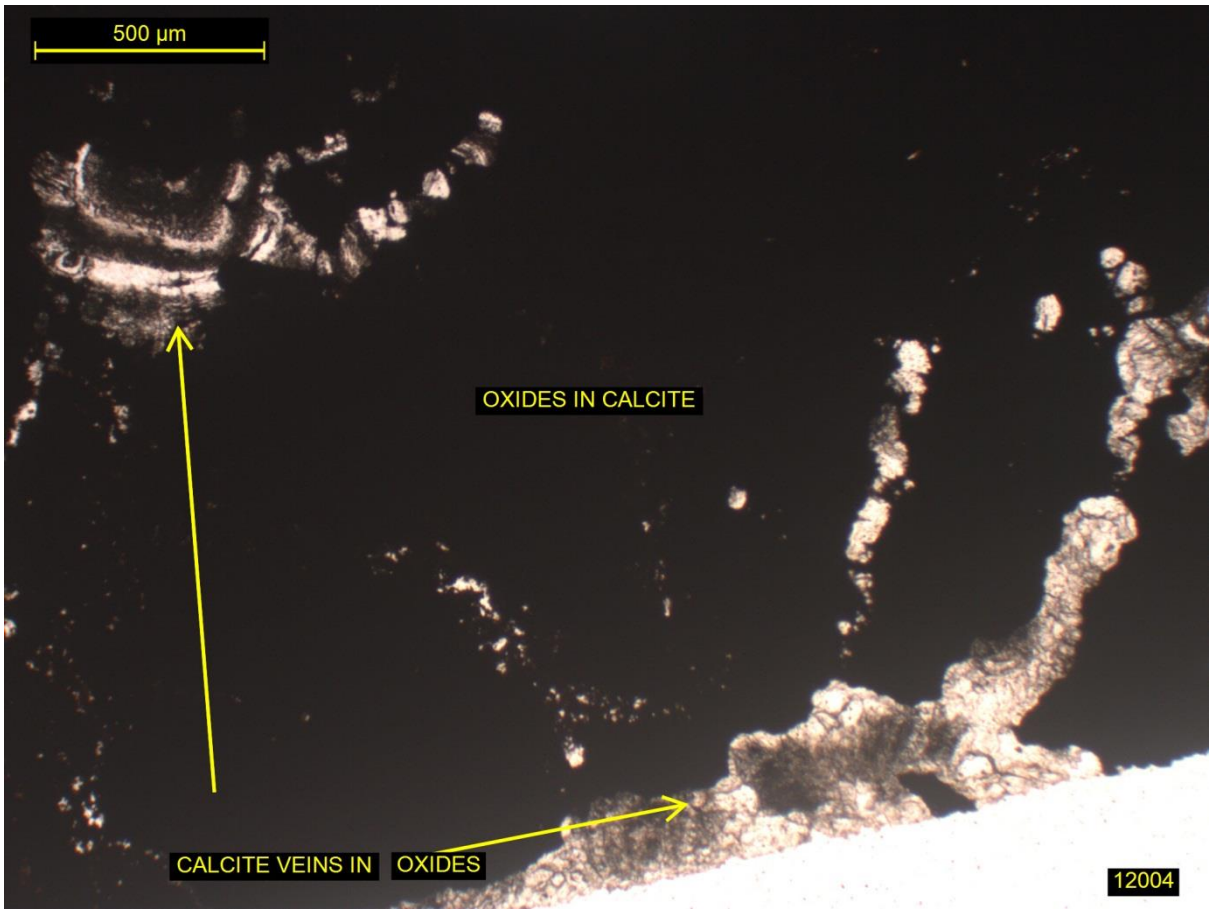
SEM/EDS analyses (see SEM images)

WT%	A1	A2	A3
MgO			2.2
Al2O3		4.5	4.9
SiO2		28.5	17.8
K2O	1.7	1. 2	1.3
CaO		27	30.7
BaO	1.8		
MnO	75.1	9.7	12.8
FeO	21.3	29.1	30.2


ANALYSIS 1
Magn WD 100 µm
400x 12.8 0.5 mBar 2004


ANALYSIS 2
Magn WD 100 µm
400x 12.9 0.1 mBar 2004


ANALYSIS 3
Magn WD 500 µm
100x 12.8 0.5 mBar 2004


500 µm
OXIDES IN CALCITE
CALCITE VEINS IN OXIDES
12004

SAMPLE BC 11 12007

ROCK SPECIMEN mottled black to orange brown manganese iron oxide ore (21.7Mn 2.9Fe)

POLISHED THIN SECTION/XRD/SEM

MINERAL CLASTS	**MAJOR**
QUARTZ	DOMINANT
TOURMALINE	TRACE
MATRIX	**MINOR**
OPAL	DOMINANT
CHALCEDONY	ACCESSORY
GOETHITE	ACCESSORY
BARITE	TRACE
ORES	**MAJOR**
PYROLUSITE	DOMINANT

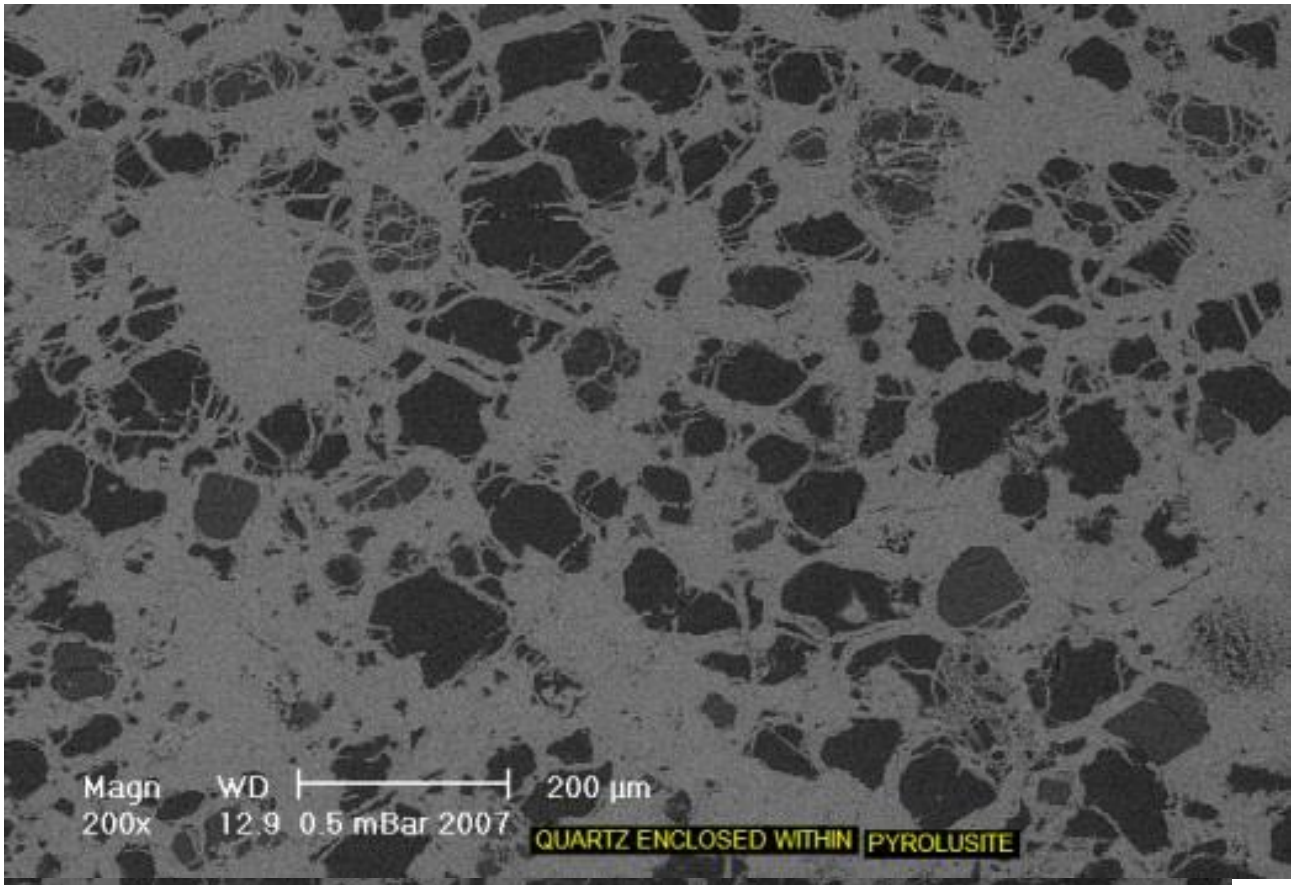
CLASSIFIED AS A PART SILICIFIED MANGANESE OXIDE MINERALISED QUARTZ SANDSTONE

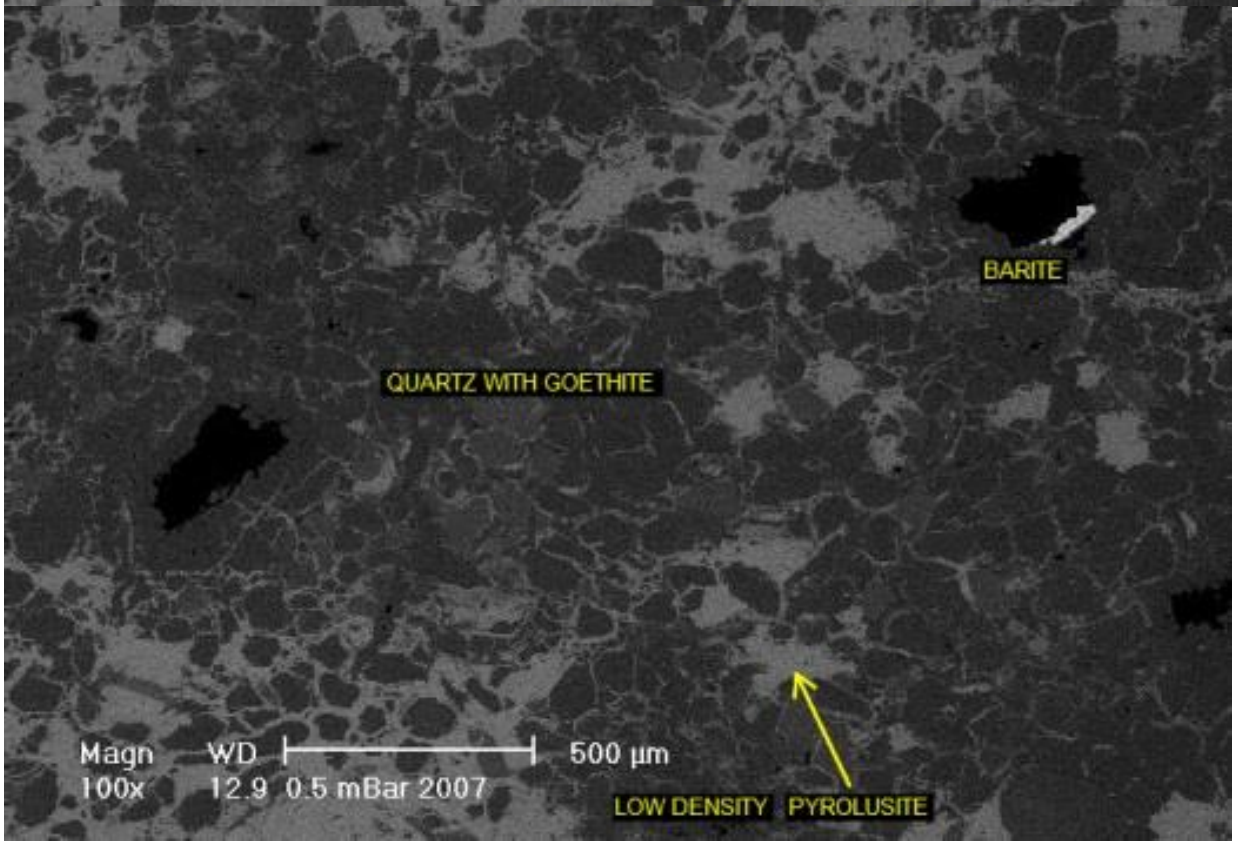
The sandstone is represented by a major content of rounded to sub angular quartz clasts . The coarsest grains are well rounded and exceed 0.5 mm, ranging down to 0 .1 mm sub angular examples. Otherwise detrital material is restricted to very rare fine tourmaline. The quartz as the greatest density in the less mineralised part of the sediment. Within the almost massive oxide areas, the sporadic quartz is much coarser than average. Uncommonly these quartz clasts may be crossed by opal veins.

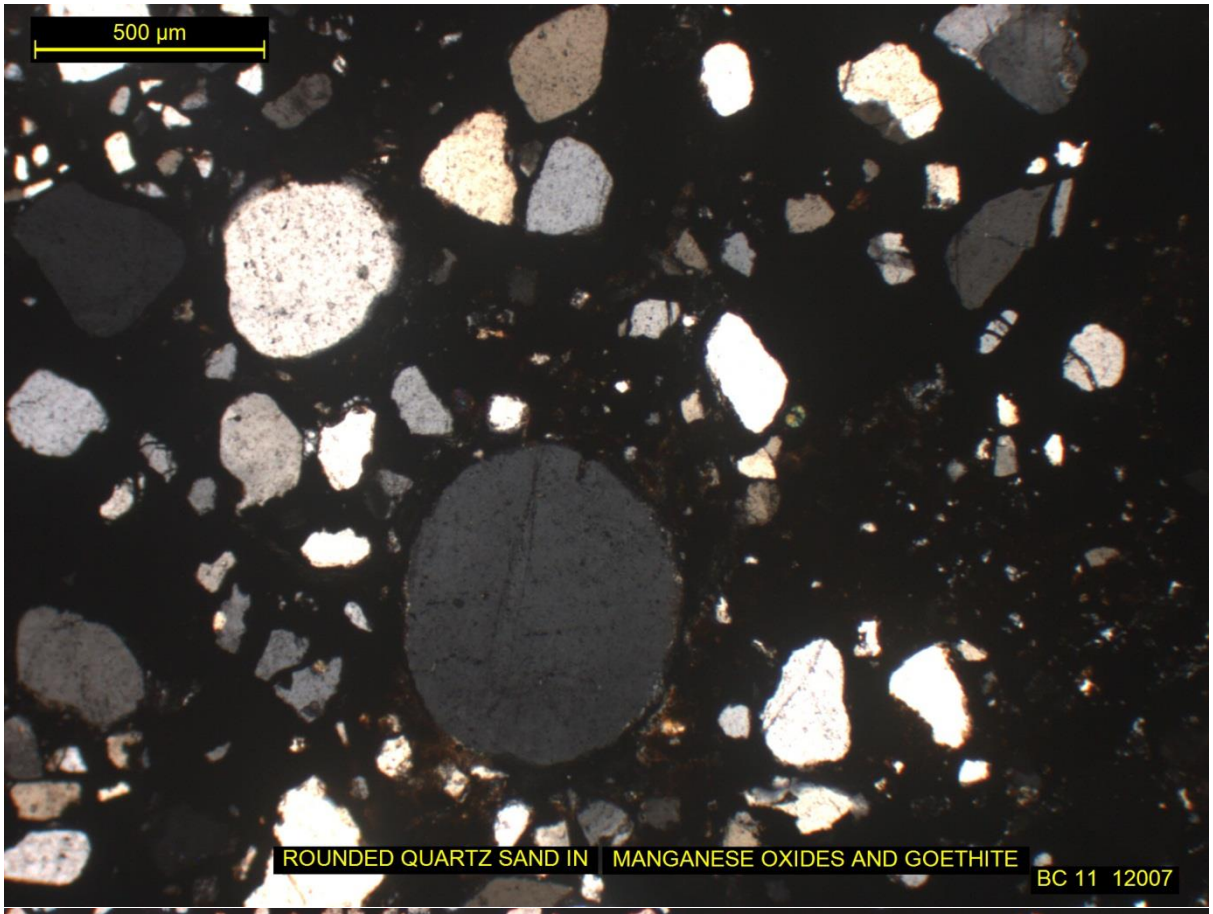
Silica is also common in the form of opal and chalcedony. The silica is mainly present in low oxide parts of the sample as veins and pockets of opal rims to chalcedony nuclei. The goethite is more prevalent in the siliceous low manganese oxide areas as marginal matrix

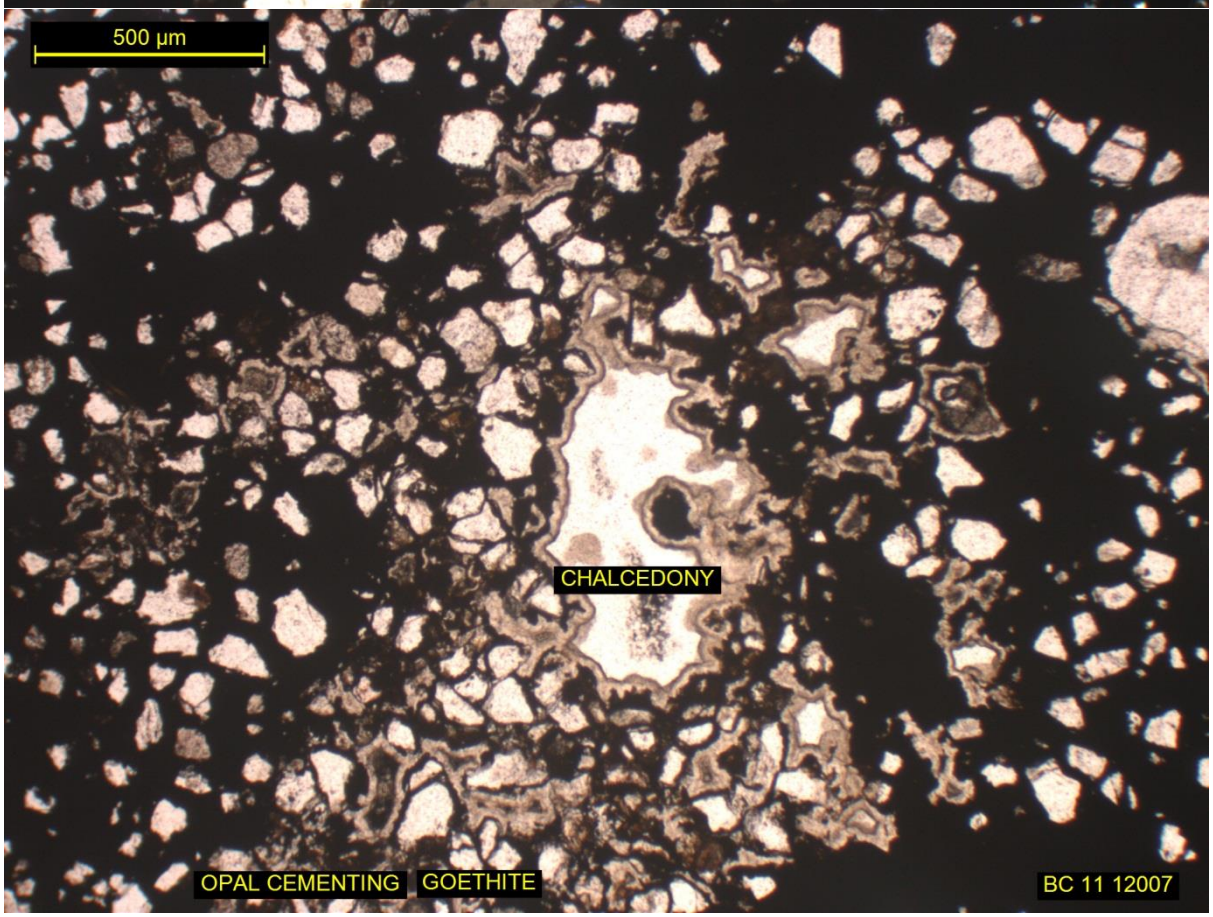
MANGANESE ORES

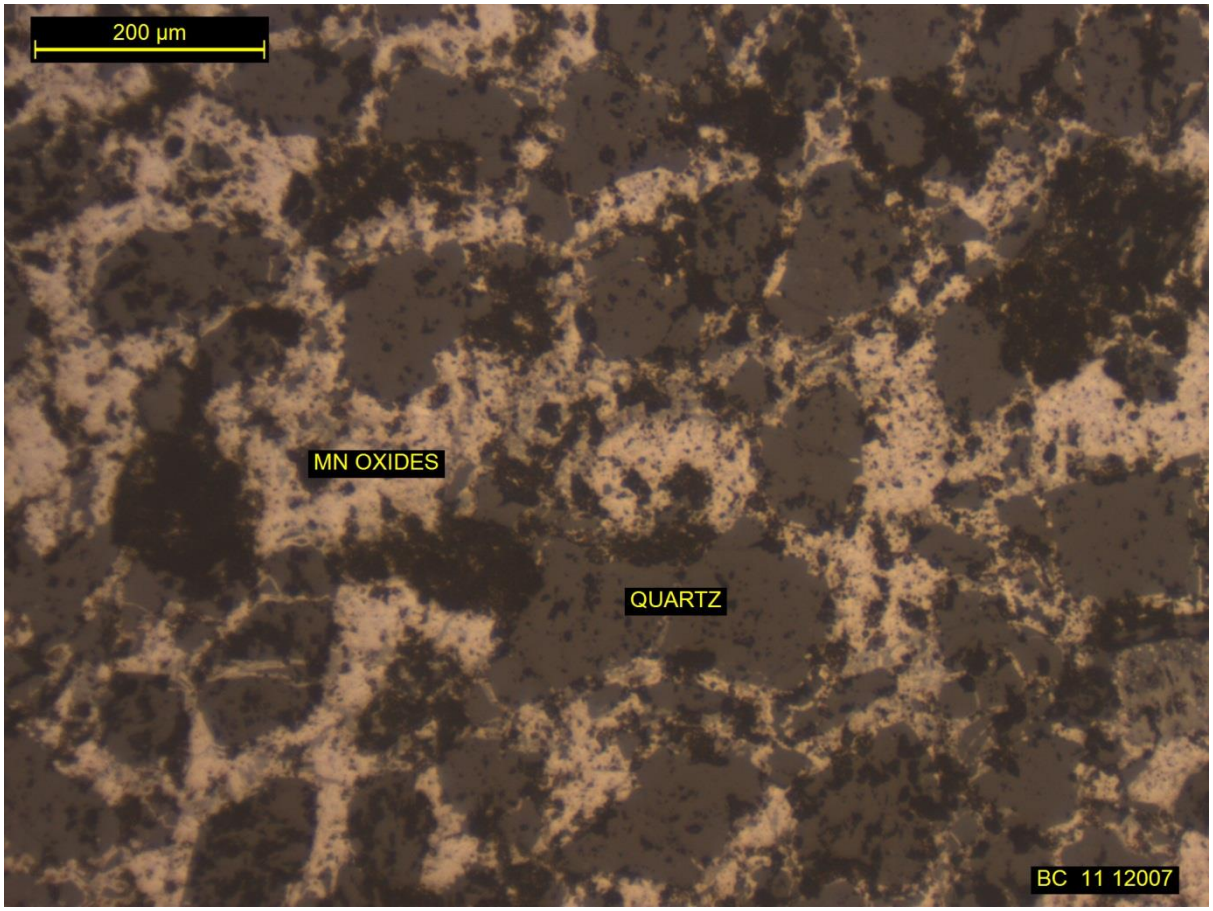
The manganese ore identified was pyrolusite. This occurs as a fine-grained matrix to the quartz sand, varying from an estimated 70% to less than 30%. See SEM images.


Magn WD 200 µm
200x 12.9 0.5 mBar 2007
QUARTZ ENCLOSED WITHIN PYROLUSITE


BARITE
QUARTZ WITH GOETHITE
Magn WD 500 µm
100x 12.9 0.5 mBar 2007
LOW DENSITY PYROLUSITE


500 µm
ROUNDED QUARTZ SAND IN
MANGANESE OXIDES AND GOETHITE
BC 11 12007


500 µm
CHALCEDONY
OPAL CEMENTING
GOETHITE
BC 11 12007


200 µm
MN OXIDES
QUARTZ
BC 11 12007