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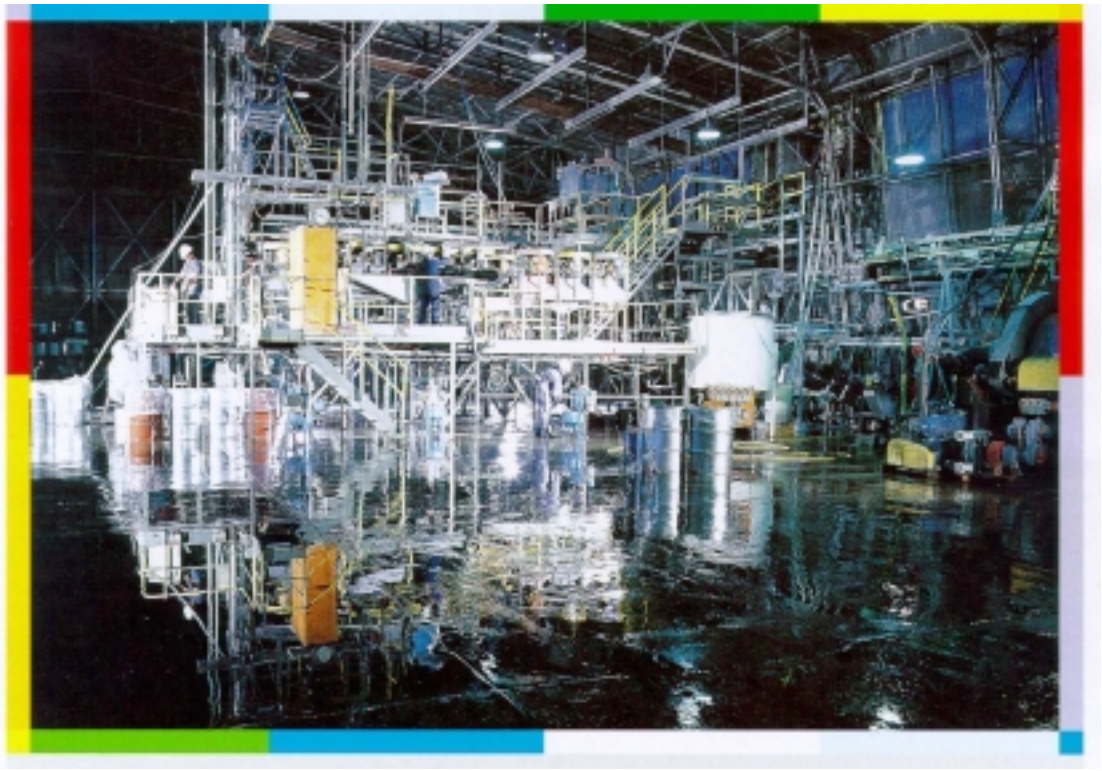

PETROLOGY AND CHEMICAL ANALYSIS OF FIVE SANDSTONE SAMPLES

Report No. G322PE98 23 April 1999

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Attn: Gavin Otto

REPORT G332PE98

PETROLOGY AND CHEMICAL ANALYSIS OF FIVE SANDSTONE SAMPLES

YOUR REFERENCE:	Purchase Order No. 00802 dated 14/12/98
SAMPLE IDENTIFICATION:	DA98C1003, DA98C21238, DA98C41211, DA98C13608 and 1E1 to 1E4
MATERIAL:	Rock samples
DATE SAMPLES RECEIVED:	21 December 1998
DATE AUTHORISATION RECEIVED:	16 December 1998
WORK REQUIRED:	Mineralogical and chemical analyses
INVESTIGATION AND REPORT BY:	Frank Radke
X-RAY DIFFRACTION ANALYSIS BY:	Michael Till

Dr Keith J Henley
Group Leader, Mineralogy

ck/cjc

PETROLOGY AND CHEMICAL ANALYSIS OF FIVE SANDSTONE SAMPLES

SUMMARY

Five samples submitted for petrological and chemical analysis by Cameco Australia Pty Ltd are all quartz-rich sandstones showing varying degrees of recrystallisation. Samples DA98C10003 and 1E are cemented mainly by overgrowth quartz. The other three samples (DA98C21238, DA98C41211 and DA98C13608) consist largely of recrystallised quartz which at least locally contains remnant detrital grain shapes in some quartz bodies. Sample DA98C21238 contains potash feldspar believed to be of metasomatic origin. This sample also contains fine concentrations of apatite and zircon which could be related to the potash alteration.

The clay minerals in these samples consist mainly of kaolinite along with smaller amounts of a birefringent clay which has been termed sericite in the thin section description and mica-illite by X-ray diffraction analysis. Sample 1E3 is different from the other four samples in that it contains chlorite, which is lacking in the other four samples, and contains no detectable kaolinite, which is present in the other four samples.

Uranium mineralisation in these samples consists of threadgoldite, which was identified in both samples DA98C13608 and 1E and could be present in other samples at very low levels. Metatorbenite was also identified in sample DA98C13608. Both threadgoldite and metatorbenite are hydrated uranyl phosphates. It is worth noting that crandallite was noted by X-ray diffraction analysis in samples DA98C10003, DA98C21238 and DA98C41211 but was not detected in the two samples containing uranyl-bearing phosphates. It is possible that the crandallite could be the source of phosphorus for the formation of uranyl phosphates. Metatorbenite is a copper-bearing mineral and sample DA98C13608 also contains trace levels of chalcopyrite as very small inclusions in quartz. This chalcopyrite could be the source of copper for the production of metatorbenite.

PETROLOGY AND CHEMICAL ANALYSIS OF FIVE SANDSTONE SAMPLES

1. INTRODUCTION

Five rock samples were submitted by Cameco Australia Pty Ltd for mineralogical and chemical analysis. One of the samples consisted of four large slabs labelled 1E1 to 1E4. Another sample consisted of a large grab sample and the other three samples consisted of small rock chips. A quotation for this work was sent to Gavin Otto of Cameco Australia Pty Ltd on 15 December 1998 (Amdel Quotation No. LG0588.98). Some variations between this quotation and the work program, including the number of samples submitted and the addition of photomicrography, were made. Preliminary results were sent to Gavin Otto of Cameco Australia Pty Ltd on 12 April 1999 and this report completes the investigation.

2. PROCEDURE

The four large slabs of sample 1E as well as the large grab sample (sample no. DA98C113608) and the three smaller samples (sample nos. DA98C10003, DA98C21238 and DA98C41211) were autoradiographed to aid in the location of any radioactive minerals. Thin sections (TS C71240–71242) were made of samples DA98C10003, DA98C41211 and DA98C21238 and polished thin sections (TS C71835–71836) were made of samples DA98C3608 and 1E4. The thin sections were microscopically examined. The offcut chips from thin section preparation were stained for potash feldspar using a sodium cobaltinitrite solution after a hydrofluoric acid etch. Photomicrographs were taken to illustrate typical textures.

The samples were examined under ultraviolet light to reveal any fluorescent minerals. Selective areas containing radioactive and/or fluorescent minerals were examined by X-ray diffraction analysis to identify possible uranium minerals.

Portions of each sample were pulverised and analysed for a range of elements. For sample 1E a portion of sample 1E3 was pulverised for chemical analysis.

The bulk mineralogy and clay mineralogy were determined by X-ray diffraction analysis. A portion of the pulverised material from each sample was examined in the X-ray diffractometer to determine the bulk mineralogy of each sample. The –2 μm mineralogy was determined by taking lightly pre-ground subsamples dispersed in water with the aid of deflocculants in a mechanical shaker and allowing these to sediment to produce –2 μm e.s.d. size fractions by the pipette method. The resulting dispersions were examined by plummet balance to determine their solids contents and were then used to prepare oriented clay preparations on ceramic plates. Two plates were prepared per sample, both being saturated with Mg^{++} ions, and one in addition being treated with glycerol. When air-dry these were examined in the X-ray diffractometer.

3. CHEMICAL ANALYSES

The analytical results for major elements, trace elements and rare earth elements are given in Tables 1-3 respectively.

4. MINERALOGY BY X-RAY DIFFRACTION

The bulk mineralogy as well as the mineralogy of the –2 μm fraction for each sample are given in Table 4, which lists the minerals detected by X-ray diffraction using the given semi-quantitative abbreviations. All of the samples consist mainly of quartz with small amounts of phyllosilicates comprised of kaolinite in samples DA98C41211 and DA98C11368 and chlorite in sample 1E3. Potash feldspar was detected only in sample DA98C21238. Hematite was detected in samples DA98C10003 and 1E3. Phosphate minerals identified in these samples consist of apatite in sample DA98C21238 and crandallite in the –2 μm fractions of sample DA98C10003, DA98C21238 and DA98C41211.

Threadgoldite was detected in the -2 μm fraction of sample DA98C11368 but is present at such a dispersed level in the host rock that it could not be identified by X-ray diffraction analysis.

Also given in Table 4 is the proportion of the sample reporting to the –2 μm size fraction as determined by the plummet balance. This figure applies only to the pre-treatment and dispersion conditions used.

5. PETROLOGY

The individual petrographic and mineragraphic descriptions follow. Descriptions of the autoradiographs and uranium mineral identifications are included in the hand specimen descriptions. The only uranium minerals detected in these samples are metatorbenite in sample DA98C11368 and threadgoldite in sample 1E3. Both these minerals are hydrated uranyl phosphates, with metatorbenite containing copper and threadgoldite containing aluminum. Threadgoldite was originally found in a sample from Rock Hole mine, South Alligator District in the Northern Territory but was not named. It was reported by Threadgold in a CSIRO report (CSIRO Min. Invest. Tech. Paper 2, 1960).

SAMPLE: DA98C10003 : TS C71240

ROCK NAME: Quartzite

HAND SPECIMEN:

This is a very well indurated reddish-brown rock transected by an iron oxide vein approximately 1-2 mm wide. Marginal to the iron oxide vein the host rock has a slightly paler, bleached colour. Microchemical tests failed to detect any potash feldspar.

An autoradiograph made of the offcut chip from the thin section preparation detected no radioactive areas.

THIN SECTION:

An optical estimate of the constituents gives the following:

Mineral	%	Origin
Quartz	90	Detrital/authigenic
Clay/sericite	4	Authigenic
Zircon	Tr	Detrital
Tourmaline	Tr	Detrital
Muscovite	Tr	Detrital
Biotite	Tr	Detrital
Opaques and semi-opaques	5	Authigenic

This sample consists mainly of detrital quartz grains between 0.2 and 0.5 mm in size which are cemented by overgrowth quartz. Virtually all of the quartz grains exhibit well developed overgrowths located interstitially between the original detrital grains whose outline are defined by very fine inclusions, mainly of opaque material.

Irregular patches of weakly birefringent clay intergrown with smaller amounts of a birefringent sericite occur as intergrowths with the quartz. Most of these clay aggregates occur as interstitial patches but some contain concentrations of opaque material defining an original detrital grain (Plate 1) suggesting that at least some of these sericite/clay patches could represent altered mineral grains, possibly of feldspar. Some clay/sericite patches have vague prismatic shapes, possibly pseudomorphic after original detrital feldspar grains (Plate 2). X-ray diffraction analysis shows that the weakly birefringent clay is kaolinite and the birefringent sericite is illite.

Traces of zircon form small detrital grains generally below 0.05 mm in size. Tourmaline was noted as detrital grains and as fibrous to acicular inclusions within at least one quartz grain. Both muscovite and biotite occur as very small flakes (below 0.05 mm) included within detrital quartz grains.

Moderate amounts of opaque to translucent, reddish-brown iron oxides occur as interstitial intergrowths between the detrital quartz grains. Many of these iron oxides are intergrown with the clay patches but iron oxides also occur as individual patches associated with clay. X-ray diffraction analysis indicates that these iron oxides consist mainly of hematite although they could include small amounts of other iron oxides or possibly small amounts of leucoxene.

This is a quartz-rich detrital sedimentary rock showing strong development of overgrowth quartz with the development of interstitial sericite/clay and iron oxides (mainly hematite). Photomicrographs of this sample are given in Plates 1 and 2.

SAMPLE: DA98C21238 : TS C71242

ROCK NAME: Potash-metasomatised quartzite

HAND SPECIMEN:

This is a fine grained rock with a mottled pale grey to pale tan colour. Microchemical tests show that the rock contains abundant potash feldspar which tends to be concentrated in finer grained, pale tan patches up to several mm in size.

An autoradiograph of the offcut chip from the thin section preparation failed to detect any radioactive minerals.

THIN SECTION:

An optical estimate of the constituents gives the following:

Mineral	%	Origin
Quartz	75	Recrystallised detrital
Potash feldspar	20	Alteration
Clay/sericite	3	Alteration
Apatite	1	(?)Alteration
Zircon	Tr-1	(?)Alteration/detrital
Biotite	Tr	Detrital
Tourmaline	Tr	(?)Alteration
Opaques and semi-opaques	1	Alteration

This sample consists mainly of strongly recrystallised quartz which forms a granular mosaic with a grain size ranging up to 0.4 mm and is intergrown with finely granular mosaics of potash feldspar which typically have a grain size of 0.05-0.1 mm. A small amount of potash feldspar also forms slightly larger prismatic crystals ranging up to 0.3 mm in size. The recrystallised quartz mosaics form irregular patches ranging up to several mm in size which contain irregular domains of finer grained potash feldspar. Despite the recrystallisation of the quartz in at least some areas, remnant detrital mineral grains are defined by fine inclusions with the development of overgrowth quartz. In these areas, the quartz generally has a slightly less recrystallised character while in the more intensely recrystallised zones, the quartz generally forms mosaics with straight grain boundaries.

Intergrown with the potash feldspar are moderate amounts of finely divided sericite. Weakly birefringent clay is locally present as irregular patches ranging up to 0.3 mm in size. X-ray diffraction analysis shows that the weakly birefringent clay is kaolinite and the sericite is illite. Also intergrown with the fine grained potash feldspar are small apatite and zircon crystals below 0.1 mm in size. Many of the zircon crystals have a concentrically zoned character. Traces of tourmaline were also noted as fine intergrowths with potash feldspar. Tourmaline is much less abundant than apatite and zircon.

Traces of biotite were noted as pleochroic brown flakes below 0.1 mm in length totally included within quartz grains.

Minor amounts of opaque material form finely disseminated grains below 0.1 mm in size. Most of the finely disseminated opaques are intergrown with fine grained potash feldspar.

This sample is thought to represent a quartz sandstone which has been subjected to potash metasomatism producing finely granular potash feldspar and recrystallising much of the original detrital quartz. The apatite, tourmaline and at least some of the zircon are intergrown with the potash feldspar and thought to be associated with the potash feldspar mineralisation, although at least some zircon probably represents remnant detrital grains. Most of the clay/sericite is also associated with the potash feldspar and could be either associated with the potash feldspar mineralisation or a later alteration product. Photomicrographs of this sample are given in Plate 3.

SAMPLE: DA98C41211 : TS C71241

ROCK NAME: Quartzite

HAND SPECIMEN:

This is a pale coloured, well indurated rock with a fine grain size. Some weathered surfaces exhibit a deep reddish-brown iron staining.

An autoradiograph of the offcut chip shows the presence of weakly radioactive areas below 1 mm in size which produce a very faint clouding of the autoradiograph. The cause of this radioactivity is unknown but could be due to a finely divided secondary uranium mineral. No fluorescence is associated with these radioactive areas although some surfaces of this sample exhibit a very weak fluorescence possibly due to very small amounts of a secondary uranium mineral such as threadgoldite.

THIN SECTION:

An optical estimate of the constituents gives the following:

Mineral	%	Origin
Quartz	95	Recrystallised detrital
Clay/sericite	3	Authigenic
Zircon	Tr	Detrital
Opaques and semi-opaques	2	Authigenic

This sample consists of a recrystallised quartz mosaic with a typical grain size between 0.1 and 0.4 mm. Most of the quartz forms an irregular, interlocking mosaic of grains although within localised areas vague outlines of original detrital grains are evident in some of the quartz mosaics. Within some areas, the rock is transected by fractures or veinlets up to 0.3 mm wide along which the quartz has been subjected to fine granulation, producing finely granular mosaics with a grain size below 0.02mm.

Small amounts of finely divided clay and birefringent sericite are present as very fine interstitial intergrowths located between quartz grains. Irregular pore spaces ranging up to 0.5 mm in size often have coatings or partial fillings of clay and sericite. X-ray diffraction analysis shows the weakly birefringent clay is kaolinite. Opaque to translucent reddish-brown iron oxides form finely disseminated aggregates ranging up to 0.4 mm in size. Most of these opaques have irregular shapes and many appear to occur as void fillings. Traces of zircon form disseminated grains ranging up to 0.1 mm in size.

This is a detrital quartz-rich sediment which has been strongly recrystallised, forming a granular mosaic leaving only minor remnant detrital textures. Locally the rock has also been subjected to fine granulation along narrow vein-like structures. Photomicrographs of this sample are given in Plate 4.

SAMPLE: DA98C3608 : TS C71386

ROCK NAME: Quartzite

HAND SPECIMEN:

This is a dark red rock with a well indurated, fine grain size.

The autoradiograph shows a concentration of radioactive minerals along a fracture and as disseminations producing clouding over areas up to about 5 mm wide. The most radioactive area was examined by X-ray diffraction analysis and found to contain metatorbenite. Some fracture surfaces of this sample have a weakly developed yellowish-green fluorescence which is thought to be due to the presence of finely divided threadgoldite which was detected in the -2µm fraction of this sample by X-ray diffraction analysis. Some of the disseminated radioactivity could also be due to threadgoldite as well as metatorbenite.

POLISHED THIN SECTION:

An optical estimate of the constituents gives the following:

Mineral	%	Origin
Quartz	95	Recrystallised detrital
Clay/sericite	4	Authigenic
Hematite	1	Authigenic
Goethite	Tr	Alteration
Zircon	Tr	Detrital
Apatite	Tr	(?)Detrital
Chalcopyrite	Tr	(?)Detrital

This sample consists mainly of a recrystallised quartz mosaic with a grain size between 0.1 and 0.4 mm. Despite the strong recrystallisation of the quartz, some of the quartz grains retain internal textures with vague detrital shapes and overgrowth quartz. Most of the quartz forms an interlocking mosaic with a strongly recrystallised character.

Small amounts of clay occur as interstitial intergrowths between the quartz grains. This clay forms patches below 0.2 mm in size comprised mainly of weakly birefringent clay (probably kaolinite) and birefringent sericite (identified as mica-illite by X-ray diffraction analysis). Intergrown with the clay minerals are iron oxides comprised mainly of hematite. Hematite also forms irregular interstitial patches ranging up to 0.3 mm in size. Minor goethite is also intergrown with some clay patches and is thought to represent a later alteration product of hematite.

Traces of zircon are disseminated through the rock as small grains below 0.1 mm in size. Chalcopyrite was noted as very small (below 0.05 mm), anhedral inclusions within quartz grains. Prismatic apatite crystals up to 0.05 mm in length also occur as small inclusions within some quartz grains.

This is a quartz-rich detrital sedimentary rock with a recrystallised texture. The rock contains chalcopyrite of uncertain origin although it could represent chalcopyrite included within original detrital quartz grains. Secondary uranium minerals identified in this sample consist of threadgoldite and metatorbenite, both of which are hydrated uranyl phosphates. Metatorbenite is a copper-bearing mineral and it is considered likely that the finely disseminated chalcopyrite noted in this rock is the source of the copper. Photomicrographs of this sample are given in Plates 6 - 8.

SAMPLE: 1E : TS C71385 (1E4)

ROCK NAME: Quartzite

HAND SPECIMEN:

Sample 1E consists of four very large slabs, all of which are fine grained, well indurated rocks with a reddish-brown colour. The fracture surfaces often exhibit deeper brown iron staining.

Autoradiographs of the four slabs show that the radioactive minerals are concentrated along fractures and are particularly well developed along one fracture showing intense iron staining of the host rock to a depth of about 1 cm. The radioactive areas also have a yellowish-green fluorescence. The fluorescent, radioactive mineral in this sample was identified as threadgoldite by X-ray diffraction analysis. Threadgoldite is a hydrated aluminium uranyl phosphate and is identical to an unnamed mineral first reported by Threadgold in a CSIRO report (CSIRO Mineral Investigation Technical Paper 2, 1960) from the Rock Hole mine in the South Alligator District of the Northern Territory.

POLISHED THIN SECTION:

An optical estimate of the constituents gives the following:

Mineral	%	Origin
Quartz	92	Detrital/authigenic
Clay/sericite	4	Authigenic
Hematite	3	Authigenic
Tourmaline	Tr-1	Detrital
Zircon	Tr	Detrital
Goethite	Tr	Alteration
Leucoxene	Tr	Alteration
Biotite	Tr	Detrital

This sample consists mainly of detrital quartz grains between 0.1 and 0.2 mm in size which are cemented by the strong development of overgrowth quartz. The quartz grains exhibit rounded to subrounded shapes and are defined by the zone of fine inclusions from the overgrowth quartz. Within some areas the quartz grains exhibit a slight preferred orientation defining a vague foliation direction which is thought to be a compaction feature.

Interstitially between the quartz, the rock contains irregular voids, many of which are partially filled by clay minerals or iron oxides. X-ray diffraction analysis indicates that the clay minerals are mainly chlorite but the clay includes some birefringent sericite flakes which would report as mica/illite in the X-ray diffraction analysis. The clay generally fills or partially fills regular voids and typically has a weakly birefringent character. Some of the clay appears to be altered detrital particles (Plate 5a). The hematite forms fine intergrowths with clay and irregular, interstitial patches ranging up to 0.2 mm in size. Minor goethite is also intergrown with the clay particularly marginal to a fine fracture included within the thin section. Traces of leucoxene also form fine intergrowths with clay.

Tourmaline is disseminated through the rock as detrital grains ranging up to 0.1 mm in size which generally have a pleochroic yellow or green colour. Traces of zircon also form disseminated, detrital grains. Biotite forms small flakes below 0.05 mm in size which are totally included within quartz grains.

This is a quartz-rich sandstone showing strong development of overgrowth quartz. Uranium mineralisation is concentrated along fractures and consists mainly of threadgoldite. Photomicrographs of this sample are given in Plate 5.

TABLES

TABLE 1: CHEMICAL ANALYSES FOR MAJOR ELEMENTS

Element	Units	Sample No.					Detection Limit	Analytical Code
		DA98C1003	DA98C21238	DA98C41211	DA98C13608	1E3		
SiO_2	%	92.6	87.9	95.9	95.9	90.9	0.01	IC4E
TiO_2	%	0.07	0.41	0.12	0.14	0.09	0.01	IC4E
Al_2O_3	%	2.03	3.45	1.77	1.84	2.72	0.01	IC4E
Fe_2O_3*	%	2.54	0.87	0.31	1.05	2.56	0.01	IC4E
MgO	%	0.16	0.16	0.05	0.08	0.50	0.01	IC4E
MnO	%	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	IC4E
CaO	%	0.30	1.61	0.19	0.13	0.14	0.01	IC4E
K_2O	%	0.39	1.72	0.07	0.15	0.18	0.01	IC4E
Na_2O	%	<0.01	0.03	<0.01	<0.01	<0.01	0.01	IC4E
P_2O_5	%	0.32	1.23	0.20	0.16	0.26	0.01	IC4E
LOI	%	1.36	1.13	0.80	1.02	1.48	0.01	GRAV7
Total	%	99.8	98.5	99.4	100.5	98.8		

*Total Fe as Fe_2O_3

TABLE 2 : CHEMICAL ANALYSES FOR TRACE ELEMENTS

Element	Units	Sample No.					Detection Limit	Analytical Code
		DA98C1003	DA98C21238	DA98C41211	DA98C13608	1E3		
U	ppm	360	250	700	550	500	0.5	IC4M
Th	ppm	4.5	97	8.0	4.5	3.0	0.5	IC4M
Au	ppb	70	9	27	345	1420	1	FA3
Pt	ppb	20	<5	<5	<5	10	5	FA3
Pd	ppb	16	1	<1	<1	340	1	FA3
Ag	ppm	0.2	0.4	3.1	2.4	0.3	0.2	IC3M
Cu	ppm	24	220	170	195	21	2	IC3M
Pb	ppm	10	25	56	2	<2	2	IC3M
Zn	ppm	8	7	3	9	65	2	IC3M
As	ppm	14	10	32	22	10	3	IC3M
B	ppm	50	25	20	40	55	5	COL7
Ba	ppm	370	800	240	185	500	10	IC4M
Bi	ppm	4	<3	10	4	<3	3	IC4M
Co	ppm	<15	<15	<15	<15	20	15	IC4M
Cr	ppm	160	<20	<20	<20	<20	20	IC4E
Ga	ppm	5	5	8	6	6	1	IC4M
Hf	ppm	6	26	4	5	3	1	IC4M
Mo	ppm	3	5	4	9	3	2	IC4M
Ni	ppm	4	4	4	3	33	2	IC3M
Rb	ppm	13.5	43	2.5	6.5	5.5	0.5	IC4M
Sb	ppm	1	1	1	2	2	1	IC4M
Sn	ppm	<10	<10	<10	<10	85	10	IC4M
Sr	ppm	65	140	75	40	75	5	IC4M
V	ppm	140	<20	<20	30	<20	20	IC4E
W	ppm	<3	<3	4	4	<3	3	IC4M
Y	ppm	56	49	17	8	76	1	IC4M
Zr	ppm	230	950	160	190	100	15	IC4M

The following elements were not detected (detection limits in ppm given in parentheses): Cd(3), Cs(3), In(0.5), Nb(10), Ta(2), Te(5), Tl(3). All by Analytical Code IC4M.

TABLE 3 : CHEMICAL ANALYSES FOR RARE EARTH ELEMENTS

Element	Units	Sample No.					Detection Limit	Analytical Code
		DA98C1003	DA98C21238	DA98C41211	DA98C13608	1E3		
La	ppm	30	110	13	6	125	1	IC4R
Ce	ppm	57	200	24	20	195	1	IC4R
Pr	Ppm	9	25	4	2	27	1	IC4R
Nd	Ppm	37	100	16	9.5	105	0.5	IC4R
Sm	Ppm	13	27.5	7.5	3.5	20	0.5	IC4R
Eu	ppm	4.5	4.0	2.5	1.0	6.0	0.5	IC4R
Gd	ppm	14	24	9	3	21	1	IC4R
Tb	ppm	2.0	2.5	1.5	<0.5	2.5	0.5	IC4R
Dy	ppm	10	13	7.5	2.5	15	0.5	IC4R
Ho	ppm	2.0	2.0	1.0	<0.5	2.5	0.5	IC4R
Er	ppm	4	5	2	1	6	1	IC4R
Tm	ppm	<1	<1	<1	<1	<1	1	IC4R
Yb	ppm	3	4	2	1	4	1	IC4R
Lu	ppm	<0.5	0.5	<0.5	<0.5	0.5	0.5	IC4R

TABLE 4 : MINERALOGY BY X-RAY DIFFRACTION

Mineral	Sample No.				
	DA98C10003	DA98C21238	DA98C41211	DA98C13608	1E3
Bulk Sample					
Quartz	D	D	D	D	D
Kaolinite	-	-	Tr-A	Tr-A	-
Chlorite	-	-	-	-	Tr-A
K-feldspar	-	A	-	-	-
Apatite	-	Tr	-	-	-
Hematite	Tr	-	-	-	Tr
Unidentified clay	Tr	Tr	-	-	-
-2 μm Fraction					
Quartz	D	D	D	A	A
Kaolinite	Tr	Tr-A	SD	D	-
Chlorite	-	-	-	-	D
Mica-illite	A	Tr-A	-	A-SD	A-SD
Apatite	-	Tr-A	-	-	-
Crandallite	Tr	Tr	Tr	-	-
Hematite	Tr	-	-	-	Tr
Goethite	-	-	-	-	Tr
K-feldspar	-	Tr	-	-	-
Threadgoldite	-	-	-	Tr	-
% -2 μm	9	8	4	4	5

Semiquantitative abbreviations

D = Dominant. Used for the component apparently most abundant, regardless of its probable percentage level.

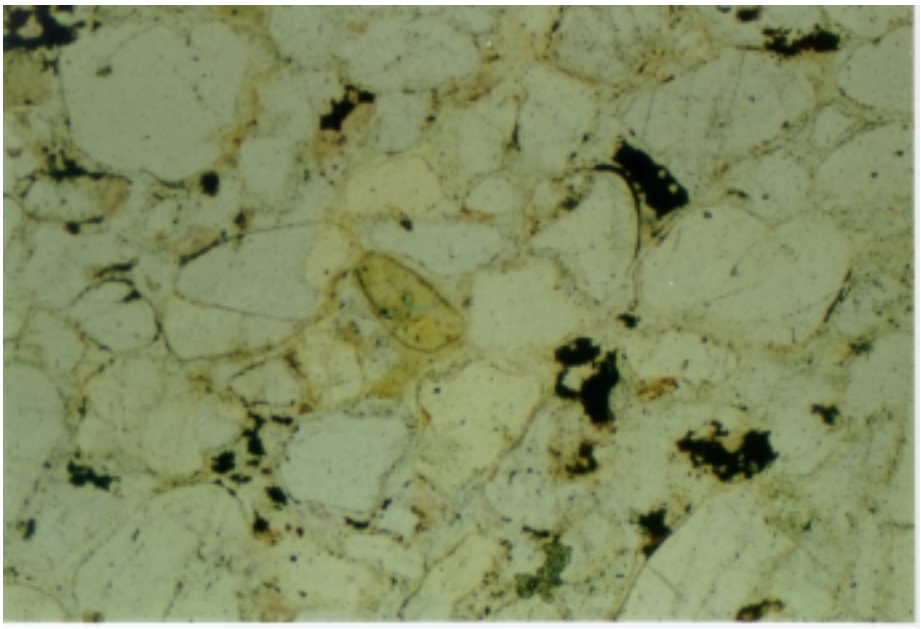
SD = Sub-dominant. The next most abundant component(s) providing its percentage level is judged above about 20.

A = Accessory. Components judged to be present between the levels of roughly 5 and 20%.

Tr = Trace. Components judged to be below about 5%.

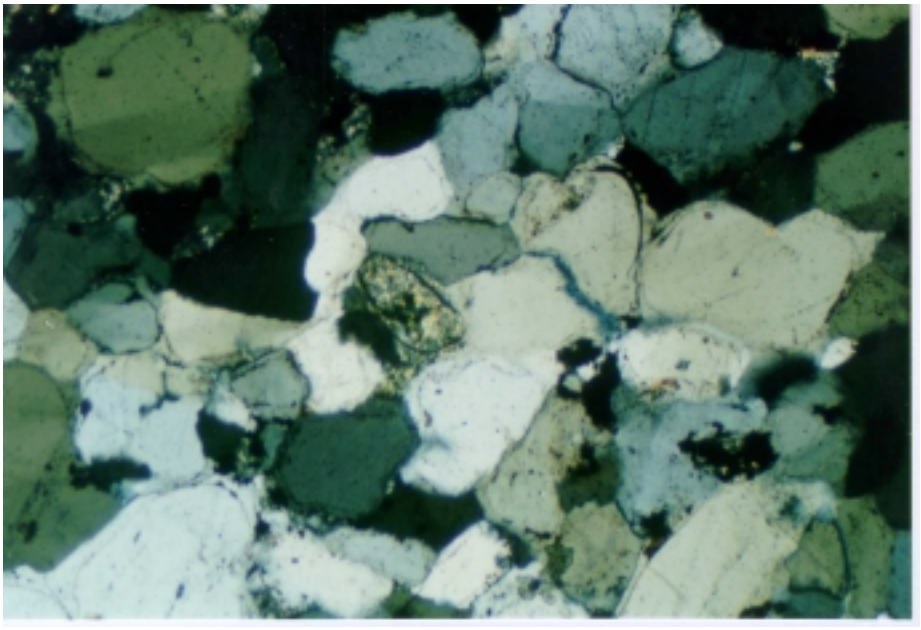
PLATES

PLATE 1 : SAMPLE : DA98C1003 : TS C71240



500 µm

(a) Transmitted, plane polarised light (11, 5)

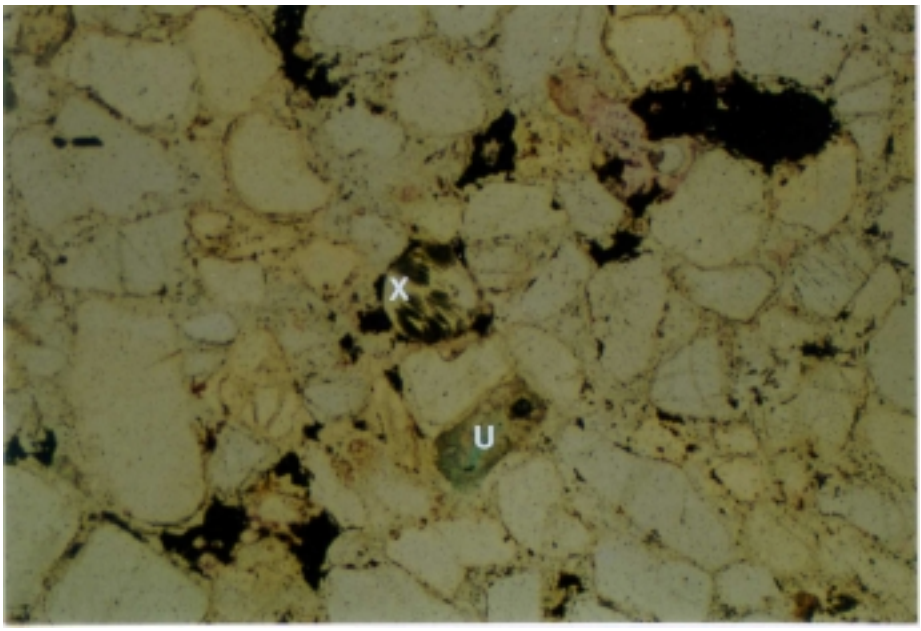


500 µm

(b) Same field as (a); crossed polars (12, 5)

Rounded, detrital quartz grains are cemented by strongly developed overgrowth quartz. Note clay/sericite in the centre of the field (variable birefringence) with an outline of an original detrital grain, suggesting it represents an altered detrital particle (possibly a feldspar).

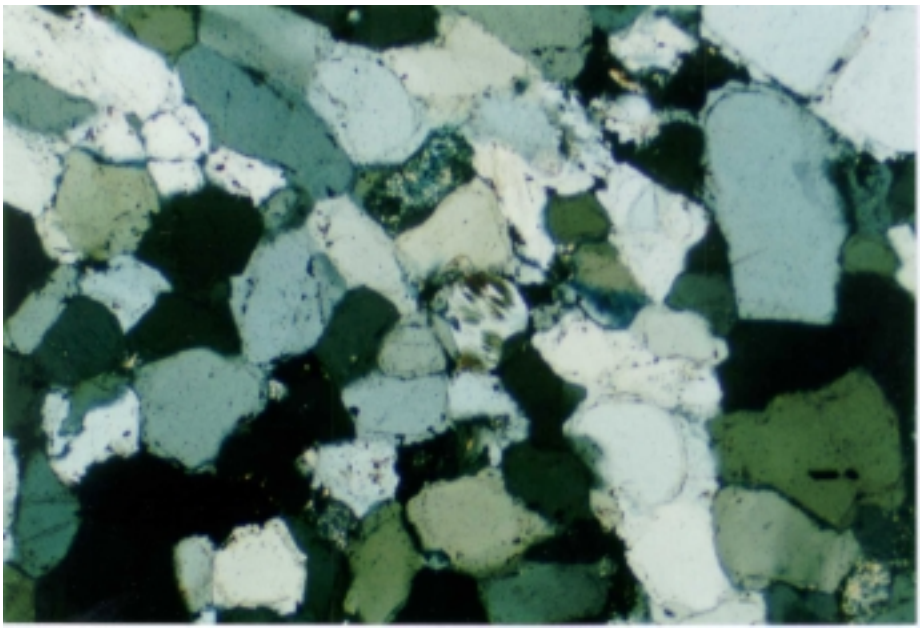
PLATE 2 : SAMPLE : DA98C1003 : TS C71240



500 μm

(a) Transmitted, plane polarised light (13, 5)

The grain in the centre of the field labelled X contains fibrous tourmaline inclusions. The area marked U is a clay/sericite patch with a vague prismatic shape, possibly pseudomorphic after an original feldspar grain.

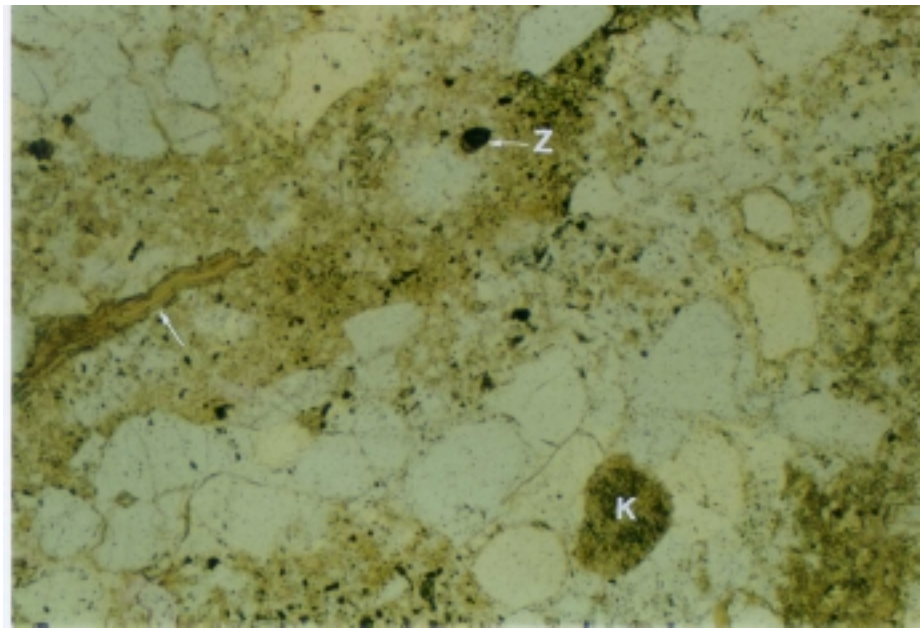


500 μm

(b) Same field as (a); crossed polars (14, 5)

Rounded, detrital quartz grains are cemented by overgrowth quartz.

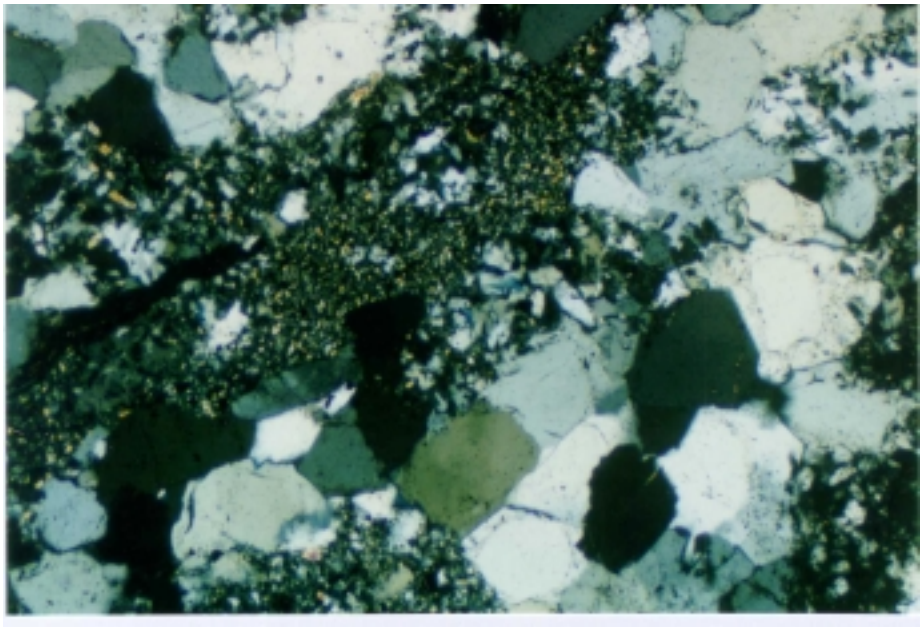
PLATE 3 : SAMPLE : DA98C21238 : TS C71242



500 μm

(a) Transmitted, plane polarised light (15, 5)

A large potash feldspar grain intergrown with coarser grained quartz is labelled K. The turbid area arrowed consists of weakly birefringent clay (probably kaolinite). A zoned zircon grain is labelled Z.

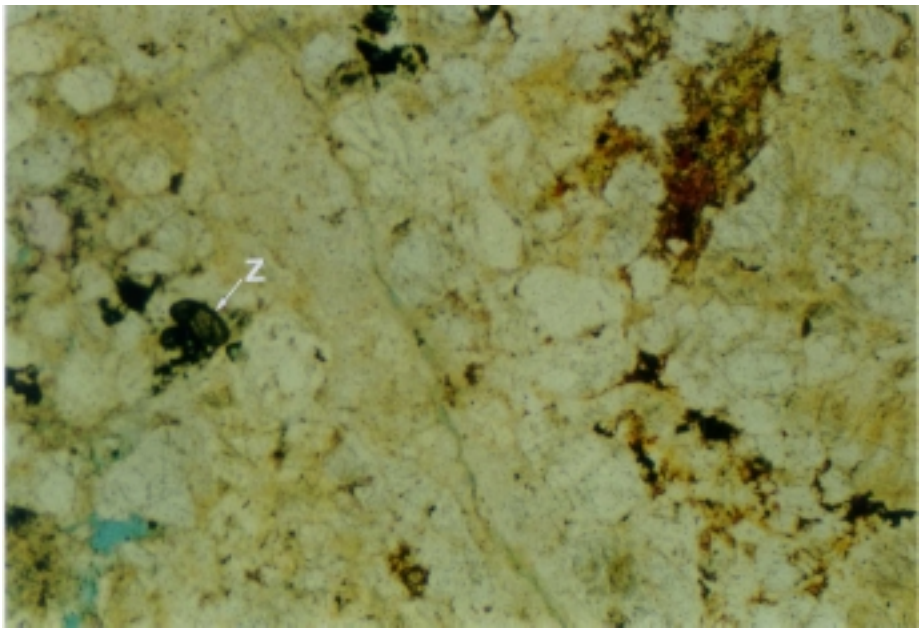


500 μm

(b) Same field as (a); crossed polars (16, 5)

This field shows coarser grained recrystallised quartz with remnant detrital shapes and very finely granular potash feldspar, which has a slightly turbid character in plane polarised light. The fine birefringence in the potash feldspar visible under crossed polars is due to finely divided sericite.

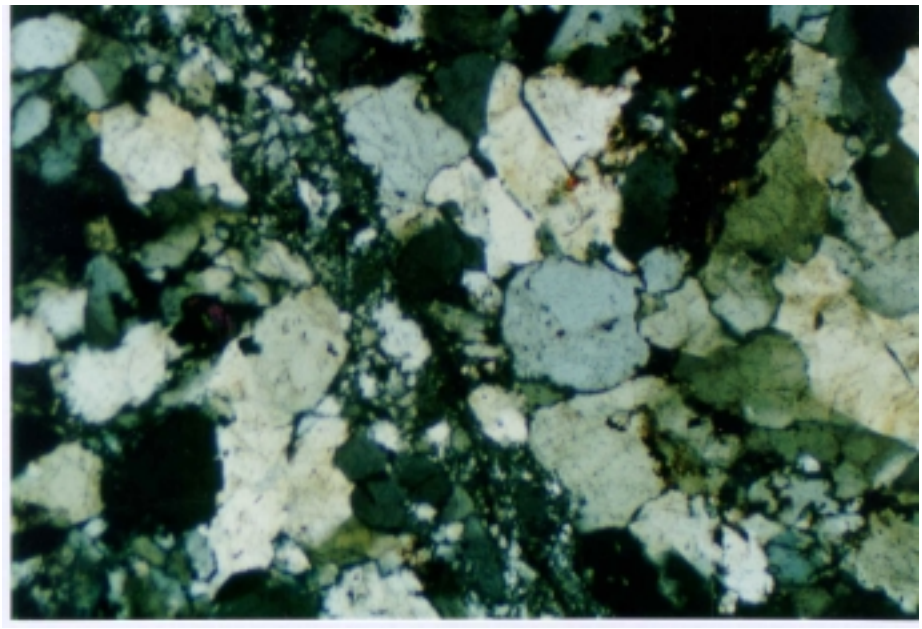
PLATE 4 : SAMPLE : DA98C41211 : TS C71341



500 μm

(a) Transmitted, plane polarised light (17, 5)

A zircon grain is labelled Z.

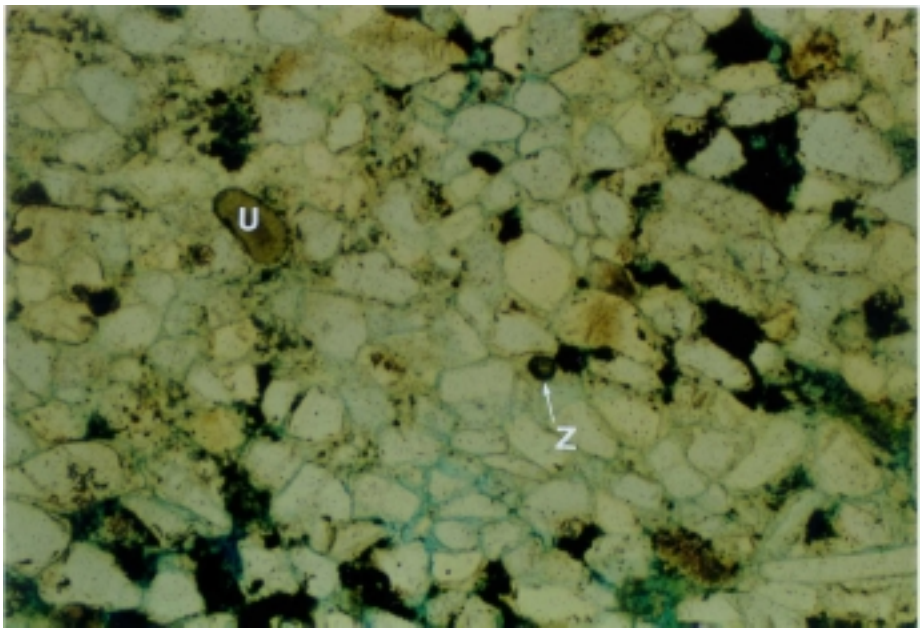


500 μm

(b) Same field as (a); crossed polars (18, 5)

This field shows strongly recrystallised quartz, which is transected by a vein containing finely granulated quartz.

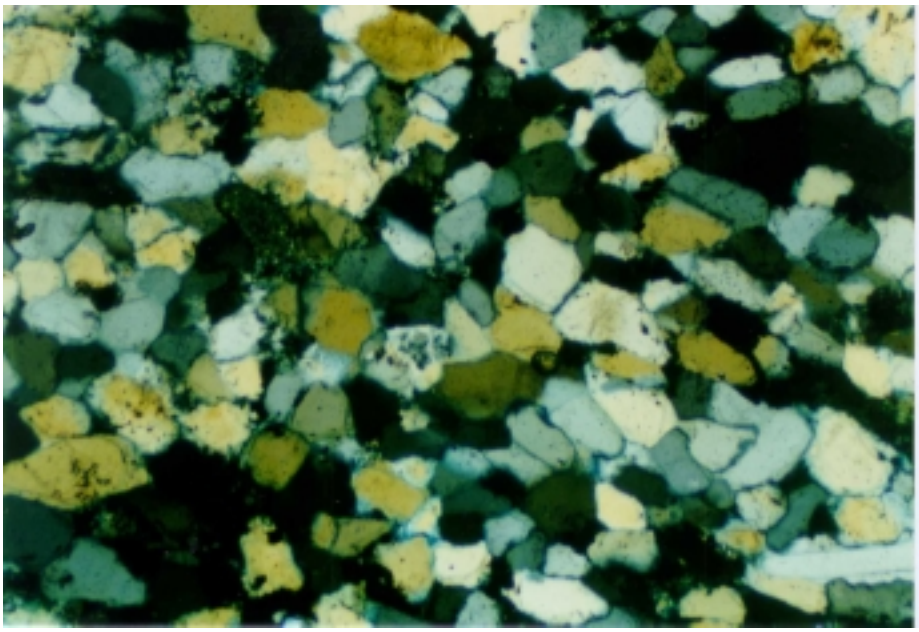
PLATE 5 : SAMPLE : 1E4 : TS C71385



500 μm

(a) Transmitted, plane polarised light (19, 5)

The clay patch (U) at upper left of field has a rounded, detrital-appearing shape and is thought to represent an altered detrital particle. A small zircon grain is labelled Z.

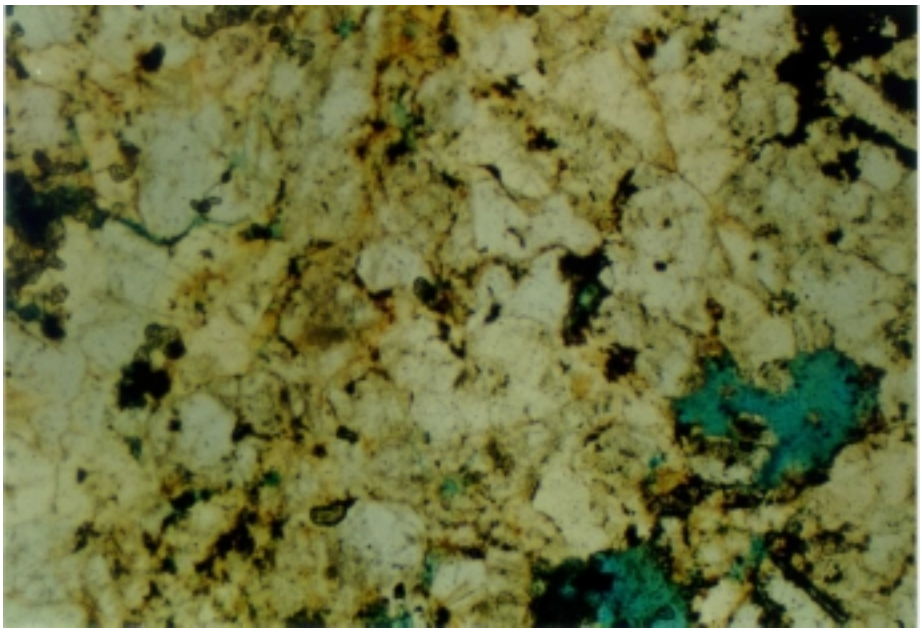


500 μm

(b) Same field as (a); crossed polars (20, 5)

This field shows detrital quartz grains cemented by overgrowth quartz.

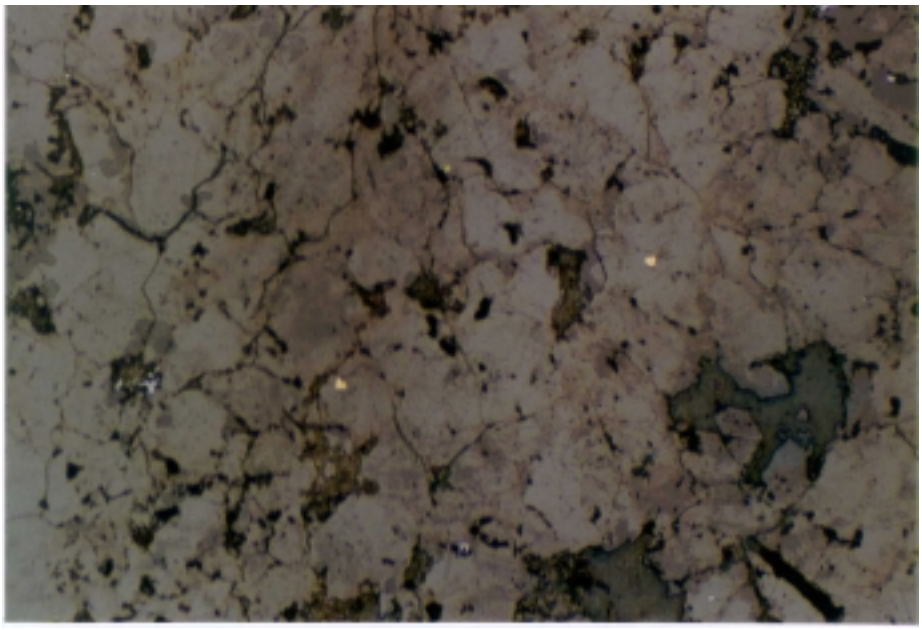
PLATE 6 : SAMPLE : DA98C3608 : TS C71386



500 μm

(a) Transmitted, plane polarised light (21, 5)

This field contains strongly recrystallised quartz grains intergrown with opaque to translucent iron oxides and iron oxide stained clay. The blue areas at lower right of the field are voids with partial linings of opaque material.

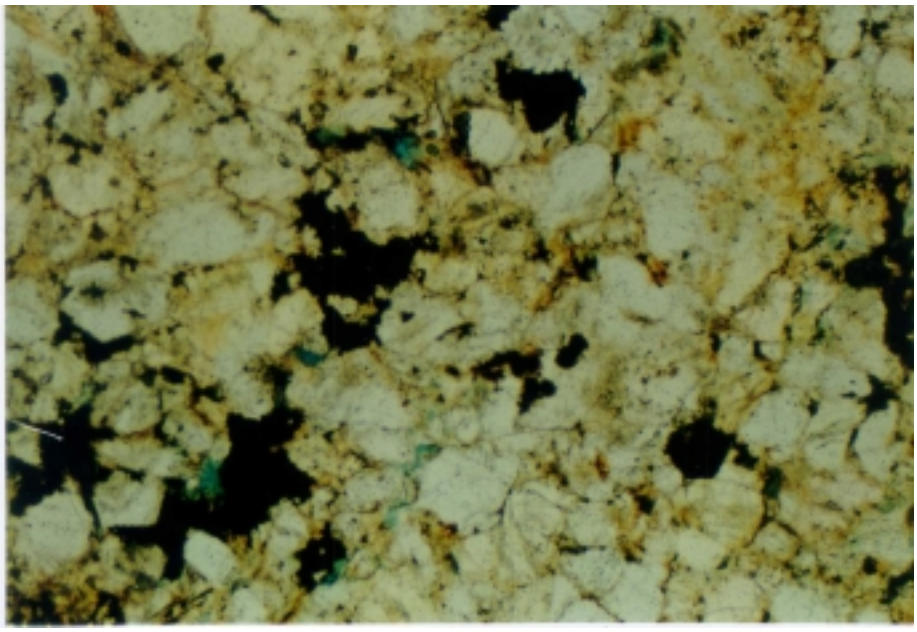


500 μm

(b) Same field as (a); reflected light (22, 5)

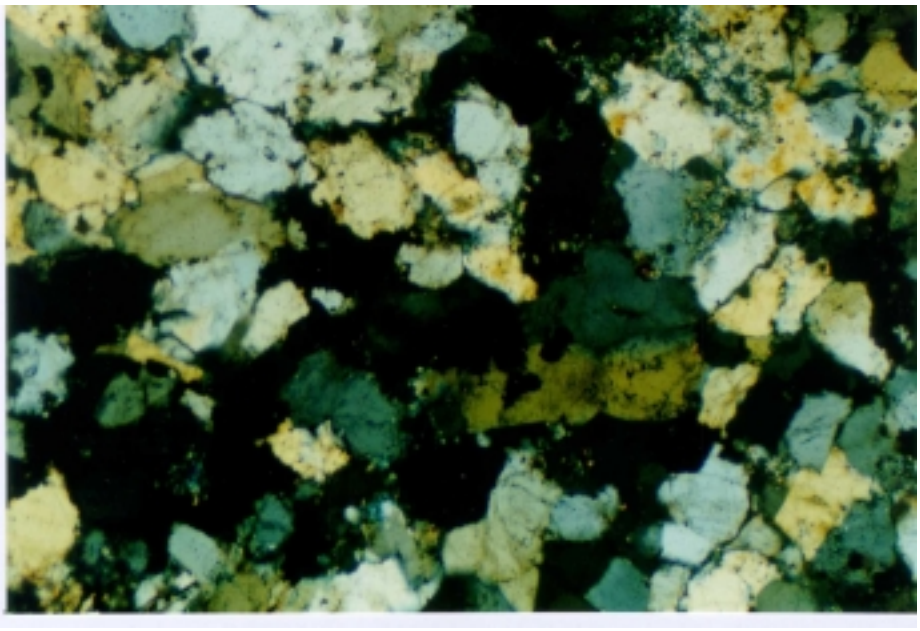
Three small chalcopyrite grains (bright yellow) occur as inclusions in quartz grains. The iron oxides are readily visible in reflected light and are thought to occur as fine intergrowths with clay, forming poorly polished interstitial intergrowths. Minor hematite (pale grey) forms fine intergrowths with clay.

PLATE 7 : SAMPLE : DA98C3608 : TS C71386



500 μm

(a) Transmitted, plane polarised light. (23, 5)

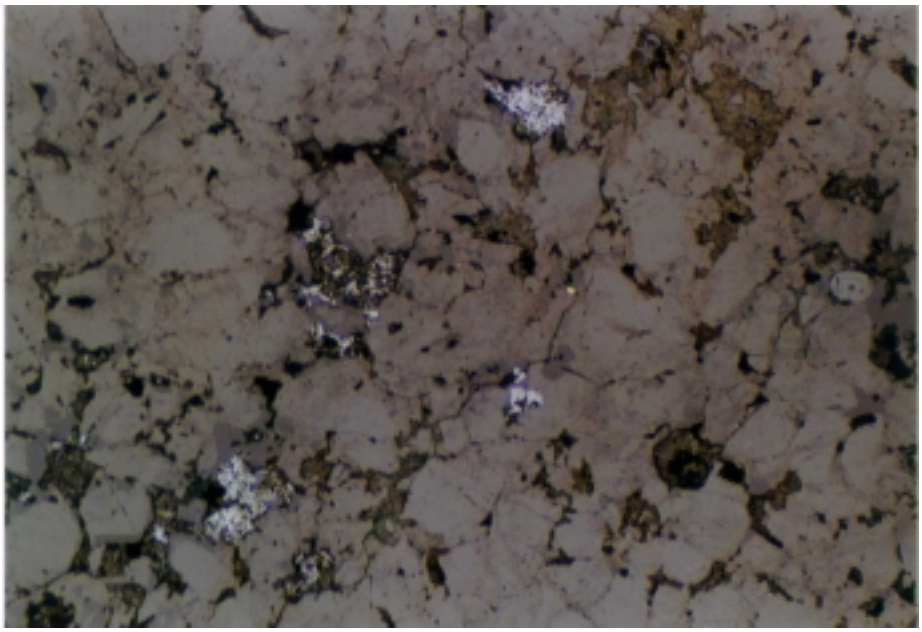


500 μm

(b) Same field as (a); crossed polars (25, 5)

Strongly recrystallised quartz is intergrown with opaque (black in field (a)) iron oxides, which occur interstitially between the quartz grains.

PLATE 8 : SAMPLE : DA98C3608 : TS C71386



500 μm

(a) Same field as Plate 7; reflected light (24, 5)

The iron oxides consist mainly of hematite (pale grey). A small chalcopyrite grain (bright yellow) is near the centre of the field.