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1986/87. Mineralogy of some King River Delta metallurgical products.

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Abstract

These products, representing a sediment overwhelmed by Mt Lyell Mine tailings, exhibit very little weathering and are rich in sulphides. Much of the chalcopyrite, as with other minerals of interest, is locked within lithic particles (Lyell Schists), but pyrite is predominantly free. A large proportion of chalcopyrite and other phases are is also free, while there are similar proportions of chalcopyrite locked with pyrite and magnetite. Overall, most chalcopyrite would be present in grains larger than 30 micrometres, despite a considerable amount of very fine, often sub-micron chalcopyrite.

Other minerals of interest include molybdenite, sphalerite, rutile, magnetite, chromite, barite, apatite, zircon and monazite.

INTRODUCTION

Four samples of King River Delta sediment, each separated into various fractions by sizing, flotation and tabling, were received from the Department of Mines' Launceston laboratories for examination. The study had an emphasis on the distribution, grain size, locking and associations of chalcopyrite and other economic minerals. The sample details are given in Table 1, the mineralogical constitutions in Table 2, chalcopyrite associations in Table 3, and chalcopyrite grain sizes in Table 4. Figure 1(a-d) illustrates chalcopyrite grain size distributions.

MINERALOGICAL CONSTITUTION

Most samples are dominated by quartz and lithics, except for the flotation concentrates which are pyrite-dominant. Most lithics are quartz-rich schist with variable amounts of muscovite, chlorite, magnetite, hematite, carbonate and sulphides, and represent Lyell Schists. Sample 17 is relatively fine-grained and thus has greater liberation of minerals, and in particular more free quartz and phyllosilicates. Most free mineral phases are also compatible with an origin in Lyell Schists, with the exception of chromite. This is well rounded and somewhat altered, in contrast to the fresh and angular nature of most of the other grains.

Chalcopyrite probably ranges about 0.2-1% through the samples, and is most abundant in the flotation concentrates.

SULPHIDE LOCKING AND ASSOCIATIONS

Pyrite is dominantly free in all samples, with only a small to negligible proportion locked in lithic grains, carbonate and magnetite. The grain size ranges between 20-250 μm. A large proportion of pyrite grains contain chalcopyrite, as very fine to coarse rounded inclusions or in fine veinlets.

Chalcopyrite is more variable in its association and locking (Table 3). The most abundant mode of occurrence of chalcopyrite overall is locked with quartz and lithic grains. This chalcopyrite varies from fine inclusions a few micrometres in size, complexly locked with phyllosilicates, to grains

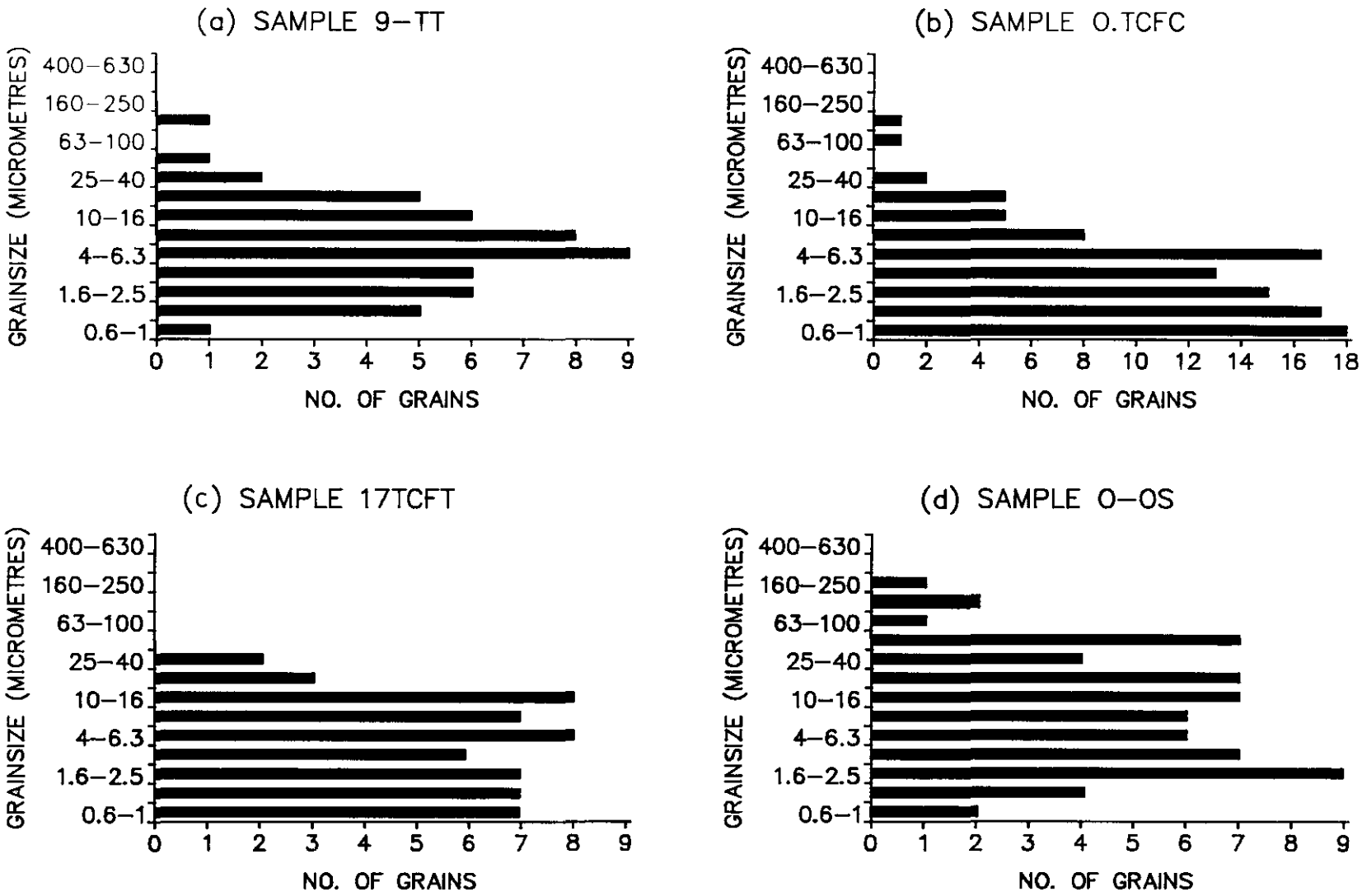

Figure 1. Grainsize distribution of chalcopyrite samples, King River Delta.

5 cm

over 100 μm in size and simply locked with quartz. The degree of liberation is frequently high, especially in flotation concentrates. Where free chalcopyrite occurs in tails it is often as fine grains (e.g. sample 17TT). Flotation concentrates also have a high proportion of chalcopyrite locked with pyrite (fig. 2), as described above, although much of this is very fine grained, often submicron (fig. 1b). Flotation tails/table concentrates have a high proportion of chalcopyrite locked with magnetite, and have very little free chalcopyrite. The chalcopyrite is relatively fine (5-20 μm), but coarser than in pyrite. The oversized fraction (O-OS) contains chalcopyrite in lithic particles. Chalcopyrite is also common in hematite grains, and is rare in carbonate, apatite and barite.

SIZE DISTRIBUTION OF CHALCOPYRITE

The size distributions of chalcopyrite were determined approximately for four samples and plotted as Figure 1. The arithmetic mean, average volume mean (the diameter of a particle of mean volume), and the volume percent less than 10 μm are shown in Table 4.

There is a wide range in grain size for all samples examined, with a strong bias towards the finer grain sizes, causing a large discrepancy between the arithmetic mean and the average volume mean. The average volume mean is affected markedly by large grains, and scarcely by the finest grains. The arithmetic mean, in comparison, is probably over-estimated in these samples due to sub-microscopic chalcopyrite not detected (see fig. 1c and 1d). The corollary of this is that three of the four samples measured have more than 50 % of the chalcopyrite present in grains above 30 μm in size, and these are likely to be free or simply locked. Sample 17TCFT has little coarse chalcopyrite, and copper recovery would be much poorer. The oversized fraction naturally has relatively coarse chalcopyrite (fig. 1d).

OTHER MINERALS

The only sulphides noted, besides pyrite and chalcopyrite, were single grains of molybdenite and sphalerite, both in flotation concentrates. The molybdenite was free and the sphalerite associated with pyrite. Some fine inclusions present in pyrite probably represent pyrrhotite.

Most other minerals of interest are enriched in the table concentrates/flotation tails, and include rutile, magnetite, chromite, barite, apatite, zircon and monazite. Rutile (including leucoxene) is present in most samples as very fine inclusions in lithics or pyrite, and in some samples is present as fine free grains. Magnetite is common as coarse grains, free or in lithics, and is notable for its chalcopyrite content. Chromite is rare, well rounded and slightly altered. Barite is present as coarse, free, subangular to subrounded grains, rarely containing chalcopyrite. Apatite is common in some samples, as subrounded, coarse, free grains with numerous gangue inclusions. Zircon and monazite are present as fine to medium grained crystals or crystal fragments, usually free.

CONCLUSIONS

The sediments are overwhelmingly composed of Mt Lyell mine tailings, which have undergone only minor abrasion and negligible leaching, weathering or alteration. No evidence was seen for the existence of any secondary minerals. About half of the chalcopyrite is present as free or simply-locked grains 30 μm or more in size, and should be readily

recoverable. There is a significant proportion of chalcopyrite in magnetite, and this may be difficult to recover unless upgraded magnetically and crushed to 10-20 μm. No cobalt-rich minerals were identified, but pyrite from Mt Lyell can contain up to 1250 ppm Co (Loftus-Hills, 1969), and this is probably the principal source of Co in the King River Delta. It should be possible to produce concentrates of zircon, monazite and other minerals which are mainly free. No gold was identified.

REFERENCE

LOFTUS-HILLS, G. 1968. *Cobalt, nickel and selenium in Tasmanian ore minerals.* Ph.D. thesis, University of Tasmania : Hobart.

[19 December 1986]

Table 1. DETAILS OF SAMPLE IDENTIFICATION AND PREPARATION

Sample no.	Equivalent sample no.	Launceston Laboratory no.	Metallurgical treatment
17	120486-17.FM, 25-KD 985	860490	Tabled, then floated
9	120486-9.FM 26-KD 985	860491	Tabled, then floated
0	120486-0.FM Composed of splits from 13, 14, 15, 16, 17, 18, and 19-KD 385	860492	-335 μ fraction tabled, then floated
CM	120486-17 + 9 + 0.FM Composed of splits from above three samples	860493	Floated, then tabled

Table 2. MINERALOGICAL CONSTITUTIONS OF KING RIVER DELTA METALLURGICAL PRODUCTS

Sample No.	Quartz	Mica	Chlorite	Lithics	Carbonate	Rutile	Monazite	Zircon	Apatite	Magnetite	Barite	Hematite	Pyrite	Chalcopyrite	Chromite	Tourmaline	Molybdenite	Sphalerite
17TT	4	3	2	3	1	1				1		1	2	1				
17TCFT	3	2	2	4	2	1	1	1	1	1	1	1	1	1	1			
17TCFC	2	1	1	2	2	1	1	1		2		1	4	1				1
9TT	3	2	3	4	1	1		1		1		1	1	1		1		
9TCFT	2		2	4	2	1	1	1	1	1	1	1	1	1				
9TCFC	1		1	2	1	1	1	1		1		1	4	1			1	
0OS	1			4									1	1				
0TT	2	1	2	4	1									1				
0TCFT	2		1	4	2	1	1	1	1	1	1	1	1	1	1			
0TCFC	1			1	1							1	4	1				
CMFC	1	1	1	1	1								4	1				
CMFTTT	2	2	1	4	2	1				1		1	1	1				
CMFTTC	1		2	4	2	1			1	2	1	2	2	1				

4 = dominant; 3 = subdominant (>20%); 2 = accessory (5-20%); 1 = trace (<5%); blank = not detected

Table 3. CHALCOPYRITE ASSOCIATIONS

Sample no.	Free	Locked with					
		Quartz & lithics	Pyrite	Magnetite	Hematite	Carbonate	Others (trace)
17TT	4	3	3	3	2		
17TCFT	2	4	1	3	2		
17TCFC	4	1	4	2	2		
9TT	3	4	1	1		1	
9TCFT		4		1			
9TCFC	4	3	4	1			
O OS		4	1				
O TT	1	4					
OTCFT	1	4	2	4	1		Apatite, barite
OTCFC	4	2	4	1			
CMFC	3	4	4		1		
CMFTTT	3	4	2	2	1		
CMFTTC		2	2	4	2		Apatite

4 = dominant or co-dominant; 3 = subdominant (›20%); 2 = accessory (5-20%); 1 = trace

Table 4. STATISTICS ON CHALCOPYRITE GRAIN SIZE

Sample	Arithmetic mean*	Average volume mean*-	Volume % ‹10 µm
9TT	11.4	36.6	7.3
OTCFC	6.8	30.2	21.0
17TCFT	6.8	12.7	28.1
O OS	21.9	60.6	0.6

* in micrometres

- $\sqrt[3]{(\text{total volume} / \text{no. grains})}$

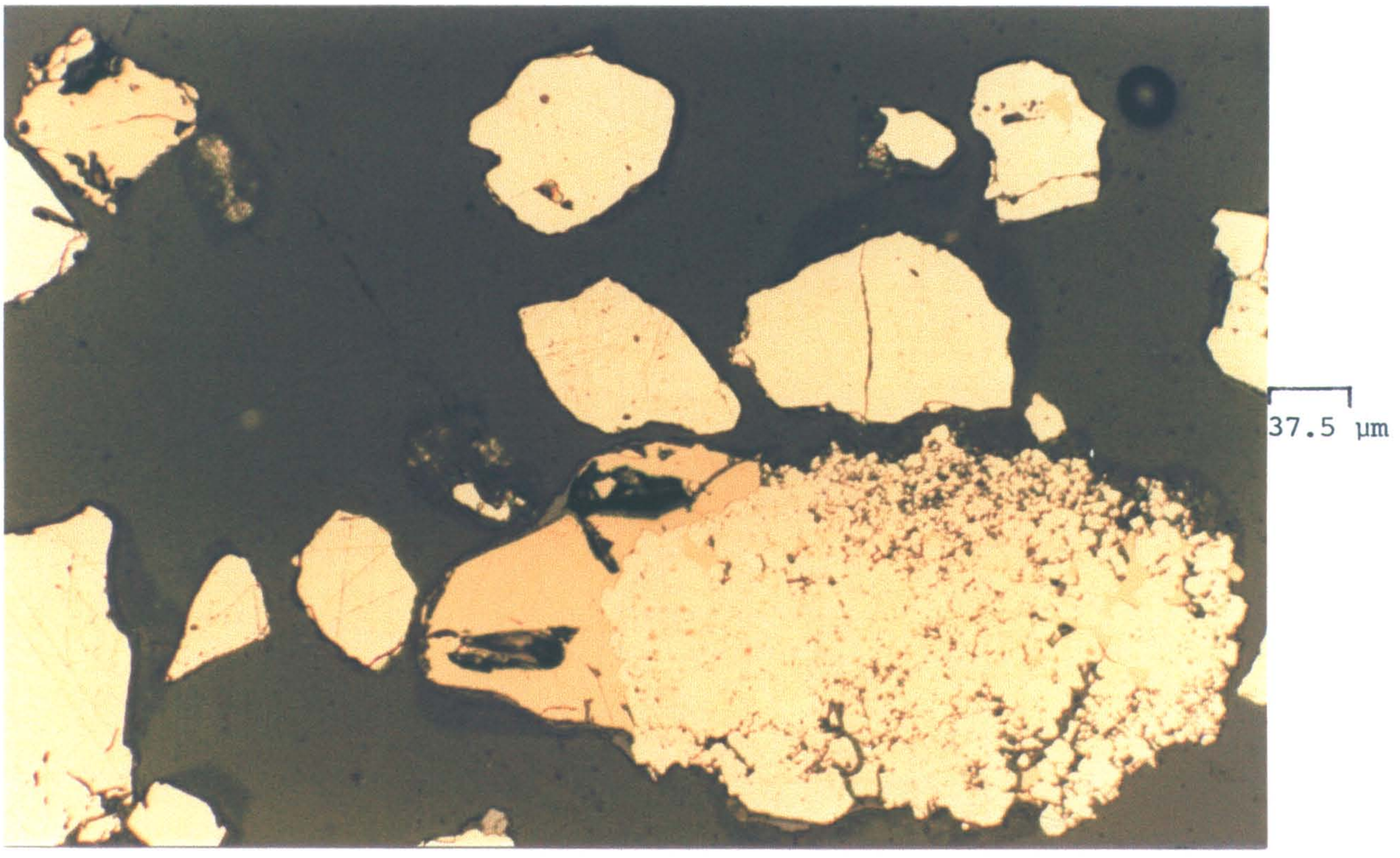

Figure 2. *Chalcopyrite (yellow): liberated (top left) and locked with pyrite (cream, bottom right). Sample O-TCFC, reflected light, in air.*

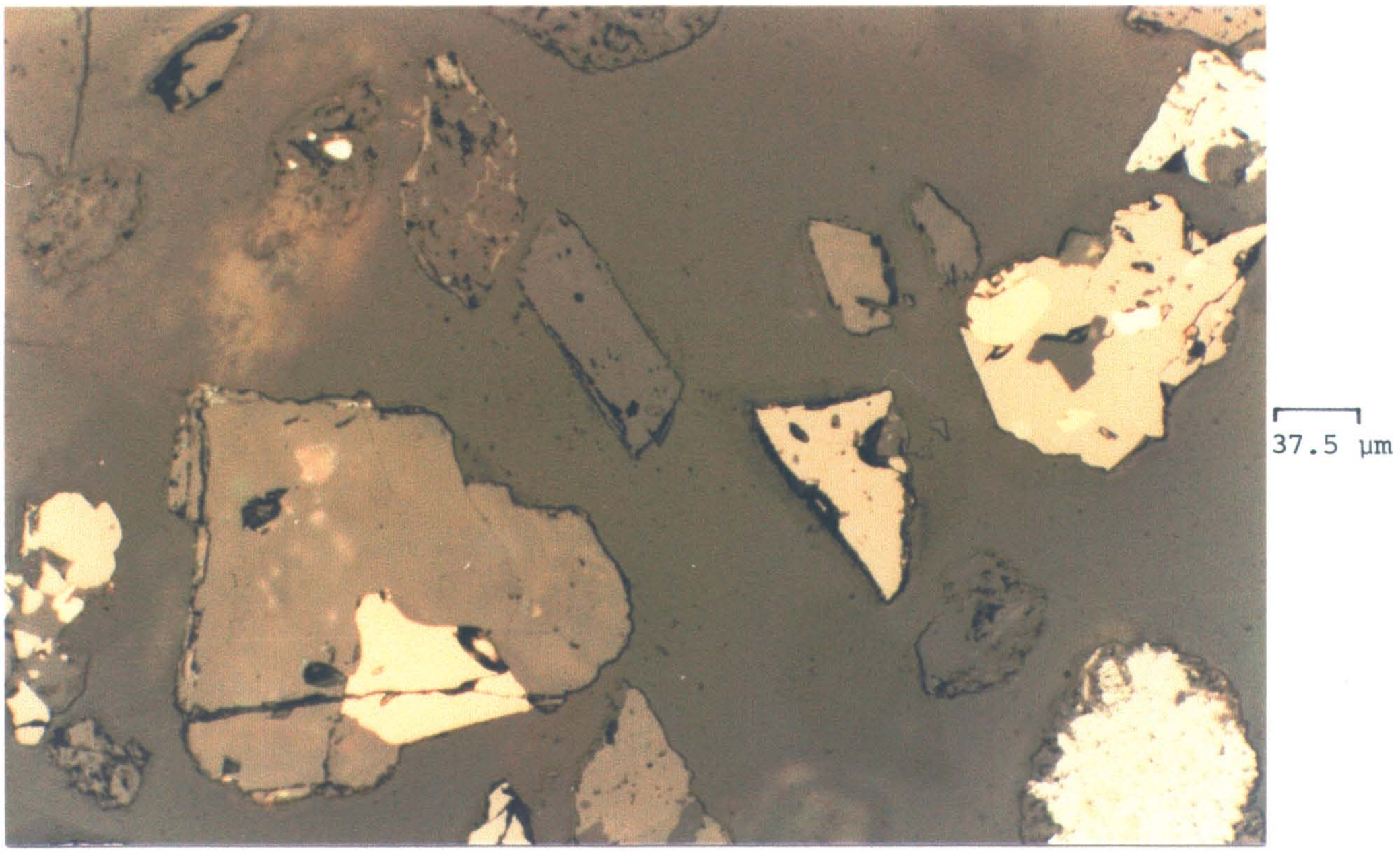

Figure 3. *Chalcopyrite (pale yellow): locked with quartz (mid-grey, lower left) and with magnetite (bright grey-brown, upper right). Sample O-TCFT, reflected light, in air.*

5 cm