
CHAPTER 9

CONCLUSIONS AND RECOMMENDATIONS

This thesis is an investigation of chemicals in the flotation of auriferous pyrite. Gold uranium and sulphur from AngloGold Ashanti's No 2 Gold were optimised using SIBX and mixtures of SIBX and TTC.

The effect of conditioning at low-pH (1.9-3.7) prior to flotation, the activation of pyrite with lead nitrate and copper sulphate in the presence of cyanide and possible mechanisms contributing to uranium flotation were studied. The following conclusions have been made:

- A steady increase in sulphur, uranium and gold recovery was found in SIBX doses from 10g/t to 40g/t. The gold grade was unaffected by dosage between these limits.
- Synergism was shown to occur in gold flotation at 25 mole percent C₁₂ TTC and 75 mole percent SIBX. Gold recovery improved from 39% to 45.3%. At a similar mole ratio, 15.6% uranium recovery was recorded with a C₁₀ TTC/SIBX mixture. This was an increase by a factor of 12% when compared to 13.92% recorded with the standard.
- A re-run of bulk flotation experiments testing fresh SIBX/C₁₂ TTC mixtures recorded almost similar mass recoveries for all three collector mixtures. These were all higher than the standard. Water recoveries indicated that the higher mass recoveries were due to increased gangue recovery. Almost similar sulphur recoveries were observed for the standard and all three SIBX/TTC mixtures. The highest uranium and gold recoveries were observed at 8 mole percent TTC. This is close to dosages of 2 - 5 mole percent TTC in SIBX used in commercial operations. The

results also indicated that SIBX/C₁₂ TTC had more effect on gold than on either sulphur or uranium.

- Based on time/recovery studies, initial rates and final recoveries shown that the combination of 92 mole percent SIBX and 8 mole percent commercial C₁₂ TTC performed better than SIBX alone. A combination of SIBX and a diluted and aged 1% wt solution of TTC marginally lost activity when compared to that of SIBX and fresh commercial TTC. This was attributed to the hydrolysis of TTC. The product of decomposition would then be a mercaptan. The mercaptan/SIBX reference sample showed a distinct reduction in grade recovery and kinetics. The conclusion therefore is that when dosed as such, mercaptan is detrimental to flotation activity. The mercaptan on its own is not an effective flotation agent and exhibits no synergism, but rather has a depressing effect.
- Micro-probe analysis, back-scattered electron images, and EDS analysis showed that all the uranium recovered in flotation concentrates was associated with either pyrite, galena or a carbonaceous material (called karogen). Since the sulphides respond to xanthates and karogen is naturally hydrophobic, its flotation of the uranium oxide minerals (brannerite and uraninite) was attributed to these mineralogical associations. It is however recommended that more work be done to quantify the distribution of uranium in each of the host minerals using instruments like the QEM SCAN. Once the mineral that hosts the largest proportion of uranium is established, further work to maximise recoveries through flotation of the host can be undertaken.
- A preconditioning step at pH 1.9-3.7 gave higher gold, sulphur and uranium initial rates. Sulphur and uranium final recoveries were lower while gold final recovery was higher than the standard. Grade-recovery curves indicated that uranium lost flotability considerably after the low-pH treatment while gold improved significantly.

- In the presence of 0.001M cyanide, 70g/t copper sulphate (440 mmol/t) Cu^{2+} failed to activate pyrite at both pH 5.5 and the standard flotation pH of 7.2. At a similar dosage an equi-molar dose Pb^{2+} did not activate the sulphide at pH 7.2 either. It was only functional at pH 5.5. The lack of activation at the alkaline pH is contrary to work by Sui et al. (1997) who observed enhanced xanthate uptake with lead-activated pyrite at pH 10.5. Since lead does not complex with cyanide, it was expected to aid xanthate uptake in the present work. The investigation by Miller (2003) that was used as a precursor to this study was run at pH 4.7. Examination of speciation diagrams showed at this pH, the Pb^{2+} species is prevalent. In this view, it is recommended that further work be done to characterise the lead adsorption onto pyrite in the presence of cyanide in order to determine whether the cationic state is a requirement for lead to activate pyrite, and possible reasons for the lack of activation at alkaline pH.

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Appendix A – Back – Scattered Electron Images

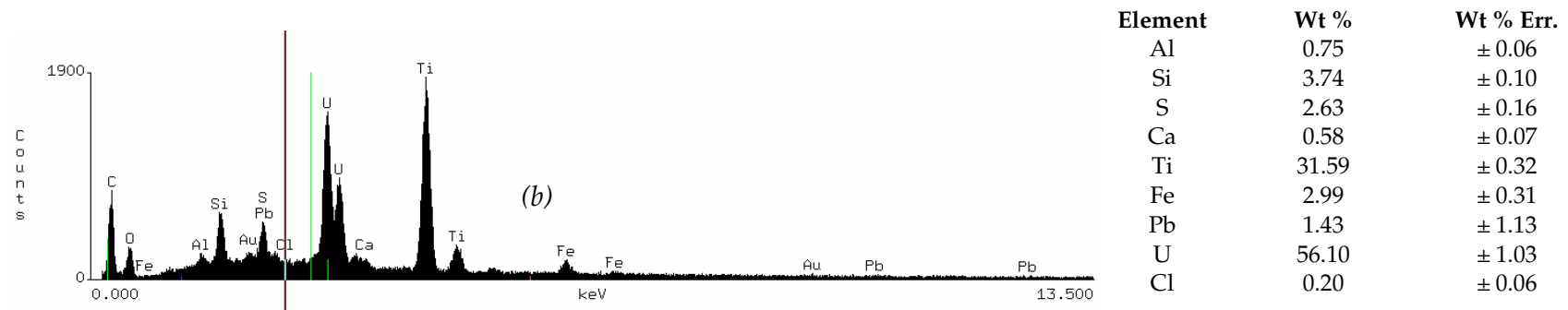
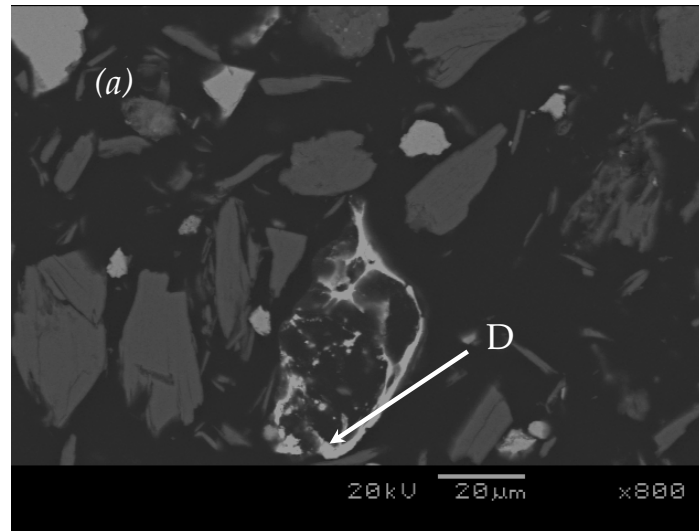
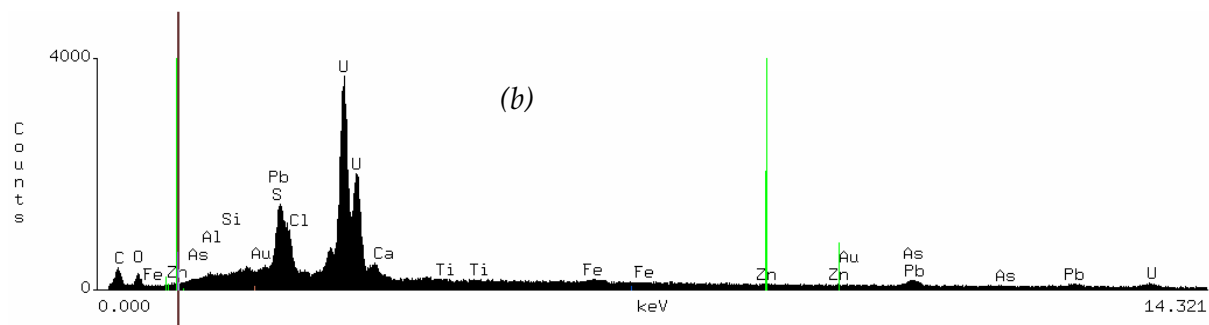
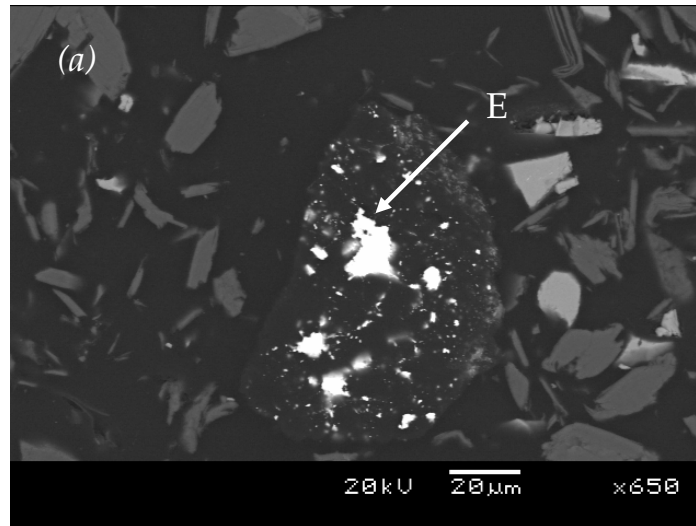


Figure A1 (a) BEI of a uranium-bearing particle and (b) corresponding EDS spectra showing its elemental composition

Appendix A – Back – Scattered Electron Images



Element	Wt%	Wt % Err.
Al	0.12	± 0.04
S	1.05	± 0.22
Fe	0.60	± 0.13
Pb	17.90	± 2.69
U	78.58	± 1.06
Cl	0.90	± 0.16
Zn	0.58	± 0.21

Figure A2 (a) BEI of a uranium-containing particle and (b) corresponding EDS spectra showing its elemental composition

Appendix A – Back – Scattered Electron Images

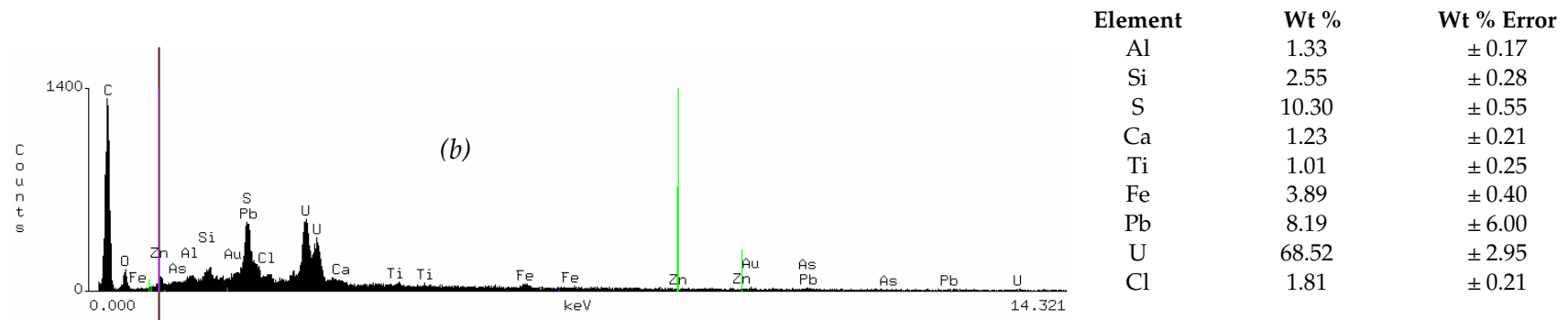
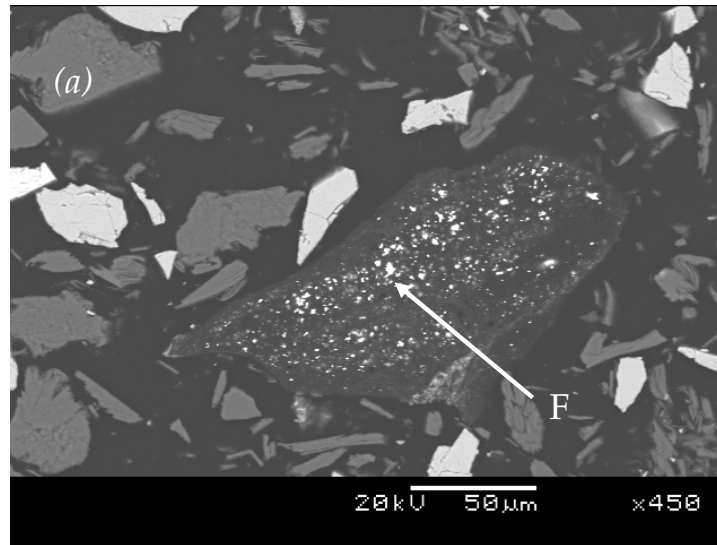


Figure A3 (a) BEI of a uranium-containing particle and (b) corresponding EDS spectra showing its elemental composition

Appendix A – Back – Scattered Electron Images

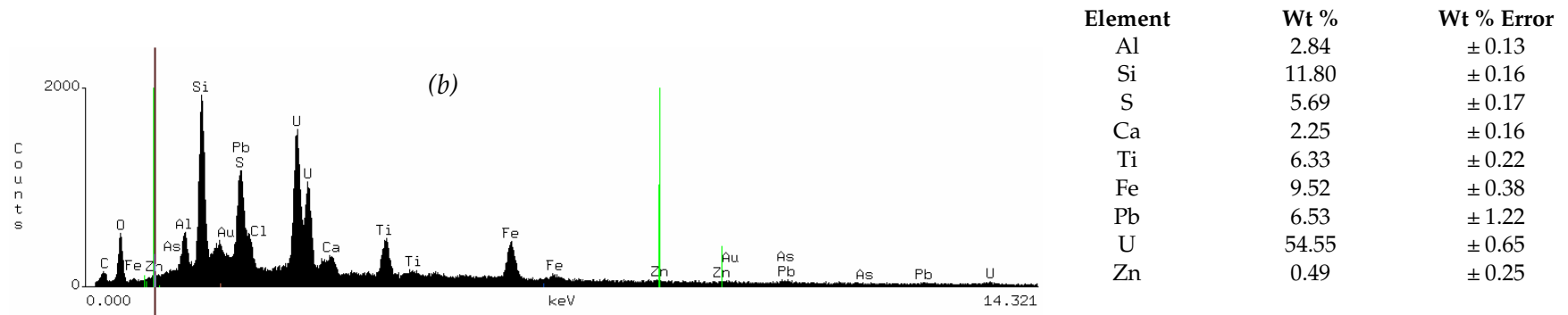
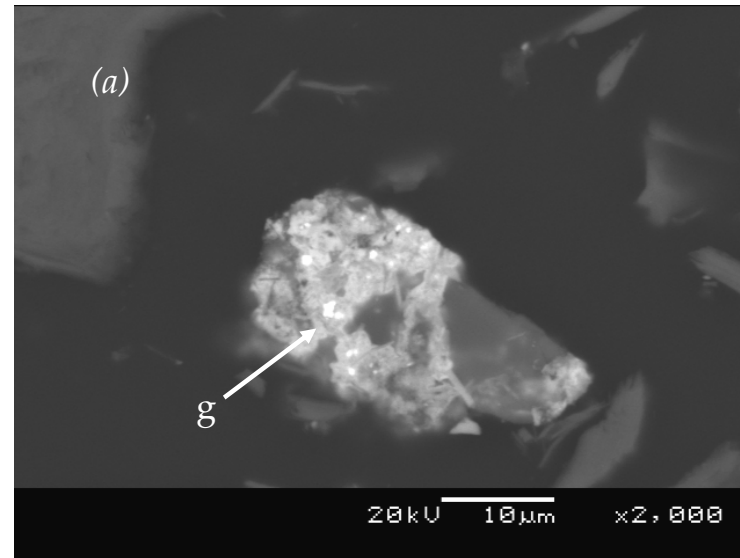


Figure A4 (a) BEI of a uranium-containing particle and (b) corresponding EDS spectra showing its elemental composition