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Flotation Chemistry of Complex Sulphide Ores:

Recycling of Process Water and Flotation Selectivity

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Introduction

Froth flotation method is used annually to concentrate more than one billion tons of global sulphide ores (Fuerstenau et al., 2007) and it requires billions of gallons of water in the process

Recycling of flotation effluents through the ore processing plant is one of the ways of reducing both plant-operating costs and industrial impact onto the local ecosystem

Background

- Recycled water in sulphide mineral processing plants have shown various effects in the recovery of sulphide minerals

- A number of major and minor species exists as components of recycled water these includes: Ca^{2+}, SO_4^{2-}, SO_3^{2-},$S_2O_3^{2-}$,$S_4O_6^{2-}$ etc, rest flotation reagents, traces of some transition metals and a number of microorganisms

AIM

To establish the effects of two major species of Ca^{2+} and SO_4^{2-} on the flotation of sulphide minerals

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Materials and methods

Pure Chalcopyrite, Galena, Sphalerite and Pyrite from various sources

Complex sulphide ores from Boliden Renström and Kristineberg mines

Deionised, process and tapwater

- Hallimond flotation
- Zeta-potential measurements
- Diffuse reflectance FTIR spectroscopy measurements
- XPS measurements
- Bench-scale flotation of sulphide ore

Hallimond flotation

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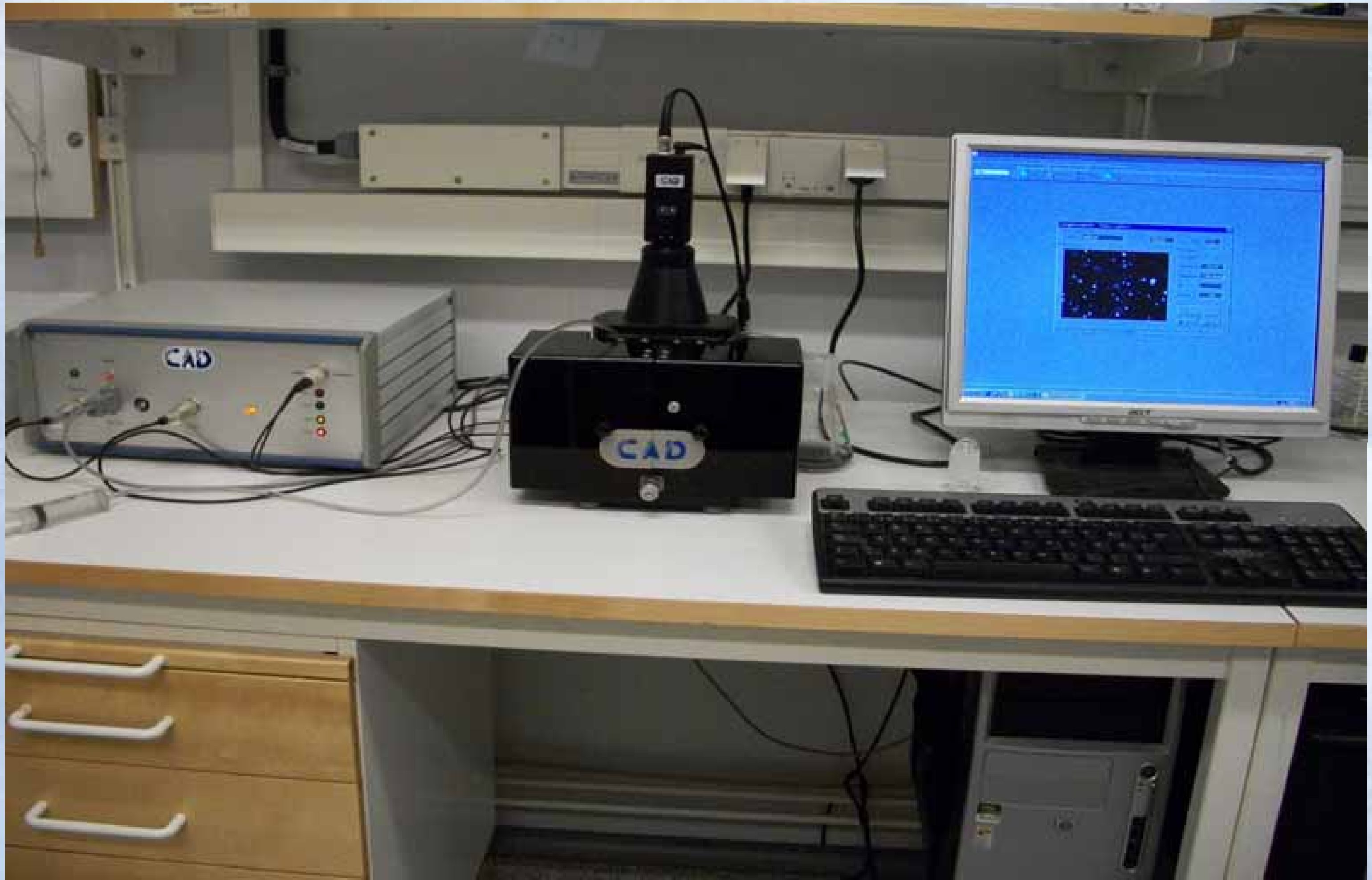
Zeta-potential measurements



DRIFT-FTIR spectroscopy

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XPS-spectroscopy

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Bench-scale flotation

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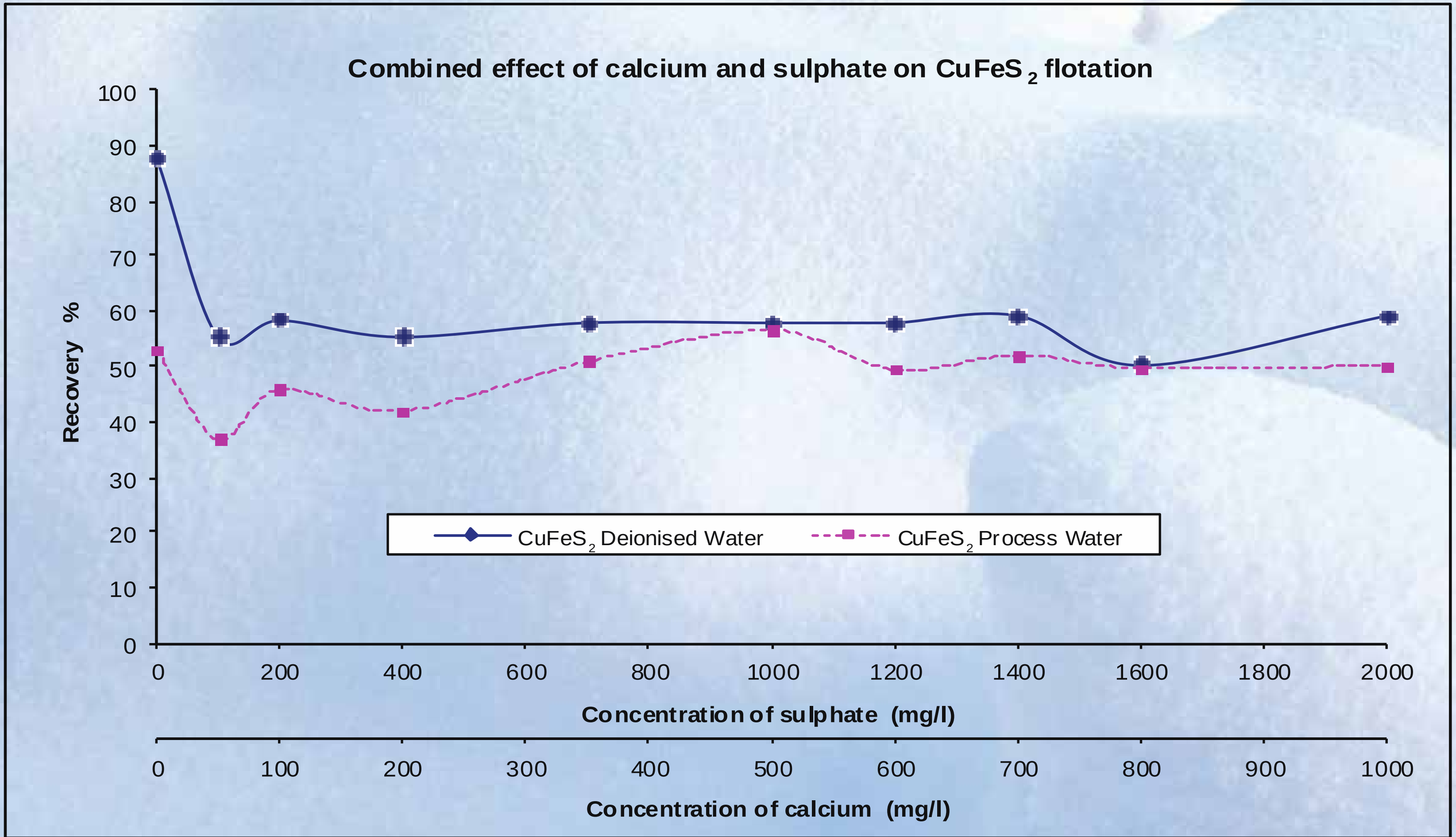
Results and discussions

Hallimond flotation results



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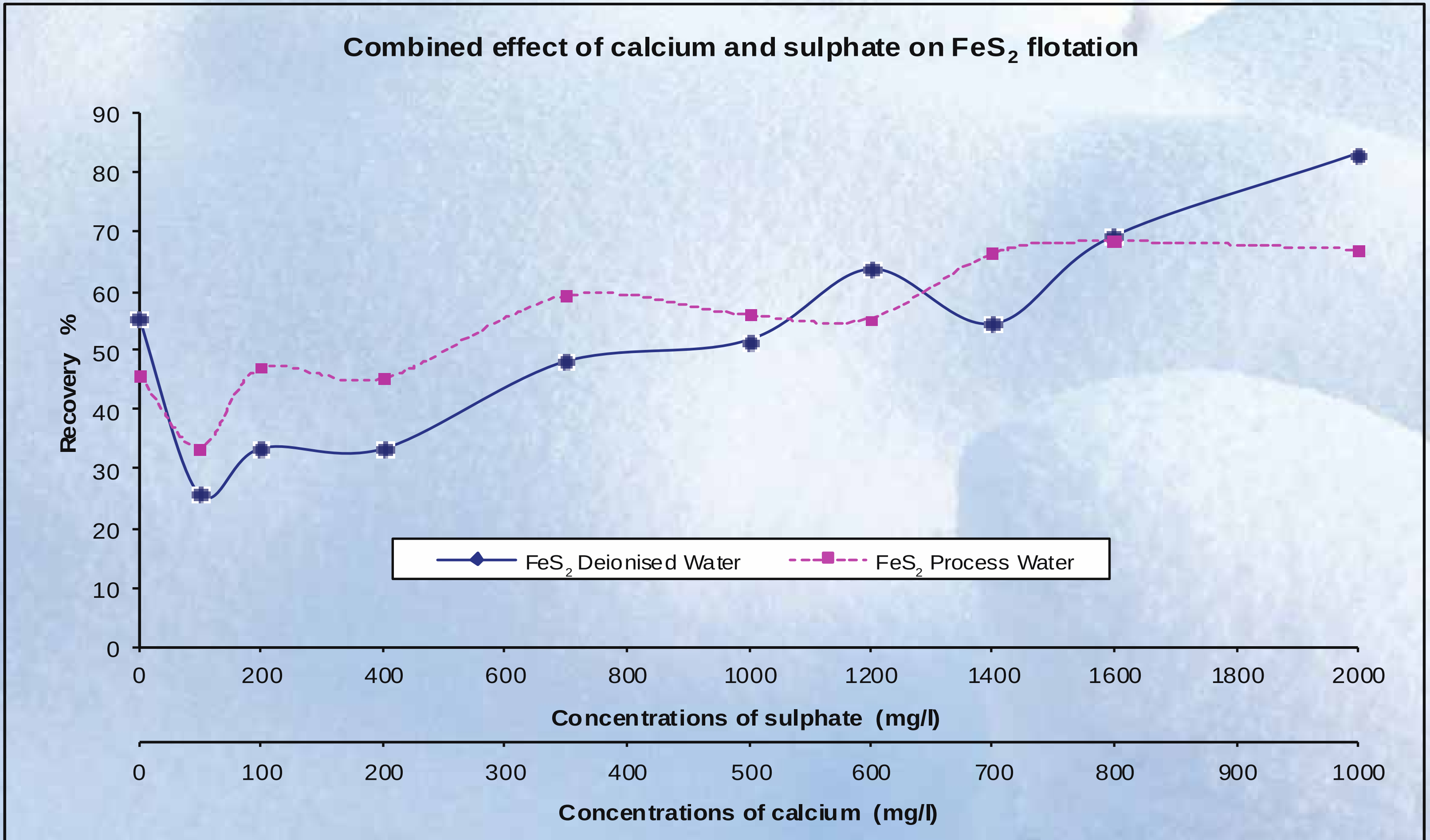
Hallimond flotation contd.



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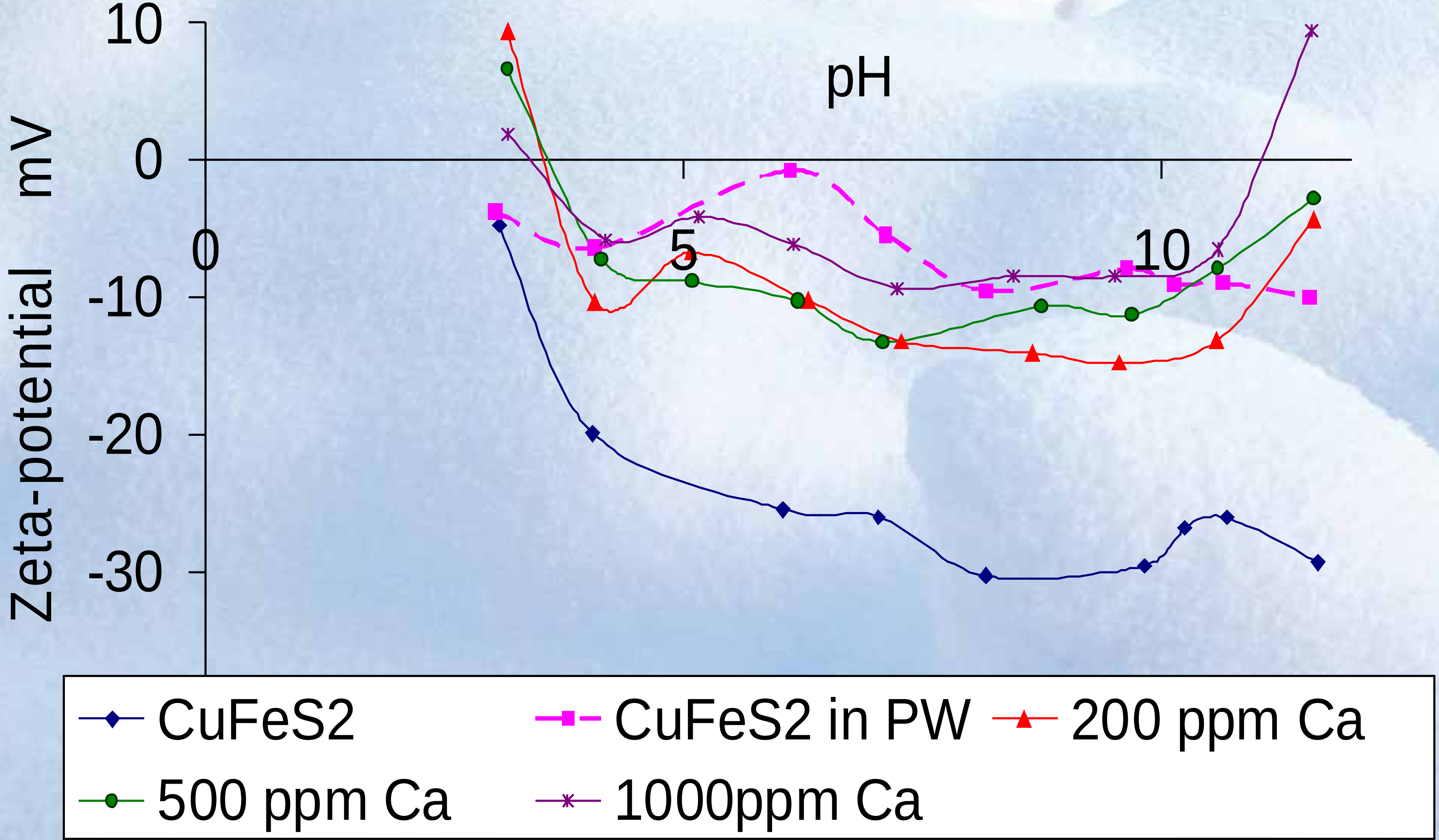
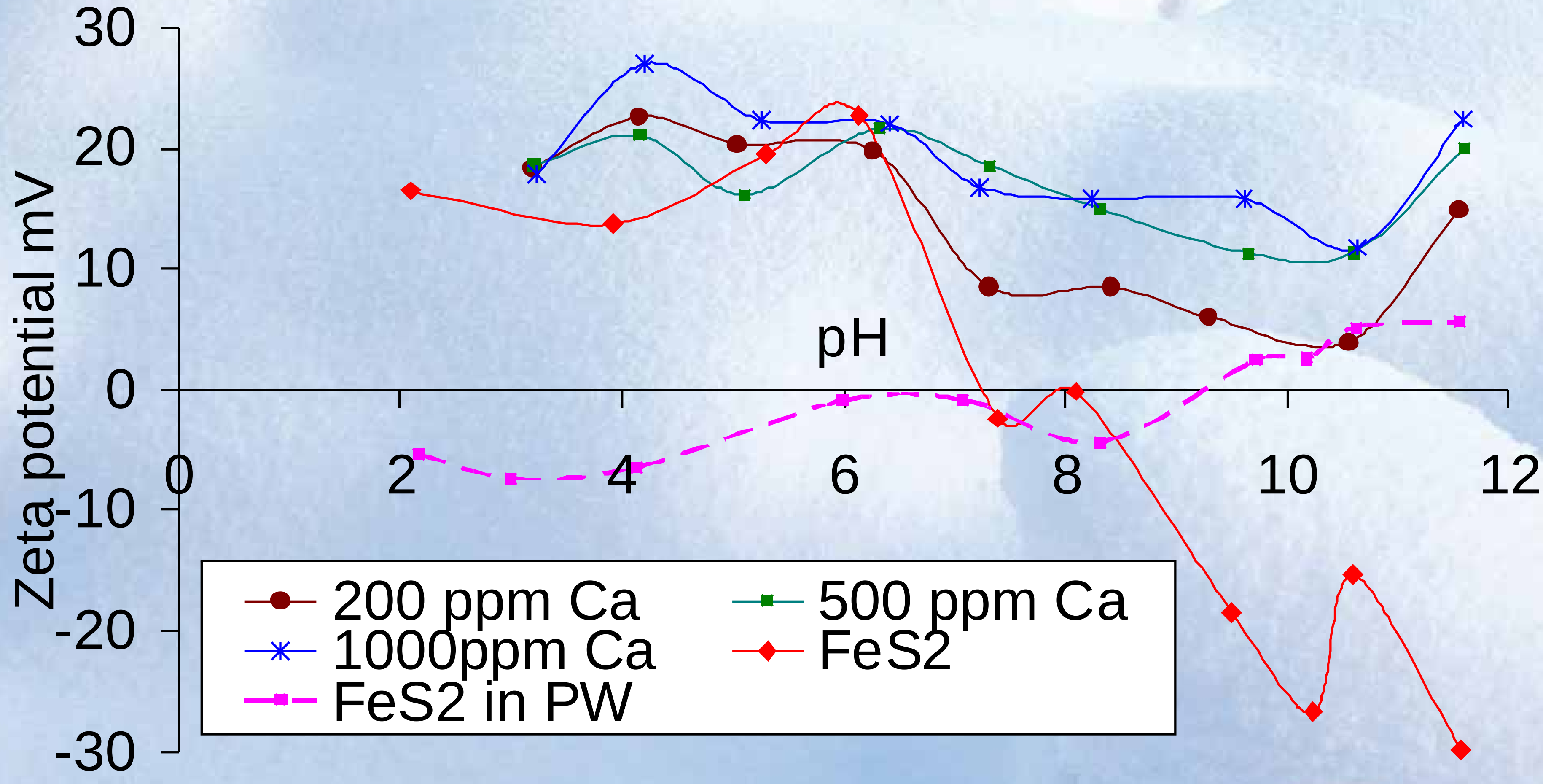
Zeta-potential



Zeta-potential contd.



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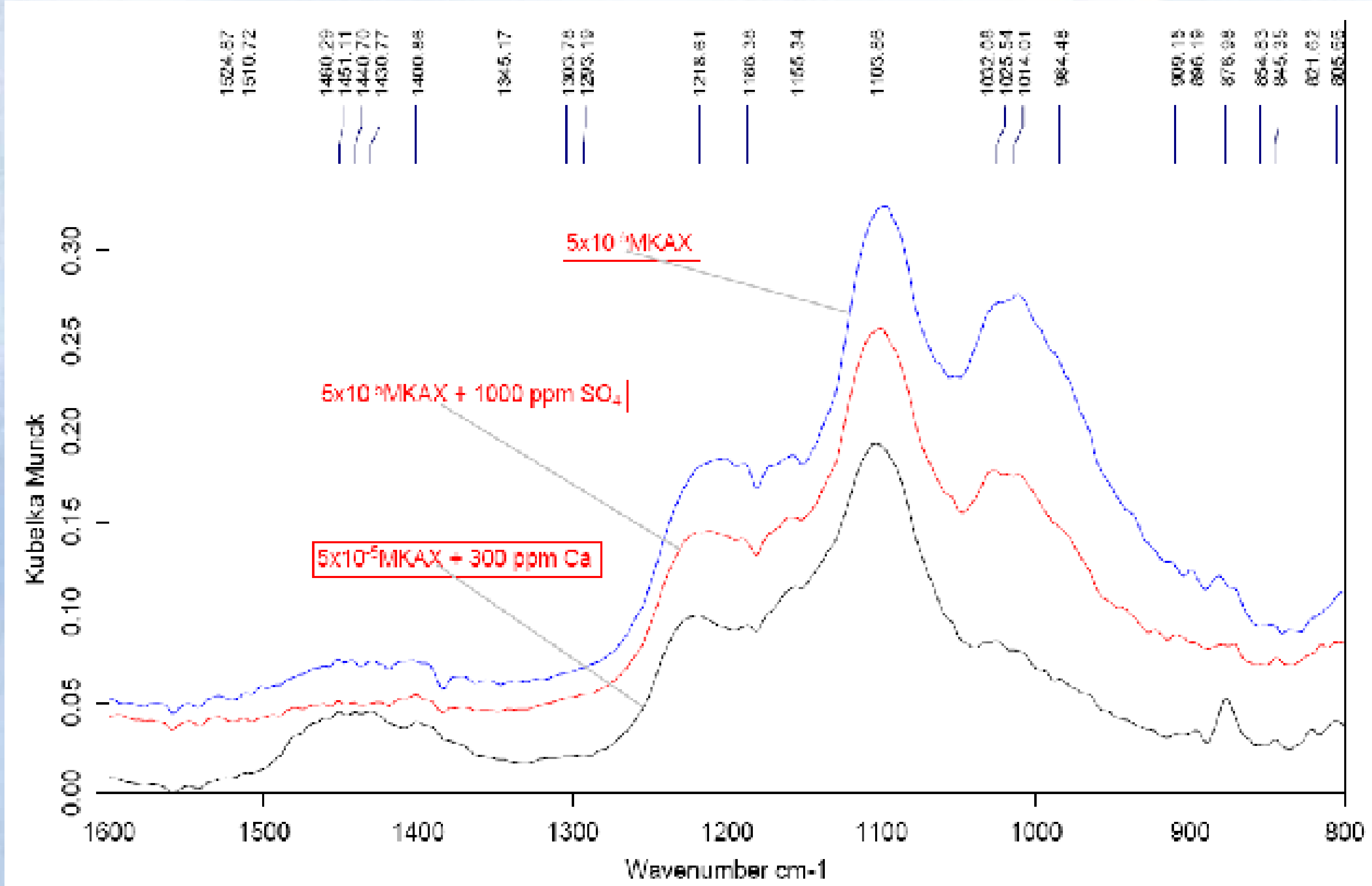
DRIFT-FTIR Contd.

Effect of Ca^{2+} and SO_4^{2-} in adsorption of xanthate on chalcopyrite in deionised water



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Bench-scale flotation

	Renström ore		Kristineberg ore	
	Tapwater	Process water	Tapwater	Process water
Recovery %				
22.5°C				
Cu	87.99	89.67	91.52	92.53
Pb	82.63	88.51	80.71	85.71
Zn	72.46	67.41	22.53	41.99
11°C				
Cu	83.81	84.94	89.91	89.13
Pb	75.44	74.48	83.48	77.15
Zn	67.76	69.88	37.98	46.81
4°C				
Cu	83.39	82.13	89.03	88.99
Pb	75.58	74.15	82.28	84.73
Zn	68.18	70.21	36.34	50.78

Conclusions

- Calcium and sulphate ions have significant depressing effect on chalcopyrite and activating effects on pyrite in Hallimond flotation
- Singnificant effect of calcium and not sulphate ions are seen on the zeta-potential of all the minerals
- FTIR and XPS shows that the minerals contains oxidised surface species which are mostly removed by xanthates
- Bench scale flotations shows that recovery decreases with temperature,Better recovery in process water, Reduced calcium concentration and increased sulphate concentration in the final pulp water

Acknowledgement

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- Assoc. Prof. Allan Holmgren (co-supervisor Ltu)
- Andreas Berggren (Manager process technology Boliden AB)
- Prof. Oleg Antzutkin (chairman ARC-MMS)

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- Finally Bergforsk (Rocktechcentre) for recognition of this work by giving the award

- Thanks for listening

- Questions?

Chemical species and their composition range in Boliden process water

Concentration range of chemical species in process water				
Species		Concentrations		
		From	To	Unit
Sulphate	SO_4	200	1500	mg/l
Calcium	Ca	100	500	mg/l
Iron	Fe	0.1	1300	mg/l
COD (Cr)		<30	130	mg/l
Nitrogen	N	0.1	10	mg/l
Phosphorus	P	<0.050	0.7	mg/l
Magnesium	Mg	4.3	53	mg/l
Manganese	Mn	4.4	8000	µg/l
Zinc	Zn	12	3900	µg/l
Aluminium	Al	59	59000	µg/l
Cadmium	Cd	0.12	5.2	µg/l
Cobolt	Co	4	540	µg/l
Copper	Cu	2.7	20000	µg/l
Mercury	Hg	<0.1	<0.13	µg/l
Conductivity at 25^{o}C		96	160	ms/m

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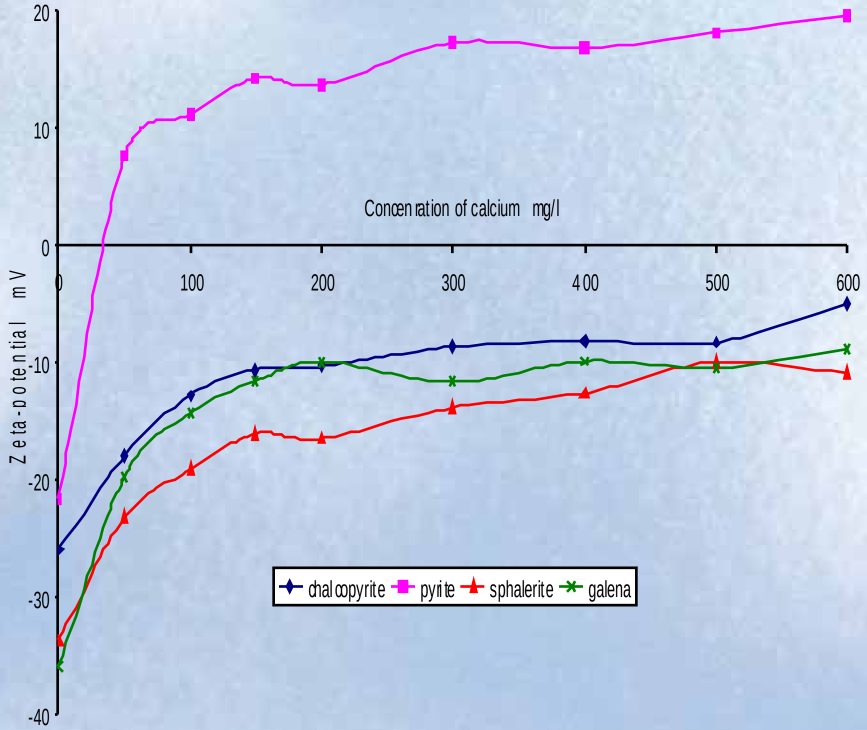
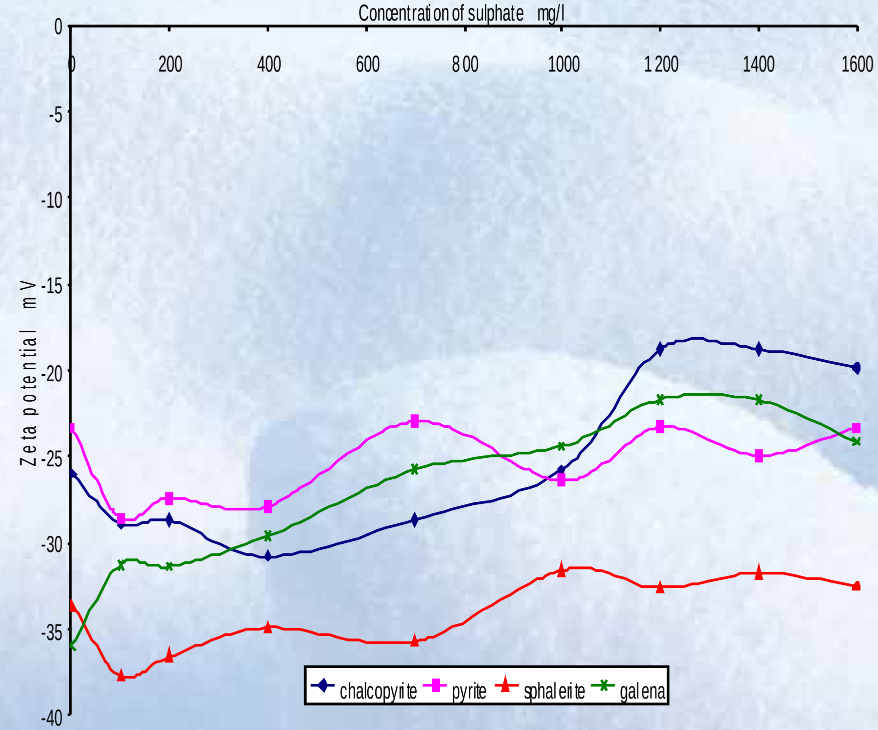
Zeta-potential contd.





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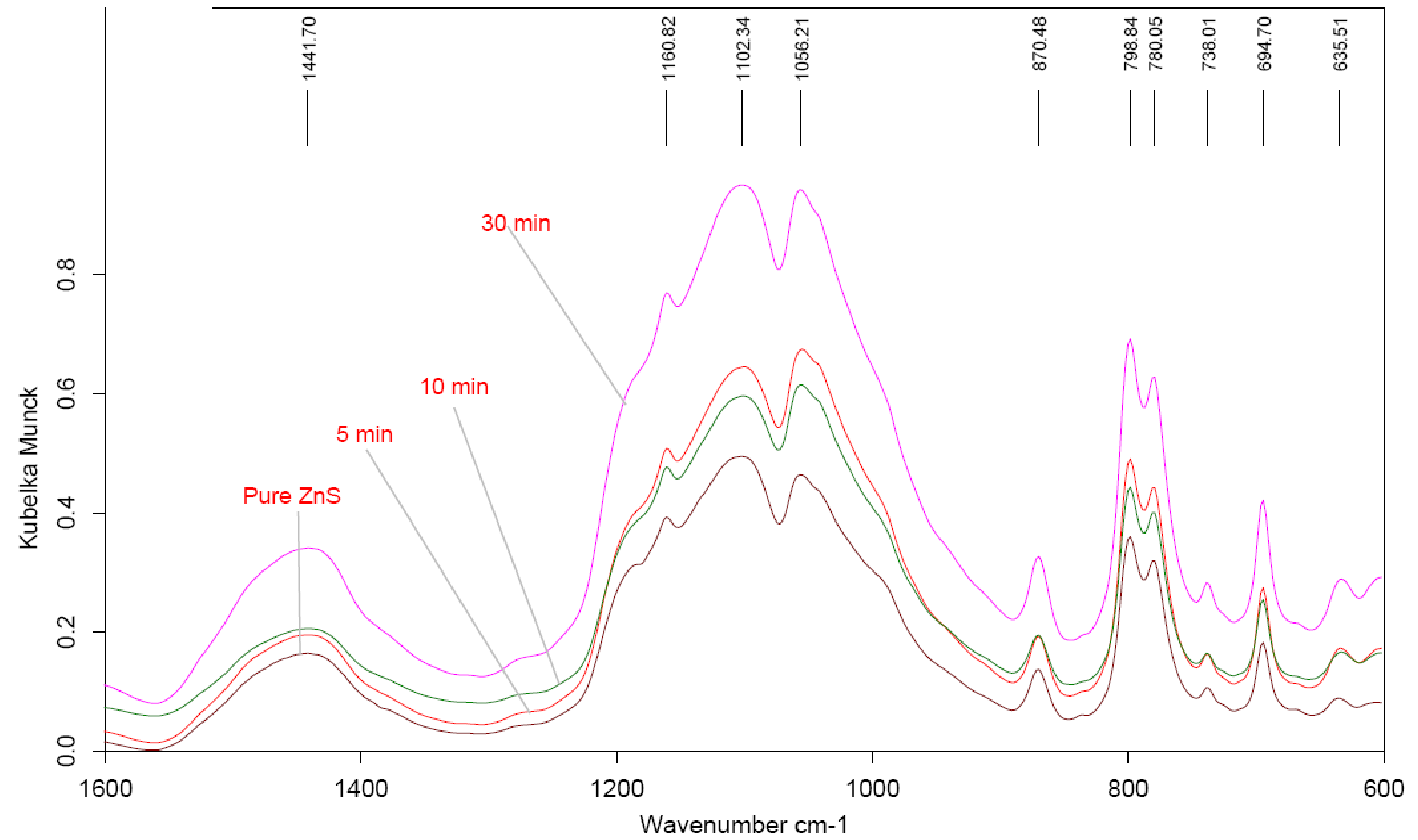
DRIFT-FTIR

Oxidation of minerals in H_2O_2



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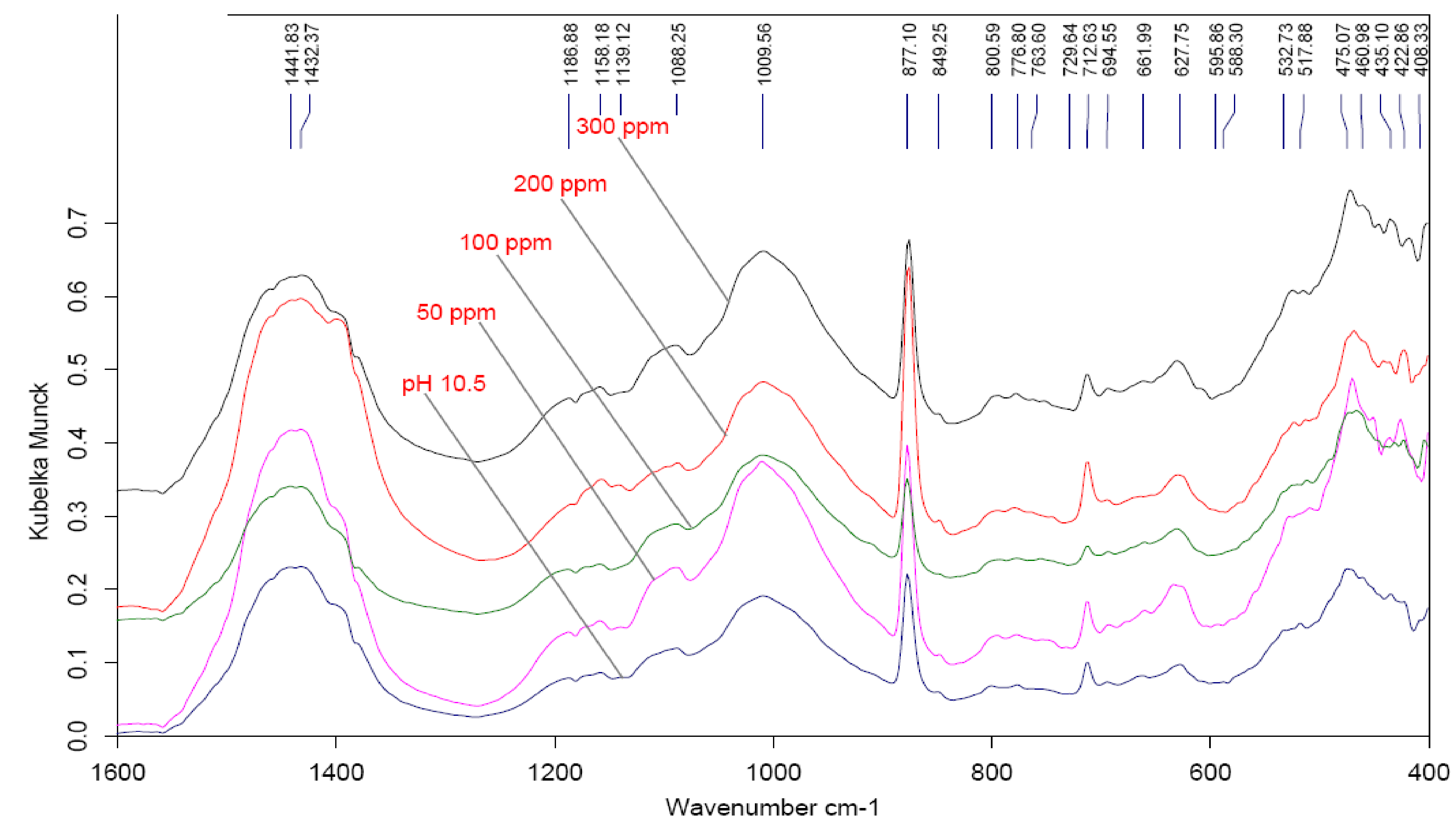
DRIFT-FTIR Contd.

Effect of Ca^{2+} on chalcopyrite in process water



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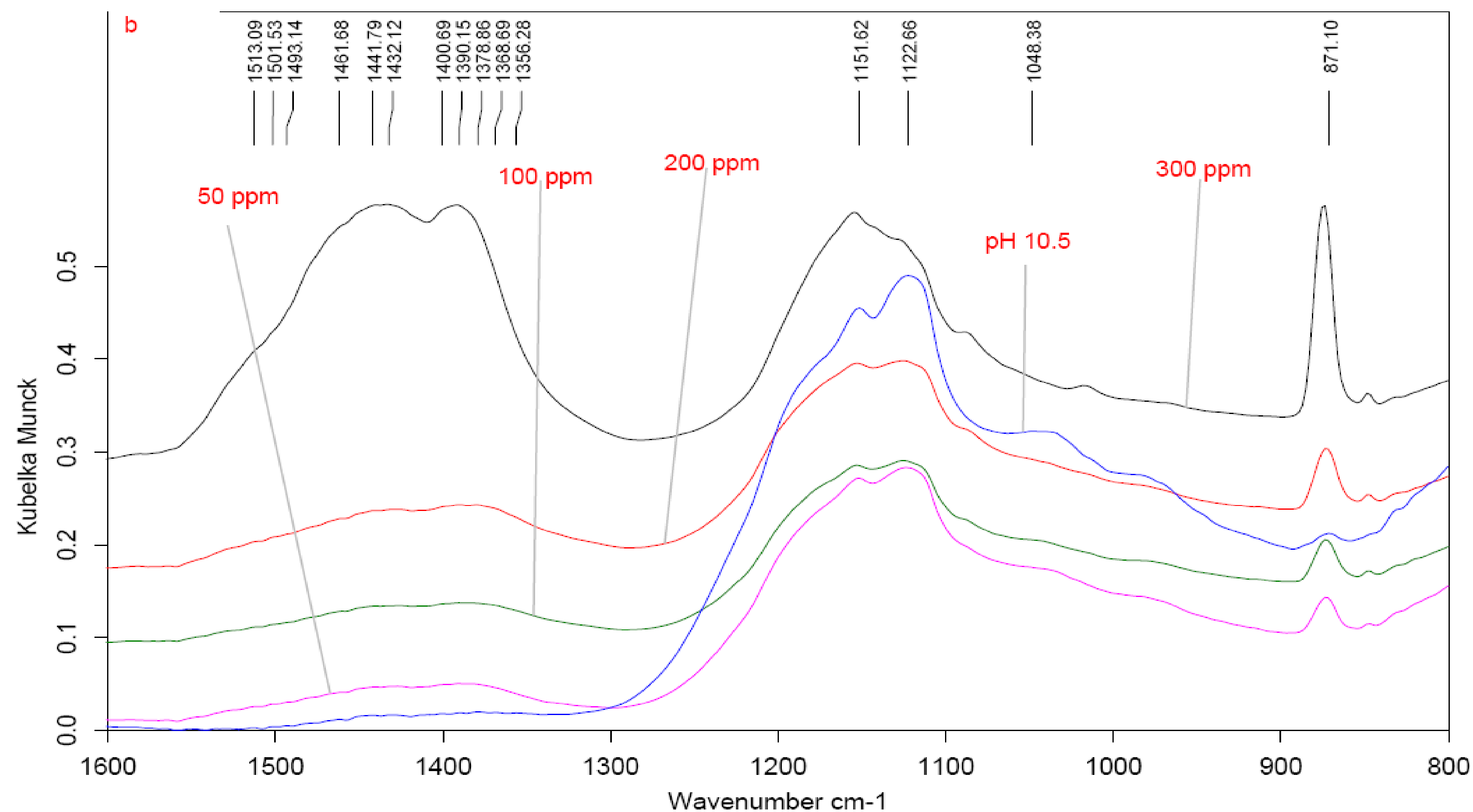
DRIFT-FTIR Contd.

Effect of Ca^{2+} on pyrite in process water



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Future work

- Effects of other minor species in process water, such as reduced sulphur compounds (RSC) (sulfoxyanions with sulphur in the oxidation state below VI), on sulphides flotation by adsorption, zeta-potential, FTIR and XPS measurements

- Find and adopt best chemical recourses to overcome the detrimental effects of the process water components

- Pilot flotation studies based on the new chemical recourses

Experimental Design of *in situ* FTIR