

TABLE OF CONTENTS

Acknowledgements.....	III
Executive summary	V
Zusammenfassung	VII
1 Introduction	1
1.1 Background and justification of research	1
1.2 Aim of the research	2
1.3 Methodology	2
1.4 Thesis structure	2
2 NIR spectroscopy for minerals.....	4
2.1 Basic principles of NIR spectroscopy.....	5
2.1.1 Interaction of electromagnetic radiation and matter	5
2.1.2 NIR wavelength range.....	7
2.1.3 Different types of NIR spectroscopy.....	8
2.1.4 Instrumentation for reflectance spectroscopy.....	10
2.2 Reflectance properties of geogenic material	14
2.2.1 Electronic transitions	14
2.2.2 Vibrational transitions.....	15
2.2.3 Overtones.....	17
2.3 Spectral presentation and interpretation	17
2.3.1 Spectral presentation.....	17
2.3.2 Interpretation of spectra	19
2.3.3 Spectroscopic data processing.....	24
2.4 NIR active minerals and geogenic material.....	26
2.4.1 Main molecular bondings	26
2.4.2 NIR spectra of geogenic material.....	28
2.4.3 Alteration minerals	28
2.4.4 Infrared inactive matter.....	29

3	Applications of NIR spectroscopy in the minerals industry	31
3.1	Offline and at line analysis	32
3.2	Online process control	33
3.3	Remote sensing	34
4	Functional principle of NIR sorting	37
4.1	Specific throughput and costs	38
4.2	Material conditioning	40
4.3	Material presentation	40
4.4	Material sensing	42
4.4.1	Line-scan detection system.....	42
4.4.2	Point scan detection system	43
4.5	Data processing	46
4.6	Material separation	47
5	Implementation of NIR sorting in the flow-sheet	49
5.1	Comparison with conventional sorting techniques	49
5.2	Pre-concentration and waste elimination	52
5.3	Marginal ore and waste dump retreatment	61
5.4	Ore and waste type diversion	63
5.5	Product quality improvement	64
5.6	Online analysis (and sampling).....	68
6	Technical potential of NIR sorting in the minerals industry.....	69
6.1	Application experience.....	69
6.1.1	Application experience of NIR spectroscopy for minerals	70
6.1.2	Technical maturity and market penetration of SBS for minerals.....	75
6.2	Comparison to other sensors applied in SBS	76

6.3	Qualitative sorting	81
6.4	Quantitative discrimination	84
6.5	Requirements for feed preparation (restrictions / characterisation).....	89
6.5.1	Liberation and homogeneity.....	90
6.5.2	Surface dust	92
6.5.3	Surface moisture	95
6.5.4	Temperature	97
6.5.5	Grain size and packing	99
6.5.6	Particle shape and surface structure	101
6.6	Spatial resolution.....	102
6.7	Spectral resolution	103
6.8	Spectral range.....	105
6.9	Signal to noise ratio.....	106
7	Conclusions	107
8	Recommendations	113
9	References	116
10	List of figures.....	129
11	List of tables.....	133
12	List of equations.....	134
13	Appendices.....	135
13.1	Spectral databases	135
13.2	Spectral mapping and imaging instrumentation	136
13.3	Used instrumentation	137
13.4	Experimental procedure	140
14	Curriculum vitae	142
15	List of own publications	143