Contents

Part I. Methods	1
1. Thermogravimetry and Differential Thermal Analysis	1
2. Heat Changes and Their Measurement in DTA	2
2.1 Cause of Heat Changes	2
2.2 DTA Apparatus	
2.3 Characteristics of DTA Curves and DTA Data	4
2.4 Factors Which Influence DTA Data	5 5
2.4.1 Furnace Atmosphere	
2.4.2 Sample Arrangement	6
2.4.3 Thermocouples	6
2.4.4 Heating Rate	7
2.4.5 Reference Material	7
2.4.6 Grain Size and Packing Density	8
2.4.7 Amount of Sample	8
2.4.8 Preparative Factors	10
2.5 The Technique of Measurement and of Standardization .	10
2.5.1 Recommendations of ICTA for the Publication of	
Thermoanalytical Data	10
2.5.2 Standardization and Indirect Characterization by	
Means of PA-Curve and Standard Temperature	11
3. Calibration and Exactness of Measurement	13
3.1 Calibration	13
3.2 Exactness and Reproducibility of Measurements	15
3.3 Improvement of the Exactness of Measurement Using	
Internal Standards	16
3.4 Sensibility of Proof	17

XII	Contents

4. Quantitative Determinations by D1A	18
 4.1 Difficulties in Quantitative DTA Determinations of Minerals 4.2 Determination of Thermodynamic Data 4.2.1 Equilibrium Temperatures 4.2.2 Heat of Reaction, ΔH 	19
5. Methods Combined with DTA	21
 5.1 DTA + High-Temperature X-Ray Analysis 5.2 DTA + High-Temperature Microscopy 5.3 High-Pressure DTA 5.4 DTA + Mass Spectrometer 5.5 Other Methods Related to or Combined with DTA 	21 22
Part II. Application of Differential Thermal Analysis to Mine ogy: Identification and Semi-Quantitative Determination Minerals	of
1. Elements and Chalcogenides	24
1.1 Elements	
2. Halogenides and Sulfates	3
2.1 Halogenides	
3. Oxides and Hydroxides	3
3.1 Oxides 3.2 Hydroxides 3.3 Soils and Iron Ores	37
4. Carbonates and Nitrates	4
 4.1 Carbonates Free of Water and without Other Anions 4.2 Carbonates Free of Water with Other Anions 4.3 Hydrated Carbonates without Other Anions 4.4 Hydrated Carbonates with Other Anions 4.5 Nitrates 	50

Contents	XIII
5. Borates, Phosphates, and Arsenates	57
5.1 Borates	
6. Ortho-, Ring-, and Chain Silicates	63
7. Sheet Silicates	64
7.1 Kaolinites 7.2 Pyrophyllite and Talc 7.3 Montmorines (Smectites) and Vermiculites 7.4 Micas 7.5 Chlorites 7.6 Serpentines 7.7 Palygorskite and Sepiolite 7.8 Clay Minerals with Mixed-Layer Structure 7.9 Mixtures of Sedimentary Minerals ("Clays")	71 73 78 79 81
8. Zeolites	88
9. Allophane, Opal, and Organic Matter of Soils and Sediments	91
10. Development of Identification Diagrams	93
Part III. Special Application of Differential Thermal Analysis in Mineralogy: Statements about Chemical Composition, Degree of Disorder, and Genesis of Minerals	107
1. Influence of the Chemical Composition on the Decomposition Temperatures of Carbonates and Hydroxides	107
 1.1 Substitution of Ca⁺⁺ by Mg⁺⁺ or Pb⁺⁺ in Calcites 1.2 Substitution of Ca⁺⁺ by Sr⁺⁺, Ba⁺⁺, and Pb⁺⁺ in Aragonites 	108 109
1.3 Substitution of Mg ⁺⁺ by Fe ⁺⁺ and Mn ⁺⁺ in Dolomites 1.4 Hydrozincite and Aurichalcite 1.5 The Incorporation of Al ⁺⁺⁺ into the Structure of Goethite	111 114

XIV Contents

2.	Influence of the Chemical Composition on the Temperatures	
	of Structural Transformations	115
	2.1 Carbonates	
	2.2 Cu-Ag Sulfides	115
3.	Influence of the Chemical Composition on the Curie-Tempera-	
	tures of Magnetites	118
4.	Contribution to the Classification of Chlorites	122
5	Smectites and Vermiculites: The Distinction between Di- and	
٥.	Tri-Octahedral Minerals and Grain Size Determination	128
6	Determination of the Degree of Disorder in Kaolinites	130
٠.	Determination of the Degree of Disordor in Rushings	150
7.	The Interdependence of Degree of Disorder, High-Low Inversion, and Temperature of Formation of Low-Temperature	
	Cristobalites	133
8.	The Determination of Inversion Temperatures of Quartz	
	Crystals as a Petrologic Tool	139
9.	The High-Low Inversion Behaviour of Microcrystalline Quartz	
	Crystals	146
Re	ferences	159
Sul	biect Index	173