Contents

Preface Comment Introduction

Part One The Phase Rule, Its Deduction and Application

∠nap	ter 1 The Phase Rule, its Deduction and Application
1.1	Why do We Discuss the Phase Rule at First · · · · · · · · · · 3
1.2	Different Methods for Deducing the Phase Rule: The Method of Gibbs Himself, Gibbs-Roozeboom's Method and the Method of Gibbs Free
	Energy Minimization4
1.3	Determination of the Number of Independent Components by Brinkley's Method14
1.4	Some Remarks on the Application of the Phase Rule25
Re	ferences-1 · · · · · · · 28
Su	mmary of Part One · · · · · · 28
	Part Two The Boundary Theory of Isobaric Phase Diagrams and Its Application ter 2 The Boundary Theory of Isobaric Phase Diagrams
•	—Rules for Phase Diagram Construction · · · · · · 31
2.1	
2.2	Several Basic Concepts for Underlying the Phase Diagram · · · · · · · · 32
2.3	The Theorem of the Corresponding Relationship between the Total Nu-
	mber of All the Different Phases in NPRs Φ and the Dimensions of the
	Phase Boundary R_1 in Phase Diagrams, and Its Theoretical
	Deduction
2.4	
	dent Theorem, Not a Variant of the Phase Rule · · · · · · · · 41
2.5	dent Theorem, Not a Variant of the Phase Rule · · · · · · · · 41

x Contents

	and the Dimensions of the Boundary R'_1 for Isobaric Multicomponent
	Phase Diagrams · · · · · 48
2.7	The Summary of the Boundary Theory of Isobaric Phase Diagrams \cdots 58
Refe	erences-2·····59
Chapt	er 3 Application of the Boundary Theory to Unary, Binary
	and Ternary Phase Diagrams
	Comparison of the Boundary Theory Application and Palatnik-
	Landau's Contact Rule of Phase Regions $\cdots \cdots 61$
3.1	Determination of Phase Assemblages of NPRs and the
	Characteristics of Their Boundaries by the Boundary Theory61
3.2	Application of the Boundary Theory to Unary Phase Diagrams $\cdots \cdot \cdot \cdot 63$
3.3	Application of the Boundary Theory to Binary Phase Diagrams64
3.4	Application of the Boundary Theory to Ternary Phase Diagrams · · · · · 68
3.5	Explanation of Rhines' Ten Empirical Rules for Constructing
	Complicated Ternary Phase Diagrams with the Bounary Theory $\cdots 82$
3.6	Comparison of the Boundary Theory and the P-L's Contact Rule of
,	Phase Regions ······85
Refe	erences-3 · · · · · · · 91
Chapt	er 4 The Application of the Boundary Theory of Phase Diag-
	rams to the Quaternary and Higher Number Component
	Phase Diagrams · · · · · 92
4.1	Introduction92
4.2	The Relationship among NPRs and their Boundaries in a Typical, Iso-
	baric, Quaternary Phase Diagram · · · · · · · 92
4.3	During Temperature Decreasing, Some Cases of Variations of the NPRs
	and their Boundaries, May be Encountered for Several Types of
	Quaternary Isobaric Phase Diagrams · · · · · · 94
4.4	The Isobaric Quinary Phase Diagrams · · · · · · · · 106
4.5	Conclusion
Ref	erences-4······106
Chapt	· · · · · · · · · · · · · · · · · · ·
	nent Isothermal Sections······107
5.1	The Relationship among Neighboring Phase Regions (NPRs) and Th-
	eir Boundaries in Isobaric Isothermal Multicomponent Sections · · · · · · 107
5.2	The Non-Contact Phase Regions and the Boundaries between
•	Them110

Contents xi

	5.3	Construction of an Isothermal Quinary Section, with Limited
		Information
	5.4	The Method of Constructing an Isothermal Eight-Component
		Section
	5.5	Summary of Using the Boundary Theory Method · · · · · · · 121
	Refe	erences-5 · · · · · · · 121
C	hapte	* * *
		Isopleth Sections · · · · · · 122
	6.1	Introduction
	6.2	The Characteristics of Boundaries in Isopleth Sections for the Case
		of $N \geqslant 2$ and $R_1 \geqslant 1$
	6.3	The Characteristics of Boundaries in the Isopleth Section for the Case
		of $N \geqslant 2, R_1 = 0$, there is no Invariant Phase Transition between the
		two NPRs · · · · · · · 126
	6.4	The Case of $N \geqslant 2, R_1 = 0$, there is an Invariant Phase Transition
		between the two NPRs. In this Case, there may be a Boundary Line
		or a Boundary Point between two NPRs · · · · · · 127
	6.5	Example
	6.6	The Theory of Two-Dimensional Sections of Isobaric Multicomponent
		Phase Diagrams · · · · · · 132
	Refe	erences-6 · · · · · · · · · · · · · · · · · · ·
\mathbf{C}	hapte	er 7 The Application of the Boundary Theory to Isobaric
		Phase Diagrams · · · · · · · · · · · · · · · · · · ·
	7.1	Brief Review of the Application for the Boundary Theory
	7.2	The Analysis of the Fe-Cr-C Isopleth Section · · · · · · · 135
	7.3	The Application of the Boundary Theory to Phase Diagram
		Calculation
	7.4	The Application of the Boundary Theory to Phase Diagram
		Assessment · · · · · · · · · · · · · · · · · · ·
	7.5	The Application of the Boundary Theory to Phase Diagram
		Determination · · · · · · · · · · · · · · · · · · ·
	7.6	The Application of the Boundary Theory to Phase Diagram
		Education · · · · · · · · · · · · · · · · · · ·
	Refe	erences-7······152

Summary of Part Two······153			
	Pa	art Three The Boundary Theory and Calculation of High Pressure Phase Diagrams	
Cl	hapte		
		Phase Diagrams · · · · · · · · · · · · · · · · · · ·	
	8.1	Introduction	
	8.2	The Theorem of Corresponding Relationship for p - T - x_i	
		Multicomponent Phase Diagrams and Its Corollaries $\cdots \cdots 158$	
	8.3	The Relationship between R_1' and R_1 in $p\text{-}T\text{-}x_i$ Multicomponent Phase Diagrams $\cdots 160$	
	8.4	The Relationship among NPRs and Their Boundaries for the p-T-x	
		Binary Phase Diagrams. · · · · · · · · · · · · · · · · · · ·	
	8.5	Relationship among NPRs and their Boundaries for the p - T - x_i	
		Ternary Phase Diagram · · · · · · 168	
	8.6	The Application of Boundary Theory for Quaternary p - T - x_i Phase	
		Diagrams · · · · · · · · · · · · · · · · · · ·	
	8.7	The Reliability of the Boundary Theory of Multicomponent p - T - x_i	
		Phase Diagrams · · · · · · 171	
	Refe	rences-8······171	
C)	hapte	er 9 The Calculation of Unary High-Pressure Phase Diagra-	
		ms and the Boundary Theory of p - T Phase Diagrams of	
		Multicomponent Systems · · · · · · 173	
	9.1	Introduction	
	9.2	Calculation of Unary p - T Diagrams $\cdots 174$	
	9.3 ·	The Boundary Theory of p - T Phase Diagrams of Multicomponent	
		Systems without Composition Variable · · · · · · · · 176	
	Refe	rences-9 · · · · · · · · · · · · · · · · · · ·	
Cl	hapte	er 10 Calculation of Binary High-Pressure Phase	
		Diagrams178	
	10.1	Principles for the Calculation of Binary Phase Diagrams at Elevated	
		Pressures	
	10.2	Calculation of the Standard Molar Gibbs Free Energy for the Pure	
		Components180	
	10.3	Calculation of Activity Coefficients $\gamma_i(T,p_0,x_i)$ of the <i>i</i> -th	
		Component in the Equilibrium Phases······181	
	10.4	Partial Molar Volumes	

10.5	Some Remarks on the Values of α and β
10.6	Example-Calculation of the Cd-Pb Phase Diagram at High
	Pressure
Refere	ences- 10 ······ 194
Chapter	11 The Calculation of High-Pressure Ternary Phase Dia-
	grams · · · · · · 196
11.1	The Characteristics of the Boundaries of the High-Pressure Ternary
	Phase Diagrams, and the Basic Equations for Their Calculation · · · · 196
11.2	The Treatment of Thermodynamic Parameters for Ternary Systems
	at High Pressure · · · · · · 201
11.3	Verification of the Estimation Method for the Excess Molar Volume
	by Experiment
11.4	The Calculation of High-Pressure Phase Diagrams of Cd-Pb-Sn and
	Cd-Sn-Zn Systems · · · · · · · 206
11.5	Verification of Calculated High-Pressure Ternary Phase Diagrams
	through Experimental Determination $\cdots 219$
11.6	The Comparison between the Methods of Experimental Determina-
	tion and Thermodynamic Calculation of High Pressure Phase
	Diagrams
	ences-11······223
Sumn	nary of Part Three · · · · · · · 224
D 6	
	ces of This Book
	ant Symbols · · · · · · 230
	232
Annex ·	$\cdots \cdots $