

CONTENTS

1.	INTRODUCTION	1
	<i>Stefðn Arndrsson</i>	
2.	STRATEGY IN GEOTHERMAL EXPLORATION, DEVELOPMENT AND PRODUCTION	5
	<i>Stefðn Arnórsson</i>	
3.	CHEMICAL REACTIONS AND CHEMICAL EQUILIBRIA	9
	<i>Stefán Arndrsson</i>	
3.1.	Some thermodynamic considerations	9
3.2.	Progressive water-rock interaction	12
3.3.	Demonstration/assumption of chemical equilibrium	15
3.4.	Thermodynamic treatment of equilibrium	18
3.5.	Effects of temperature and pressure	19
3.6.	Aqueous speciation	23
3.1.	Concentration and activity	25
3.8.	Calculation of aqueous speciation	26
4.	REACTIVE AND CONSERVATIVE COMPONENTS	40
	<i>Stefán Arndrsson</i>	
5.	ISOTOPES FOR GEOTHERMAL INVESTIGATIONS	49
	<i>Jane Gerardo-Abaya, Franco D'Amore and Stefðn Amdrsson</i>	
5.1.	Notations	49
5.2.	Use of isotopes in geothermal investigation	53
5.3.	Origin of geothermal water	54
5.4.	Stages of geothermal development where isotopes are employed	57
6.	THE SOURCE OF CHEMICAL AND ISOTOPIC COMPONENTS IN GEOTHERMAL FLUIDS	66
	<i>Stefðn Arnórsson and Franco D'Amore</i>	

7.	GEOTHERMAL MANIFESTATIONS AND HYDROTHERMAL ALTERATION	73
	<i>Franco D'Amore and Stefán Arnórsson</i>	
7.1.	Thermal springs	73
7.2.	Fumaroles and steam heated waters	75
7.3.	Hydrothermal alteration	77
7.4.	Acid surface leaching and mineral deposition	81
8.	SAMPLING OF GEOTHERMAL FLUIDS: ON-SITE MEASUREMENTS AND SAMPLE TREATMENT	84
	<i>Stefán Arnórsson and Franco D'Amore</i>	
8.1.	Objectives	84
8.2.	Selection of elements and components for analysis	85
8.3.	Selection of sites for sampling of thermal waters for geochemical exploration	86
8.4.	Sampling of surface waters, springs and hot and cold water wells	87
8.5.	Sampling of fumaroles and gases from thermal springs	89
8.6.	Sampling of wet steam wells	91
8.7.	General information of material selection, acid washing and reasons for sample treatment	96
9.	PRESENTATION OF ANALYTICAL RESULTS, ANALYTICAL PRECISION AND ACCURACY	143
	<i>Stefán Arnórsson</i>	
9.1.	Analytical precision and accuracy	144
9.2.	Presentation of analytical results	148
10.	GEOTHERMOMETRY	152
	<i>Franco D'Amore and Stefán Arndrsson</i>	
10.1.	Water geothermometers	154
10.2.	Steam (gas) geothermometers	171

10.3. Multiple mineral equilibrium approach	174
10.4. Discussion on chemical geothermometers	175
10.5. Isotope geothermometers	178
11. MIXING PROCESSES IN UPFLOW ZONES AND MIXINGMODELS	200
<i>Stefán Arndrsson</i>	
11.1. Mixing processes	200
11.2. Mixing models	202
12. ASSESSMENT OF RESERVOIR FLUID COMPOSITION FROM WET STEAM WELL DATA	212
<i>Stefán Arndrsson</i>	
13. HYDROGEN AND OXYGEN ISOTOPIC FRACTIONATION DURING BOILING	229
<i>Franco D'Amore, Jane Gerardo-Abaya</i>	
<i>and Stefán Arnórsson</i>	
14. MINERAL SATURATION	241
<i>Stefán Arndrsson</i>	
14.1. Aquifer chemistry	246
14.2. Effects of boiling and cooling	247
14.3. Errors in calculations of saturation indices	248
15. ESTIMATION OF AQUIFER STEAM FRACTION	267
<i>Stefán Arndrsson and Franco D'Amore</i>	
15.1. General remarks on boiling in geothermal systems	267
15.2. Equilibrium steam	270
15.3. Notations on geothermal gas chemistry	271
15.4. Calculation of aquifer gas partial pressures	278
15.5. Estimation of initial aquifer steam fractions and aquifer gas pressures	284
15.6. Discussion	292

16. MONITORING OF RESERVOIR RESPONSE TO PRODUCTION	309
<i>Stefán Arnórsson and Franco D'Amore</i>	
16.1. Response of geothermal reservoirs to production load	309
16.2. Injection	310
16.3. Frequency of sampling for monitoring studies and the selection of chemical and isotopic components for analysis	311
16.4. Presentation of monitoring data	312
16.5. Conservative components	313
16.6. Reactive aqueous components	319
16.7. Reactive gaseous components	328
16.8 Deuterium and ^{18}O	334
BIBLIOGRAPHY	343