

List of Figures

Figure 4.1-A1	Yangbajain Location Map	58
Figure 4.1-A2	Annual Production and Installed Capacity of Yangbajain Geothermal Power Station	59
Figure 4.1-A3	Yangbajain Geothermal Power Station, Outdoor View and Indoor View	60
Figure 4.1-A4	Hot Lake and Boiling Spring before Disappearance in Yangbajain	62
Figure 4.1-B1	Xiaotangshan Location Map	63
Figure 4.1-B2	Lower Water Level of the Eastern Spring and the Western Spring in Xiaotangshan Hot Spring Sanatorium	64
Figure 4.1-B3	Production and Reinjection with Water Level Behaviour in Xiaotangshan	65
Figure 4.1-B4	Behaviour of K-Mg and Quartz Geothermometry in Xiaotangshan	66
Figure 4.1-B5	Installation of Geothermal Reinjection Well in Xiaotangshan Field	67
Figure 4.2-1	Geothermal Power Plants in Indonesia	68
Figure 4.3-1	Geothermal Power Production and Authorised Capacity in Japan	76
Figure 4.3-2	Site of Matsukawa Geothermal Power Station	77
Figure 4.3-3	Production History of Well M-12 and Injection History of Well MR-1	78
Figure 4.3-4	Tracer Flow Paths in the Matsukawa Geothermal Field	79
Figure 4.3-5	Relationship Between Injection Well M-6 and Production Wells, M-8 and M-13	80
Figure 4.4-A1	Location of the Tiwi Geothermal Field	82
Figure 4.4-A2	Tiwi Geothermal Field	83
Figure 4.4-A3	Initial Pressures and Temperatures in Naglagbong Sector Wells	84
Figure 4.4-A4	Tiwi Generation and Steam Production History	85
Figure 4.4-A5	Tiwi Production Well Locations and Production Characteristics, December 2008	86
Figure 4.4-A6	Tritium Contours Showing Movement of MR 'Front' with Time	87
Figure 4.4-B1	Well-track Map of the Tongonan Geothermal Field	91
Figure 4.4-B2	Monthly Total Mass Extraction and Injection	90
Figure 4.4-B3	Average Enthalpy of the Different Sectors of the Tongonan Geothermal Field	92
Figure 4.4-B4	^{18}O and Cl Enrichment in Production Wells due to Incursion of Injected Brine from Tongonan-1 Injection Sink	93
Figure 4.4-B5	Flow Model of Condensate from Pad 4RC and of Injected Brine from Pad 408 based on Tracer Studies and Geochemical Data	94
Figure 4.4-B6	Plots Showing Dilution and Cooling of Production Wells due to	95

	Inflow of Cooler Peripheral Fluids	
Figure 4.4-B7	Total Steam Flow against Time, Tongonan Geothermal Field	96
Figure 5.1-1	Growth of Geothermal Utilisation in China	103
Figure 5.1-2	Growth of Ground Source Heat Pumps in China	104
Figure 5.1-3	20 Years' Growth of Geothermal Direct Use and Proportion of Ground Source Heat Pumps in China	105
Figure 5.1-4	Map Showing Shallow Geothermal Energy Conditions in Beijing	107
Figure 5.1-5	Installation of Monitoring Tools for Ground Source Heat Pump System	108
Figure 5.1-6	Temperature Curves Measured in Different Monitoring Holes	108
Figure 5.1-7	Geo-temperature Recovery During and After Heating Season	109
Figure 5.1-8	Geo-temperature Recovery During and After Cooling Season	109
Figure 5.2.1-1	Potential Heat Exchange Rate in the Fukui Plain based on Simulation Results	110
Figure 5.2.1-2	Types of Ground Source Heat Pump Systems	111
Figure 5.2.2-1	Tsugaru Plain with Model Boundary	112
Figure 5.2.2-2	Regional Scale Analysis Model of Tsugaru Plain	112
Figure 5.2.2-3	Groundwater Upflow at Tomita Spring	114
Figure 5.2.2-4	Single Ground Heat Exchanger Model and Locations of Thermal Response Test	115
Figure 5.2.2-5	Comparison of Computed and Observed Outlet Temperature of Heat Transfer Medium	117
Figure 5.2.2-6	Thematic Maps of Tsugaru Plain	118
Figure 5.2.2-7	Overlay Model for Space Heating and Space Cooling	120
Figure 5.2.2-8	Suitability Map of Tsugaru Plain	120
Figure 5.2.3-1	Aquifer Thermal Energy Storage System	123
Figure 5.2.3-2	Yamagata Basin with Model Boundary	124
Figure 5.2.3-3	3D Analysis Model of Yamagata Basin	124
Figure 5.2.3-4	Distribution of (a) Calculated Hydraulic Head, (b) Measured Groundwater Level, and (c) Comparison between Calculated and Measured Values	126
Figure 5.2.3-5	Distribution of Subsurface Temperature at a Depth of 50 Metre	127
Figure 5.2.3-6	Subsurface Temperatures along Cross-section A-A'	128
Figure 5.2.3-7	Estimated Areas Suitable for ATES System	130
Figure 5.3-1.	Bird's-eye View of Zones 1 and 2 of the Government Building Complex, Sejong Metropolitan City	133
Figure 5.3-2	Ground Source Heat Pumps for the Government Building Complex, Sejong Metropolitan City	133
Figure 5.3-3	Earthquake Research Center in KIGAM	135
Figure 5.3-4	Layout of Borehole Heat Exchangers and the Monitoring System for Earthquake Research Center Building at KIGAM	136
Figure 5.3-5	Comparison of Temperature Variations at 100 Metre Depth Between the Winter Seasons of 2006–2007 and 2008–2009	137

Figure 5.4-1	Contour Map of Maximum Temperature at Depths of 20–50 Metre	139
Figure 5.4-2	Temperature Profiles of Wells in Certain Areas of Thailand	140
Figure 5.4-3	Comparison of Atmospheric and Subsurface Temperature at Each Region	142
Figure 5.5.1-1	Three National Groundwater Observation Networks Developed Since 1995	144
Figure 5.5.1-2	Groundwater Observation Places in Southern Plain	149
Figure 5.5.1-3	Comparison of Atmospheric and Groundwater Temperatures in Ho Chi Minh	151
Figure 5.5.1-4	Comparison of Atmospheric and Groundwater Temperatures in Ca Mau	151
Figure 5.5.2-1	Locations of Temperature Observation Wells in the Red River Plain	153
Figure 5.5.2-2	Temperature Profiles of the Wells around Ha Noi	154
Figure 5.5.2-3	Comparison of Atmospheric and Subsurface Temperature around	155