

Table of Contents

	Page
List of Figures	iii–vii
List of Tables	viii–ix
List of Abbreviations	x
Abstract	1–3
Chapter 1. Introduction	4–21
1.1 The Research Problem	5
1.2 The Study Area	7
1.2.1 Geography	7
1.2.2 Geology	7
1.2.3 Tectonic Framework and Sedimentation	10
1.2.4 Geothermal Regime	13
1.2.5 Topography and Drainage	14
1.2.6 Climate	15
1.2.7 Groundwater Hydrology	16
1.3 Specific Objectives of the Study	19
1.4 Motivation and Approach	19
1.4.1 Groundwater Dating	19
1.4.2 Groundwater Helium and Temperature Anomalies	20
1.4.3 High Fluoride in Groundwater	20
1.4.4 Isotopes in Groundwater: Palaeoclimatic Imprints	21
Chapter 2. Theory	22–49
2.1 Helium	22
2.2 Radon	25
2.3 Fluoride	26
2.4 Stable Isotopes of Oxygen and Hydrogen	29
2.5 Chlorofluorocarbons (CFCs)	36
2.6 Groundwater Dating	40
2.6.1 ¹⁴ C Dating Method	43
2.6.2 ⁴ He Dating Method	45
2.6.3 ⁴ He/ ²²² Rn Dating Method	47
2.6.4 CFC Dating Method	49
Chapter 3. Experimental Procedures	50–78
3.1 Helium in Soil-air and Groundwater	50
3.1.1 Soil-air and Groundwater Sampling	50
3.1.2 Sample Storage	52
3.1.3 Analytical Procedure	53
3.1.3.1 Calibration of Helium Leak Detector	54
3.1.3.2 Dilution by Atmospheric Air	55
3.1.3.3 Estimation of Henry's Law Constant	56
3.2 Radon in Groundwater	57
3.3 Fluoride in Groundwater	58
3.4 Groundwater Radiocarbon Dating	60
3.5 Chlorofluorocarbons (CFCs) in Groundwater	61
3.5.1 Sample Collection and Storage Procedure	61

3.5.2	Purge and Trap System for Extraction of CFCs	63
3.5.3	Analytical Technique for Measurement of CFCs	72
Chapter 4.	Results and Discussion	79–130
4.1	Results	79
4.1.1	Groundwater Helium and Temperature	79
4.1.2	Groundwater Fluoride	88
4.1.3	Groundwater Electrical Conductivity	98
4.1.4	Fluoride and EC in Modern Precipitation	100
4.1.5	Stable Isotopes of Oxygen and Hydrogen	103
4.1.6	Groundwater Dating	109
4.1.6.1	^{14}C Dating	111
4.1.6.2	^4He Dating	112
4.1.6.3	$^4\text{He}/^{222}\text{Rn}$ Dating	115
4.2	Discussion	115
4.2.1	Groundwater Helium and Temperature	115
4.2.2	Fluoride and Electrical Conductivity	118
4.2.3	Oxygen and Hydrogen Isotopes in Groundwater and Precipitation	121
4.2.4	Groundwater Ages	124
4.2.4.1	^{14}C Ages	124
4.2.4.2	^4He Ages	125
4.2.4.3	$^4\text{He}/^{222}\text{Rn}$ Ages	127
Chapter 5.	Summary and Conclusions	131–141
5.1	Groundwater Helium and Temperature	132
5.2	Fluoride in Groundwater	133
5.3	Isotopes of Oxygen and Hydrogen in Groundwater and Precipitation	136
5.4	Groundwater Dating	137
5.4.1	^{14}C Dating	137
5.4.2	^4He Dating	138
5.4.3	$^4\text{He}/^{222}\text{Rn}$ Dating	138
5.5	Important Contributions	139
5.5.1	A Geo-hydrological Model of Aquifer System in NGC region	139
5.5.2	A Conceptual Tectono-hydrothermal Model of NGC region	139
5.5.3	Origin of High fluoride in Groundwater from NGC region	140
5.5.4	Palaeoclimatic Imprints in Groundwater from NGC region	140
Chapter 6.	Future Scope	142–144
6.1	Injection of Hydrothermal Fluids	142
6.2	Estimation of Paleoc-recharge Temperature	143
6.3	Identifying the Modern Recharge	143
References		145–157
List of Publications		158