

Contents

Part I Principles and Processes

1	Introduction	3
1.1	Geologic Perspective	3
1.2	Phylogeny	4
1.3	Characteristics of the Sm-Nd System and Comparison with Rb-Sr and U-Th-Pb	7
1.3.1	General Geochemistry and Cosmochemistry	7
1.3.2	Petrogenetic Significance of the Parent/Daughter Ratio	9
1.3.3	Magnitude of Isotopic Variations	11
1.3.4	Behavior in the Near-Surface Environment	12
1.4	Isotopic Abundances of Sm and Nd	13
1.4.1	Summary of Recent Measurements	13
1.4.2	Mass Discrimination Corrections and Interlaboratory Data Comparison	15
1.5	Decay Constant of ^{147}Sm	18
2	Sm-Nd Dating	19
2.1	Theory and Requirements	19
2.2	Applications	21
3	Nd Isotopes as Tracers in Planetary Evolution	27
3.1	Systematics and Constructs	27
3.2	Comparison with Other Isotopes	30
3.3	Notation	33
3.3.1	Samarium-Neodymium	33
3.3.2	Other Isotopic Systems	37
3.3.3	Alternative Notations	39

4	Igneous Processes and Nd Isotopic Variations	40
4.1	Partial Melting	40
4.2	Fractional Crystallization	44
4.3	Mixing	48
 Part II Nd Isotopic Variations – A Planetary Perspective		
5	Overview of Nd Isotopic Variations	55
5.1	Sm-Nd Isotopic Properties of Meteorites	55
5.2	Nd Isotopes in Mesozoic and Younger Basalts	58
5.2.1	Significance of Young Basalts	58
5.2.2	Summary of Data	59
5.2.3	Isotopic Variations as a Function of Sampling Scale	60
5.2.4	Implications of the Observed Isotopic Variability	62
5.3	Nd Isotopes in Paleozoic and Precambrian Igneous Rocks	65
5.3.1	A Model for the Interpretation of Initial Isotopic Ratios in Ancient Terranes	65
5.3.2	Mantle Isotopic Evolution and Model Ages	67
5.3.3	Crustal Nd Isotopic Evolution	68
5.3.4	Resolution of Crustal Ages in Multiply-Metamorphosed Terranes	72
5.4	Sedimentary Rocks	76
5.5	The Oceans	80
6	Correlation of Nd Isotopic Variations with Other Isotopic Variations	82
6.1	Strontium	82
6.2	Hafnium	86
6.3	Lead	87
6.4	Helium and Argon	88
6.5	Interpretation of Isotopic Correlations	89
7	Models of Crust-Mantle Evolution	94
7.1	Material Balance Considerations	94
7.2	Early Planetary Differentiation	97

7.3	Two-Reservoir Transport Model	101
7.4	Sm-Nd and Lu-Hf Data Relevant to the Long-Term Average Rate of Crustal Recycling	103
7.5	Chemical Earth Models	108

Part III Nd Isotopic Variations – Petrogenetic Studies

8	Oceanic Crust and Mantle	115
8.1	Oceanic Basalt	115
8.2	Ophiolites	121
8.3	Oceanic Magmatic Arcs	124
8.4	Greenstone Belts and Komatiites	126
9	Continental Magmatic Arcs	130
9.1	Model of Isotopic Variations in Igneous Source Materials	130
9.2	Volcanic Rocks	132
9.3	Plutonic Rocks	135
9.4	Evolution of Silicic Magma Systems	145
10	Continental Mafic Rocks	148
10.1	Flood Basalts	148
10.2	Extensional Provinces	155
10.3	Kimberlites and Ultrapotassic Lavas	157
10.4	Layered Mafic Intrusions	160
10.5	Ultramafic Nodules	163
	References	167
	Subject Index	183