

Table of Contents

1	Introduction	1
1.1	Preamble: Potassic Igneous Rocks and Their Importance	1
1.2	Scope of Book	2
2	Definitions and Nomenclature	3
2.1	Historical Perspective of Potassic Igneous Rocks	3
2.2	Potassic Igneous Rocks as an Umbrella Term	4
2.3	Shoshonites	5
2.4	Shoshonitic and Alkaline Lamprophyres	5
2.5	Ultrapotassic Rocks	6
2.5.1	Introduction	6
2.5.2	Lamproites	7
2.5.3	Kamafugites	7
2.5.4	Orogenic Ultrapotassic Rocks	8
2.6	Group II Kimberlites	8
2.7	Potassic Igneous Rocks as Considered in this Book	9
2.8	Field Recognition of Potassic Igneous Rocks	10
3	Tectonic Settings of Potassic Igneous Rocks	11
3.1	Introduction	11
3.2	Tectonic Settings of Potassic Igneous Rocks	11
3.2.1	Continental Arc	11
3.2.2	Postcollisional Arc	16
3.2.3	Oceanic (Island) Arc	16
3.2.4	Within-Plate	16
3.2.5	Problems with Tectonic Classifications	17
3.3	History of Discrimination of Tectonic Setting by Geochemical Means	17
3.4	Erection of Databases SHOSH1 and SHOSH2	20

3.5	Discrimination of Tectonic Setting by Multivariate Statistical Methods	28
3.6	Discrimination via Simple Geochemical Diagrams	31
3.7	Theoretical Basis for Discrimination between Potassic Igneous Rocks in Different Tectonic Settings	34
3.8	Conclusions.	37
4	Selected Type-Localities of Potassic Igneous Rocks from the Five Tectonic Settings	39
4.1	Roman Province (Italy): Example from a Continental Arc Setting	39
4.1.1	Introduction	39
4.1.2	Regional Geology	41
4.1.3	Mineralogy and Petrography of the Potassic Igneous Rocks	41
4.1.4	Geochemistry of the Potassic Igneous Rocks	41
4.2	Kreuzeck Mountains, Eastern Alps (Austria): Example from a Postcollisional Arc Setting	42
4.2.1	Introduction	42
4.2.2	Regional Geology	43
4.2.3	Mineralogy and Petrography of the Lamprophyres	45
4.2.4	Geochemistry of the Lamprophyres	46
4.3	Northern Mariana Arc (West Pacific): Example from an Initial Oceanic Arc Setting	53
4.3.1	Introduction	53
4.3.2	Regional Geology	53
4.3.3	Mineralogy and Petrography of the Potassic Igneous Rocks	54
4.3.4	Geochemistry of the Potassic Igneous Rocks	55
4.4	Vanuatu (Southwest Pacific): Example from a Late Oceanic Arc Setting	55
4.4.1	Introduction	55
4.4.2	Regional Geology	55
4.4.3	Mineralogy and Petrography of the Potassic Igneous Rocks	56
4.4.4	Geochemistry of the Potassic Igneous Rocks	57
4.5	African Rift Valley (Uganda, Rwanda, Zaire): Example from a Within-Plate Setting	59
4.5.1	Introduction	59
4.5.2	Regional Geology	60
4.5.3	Mineralogy and Petrography of the Potassic Igneous Rocks	60
4.5.4	Geochemistry of the Potassic Igneous Rocks	60
5	Primary Enrichment of Precious Metals in Potassic Igneous Rocks	63
5.1	Introduction	63
5.2	Theoretical Discussion	63

5.3	Case Study: Potassic Alkaline Lamprophyres with Elevated Gold Concentrations from the Karinya Syncline, South Australia . . .	67
5.3.1	Introduction	67
5.3.2	Regional Geology and Tectonic Setting	67
5.3.3	Mineralization in the Vicinity of the Lamprophyres	68
5.3.4	Nature of the Lamprophyres	69
5.3.5	Petrology and Geochemistry of the Lamprophyres	71
5.3.6	Precious Metal Abundance and Significance	77
5.4	Comparison of Precious Metal Abundances for Lamprophyres from the Karinya Syncline and Kreuzeck Mountains	79
6	Direct Associations between Potassic Igneous Rocks and Gold-Copper Deposits	83
6.1	Direct Associations in Specific Tectonic Settings: Introduction . .	83
6.2	Erection of Database GOLD1	87
6.3	Late Oceanic Arc Associations	89
6.3.1	Ladolam Gold Deposit, Lihir Island, Papua New Guinea	90
6.3.2	Emperor Gold Deposit, Viti Levu, Fiji	93
6.3.3	Goonumbla Copper-Gold Deposit, New South Wales, Australia . .	97
6.4	Continental Arc Associations	102
6.4.1	Bingham Copper Deposit, Utah, USA	104
6.4.2	Twin Buttes Copper Deposit, Arizona, USA	106
6.4.3	Chilean Andes	109
6.5	Postcollisional Arc Associations	111
6.5.1	Grasberg Copper-Gold Deposit, Indonesia	111
6.5.2	Porgera Gold Deposit, Papua New Guinea	115
6.6	Synthesis of Direct Genetic Associations	119
7	Indirect Associations between Lamprophyres and Gold-Copper Deposits	121
7.1	Introduction	121
7.2	Shoshonitic Lamprophyres with Elevated Gold Concentrations from the Goodall Gold Deposit, Northern Territory, Australia (Proterozoic)	121
7.2.1	Introduction	121
7.2.2	Regional Geology	122
7.2.3	Nature of Mesothermal Gold Mineralization	125
7.2.4	Mineralogy of the Lamprophyres	125
7.2.5	Geochemistry of the Lamprophyres	125
7.2.6	Direct or Indirect Link between Potassic Lamprophyres and Mineralization	129

7.3	Shoshonitic Lamprophyres from the Tom's Gully Gold Deposit, Northern Territory, Australia (Proterozoic)	130
7.3.1	Introduction	130
7.3.2	Regional Geology	130
7.3.3	Nature of Mesothermal Gold Mineralization	130
7.3.4	Petrology of the Lamprophyres	131
7.3.5	Indirect Link between Lamprophyres and Gold Mineralization	131
7.4	Shoshonitic Lamprophyres from the Eastern Goldfields, Yilgarn Block, Western Australia (Archaean)	132
7.4.1	Introduction	132
7.4.2	Regional Geology	133
7.4.3	Nature of Mesothermal Gold Mineralization	133
7.4.4	Lamprophyres and Their Association with Mineralization	135
7.4.5	Petrology and Geochemistry of the Lamprophyres	135
7.5	Shoshonitic Lamprophyres from the Superior Province, Canada (Archaean)	138
7.5.1	Introduction	138
7.5.2	Nature of Mesothermal Gold Mineralization	139
7.5.3	Lamprophyres and Their Association with Mineralization	139
7.5.4	Petrology and Geochemistry of the Lamprophyres	141
7.6	Indirect Link between Lamprophyres and Archaean Gold Mineralization	143
7.7	Synthesis of Indirect Associations	143
8	Halogen Contents of Mineralized versus Unmineralized Potassic Igneous Rocks	145
8.1	Introduction	145
8.2	Erection of Database MICA1	147
8.3	Discussion	147
8.3.1	Behaviour of Halogens in Magmatic Hydrothermal Systems	147
8.3.2	Halogen Contents of Mica in Potassic Igneous Rocks	149
8.3.3	Significance of Halogen Contents	157
9	Implications for Mineral Exploration	159
9.1	Introduction	159
9.2	Area Selection	159
9.2.1	Composition of Host Rocks	159
9.2.2	Tectonic Setting	160
9.3	Prospect Evaluation	160
9.3.1	Favourable Tectonic Elements on the Prospect Scale	160
9.3.2	High Oxidation State of the Magmas	160
9.3.3	Elevated Halogen Contents of the Magmas	161

10	Characteristics of Gold-Copper Deposits Associated with Potassic Igneous Rocks	. 163
10.1	Abbreviations	. 163
10.2	Tables of Deposit Characteristics	. 163
10.2.1	Andacollo, Chile	. 164
10.2.2	Bingham, Utah, USA	. 165
10.2.3	Choquelimpie, Chile	. 166
10.2.4	Emperor, Vitu Levu, Fiji	. 167
10.2.5	Goonumbla, New South Wales, Australia	. 168
10.2.6	Grasberg, Indonesia	. 169
10.2.7	Kirkland Lake, Superior Province, Canada	. 170
10.2.8	Ladolam, Lihir Island, Papua New Guinea	. 171
10.2.9	Maricunga Belt, Chile	. 172
10.2.10	Mount Kare, Papua New Guinea	. 173
10.2.11	Mount Morgans, Eastern Goldfields, Western Australia	. 174
10.2.12	Porgera, Papua New Guinea	. 175
10.2.13	Tom's Gully, Northern Territory, Australia	. 176
10.2.14	Twin Buttes, Arizona, USA	. 177
10.2.15	Wiluna, Eastern Goldfields, Western Australia	. 178
References		. 179
Subject Index		. 199