

## Contents

	<i>page</i>
<i>Acknowledgments</i>	<i>xi</i>
Chapter 1: Introduction, definition, and general characteristics	1
1.1 Introduction	1
1.2 Overview of LIP style through time	5
1.3 LIPs on other planets	9
1.4 Global LIP barcode record of Earth	9
1.5 Origin of LIPs	11
1.6 Global distribution of LIPs	11
1.7 Summary	39
Chapter 2: Essential criteria: distinguishing LIP from non-LIP events	40
2.1 Introduction	40
2.2 Essential attributes of LIPs	40
2.3 Associated magmatism (silicic, carbonatitic and kimberlitic)	50
2.4 Types of non-LIP magmatism	50
2.5 LIP fragments/remnants	53
2.6 Summary	55
Chapter 3: Continental flood basalts and volcanic rifted margins	56
3.1 Introduction	56
3.2 Continental flood basalts (CFBs)	56
3.3 Volcanic rifted margins	76
3.4 Thematic issues related to CFBs	77
3.5 Remnants of CFBs in the older LIP record	83
3.6 Summary	89
Chapter 4: Oceanic LIPs: oceanic plateaus and ocean-basin flood basalts and their remnants through time	90
4.1 Introduction	90
4.2 Oceanic plateaus	91
4.3 Ocean-basin flood basalts	98
	vii

viii	<i>Contents</i>	
	4.4 Reconstruction of links between oceanic LIPs	98
	4.5 Accreted oceanic plateaus	100
	4.6 Pre-Mesozoic oceanic LIPs	103
	4.7 Summary	108
Chapter 5:	Plumbing system of LIPs	111
	5.1 Introduction	111
	5.2 Dolerite dyke swarms	112
	5.3 Dolerite sill provinces	123
	5.4 Differentiated intrusions	134
	5.5 Magmatic underplating	143
	5.6 Relations between different components of LIP plumbing system	145
	5.7 Summary	152
Chapter 6:	Archean LIPs	154
	6.1 Introduction	154
	6.2 Archean flood basalts	154
	6.3 Archean greenstone belts of the tholeiite–komatiite association	162
	6.4 Summary	178
Chapter 7:	Planetary LIPs	179
	7.1 Introduction	179
	7.2 Mars	179
	7.3 Venus	192
	7.4 Mercury	205
	7.5 The Moon	207
	7.6 Io: satellite of Jupiter	211
	7.7 Summary	211
Chapter 8:	Silicic LIPs	214
	8.1 Introduction	214
	8.2 Silicic magmatism associated with LIPs	216
	8.3 Silicic LIPs (SLIPs)	219
	8.4 Precambrian SLIPs	227
	8.5 Speculative SLIPs	238
	8.6 Discussion	239
	8.7 Summary	243
Chapter 9:	Links with carbonatites, kimberlites, and lamprophyres/lamproites	245
	9.1 Introduction	245
	9.2 Carbonatites and LIPs	245

<i>Contents</i>		ix
9.3	Kimberlites and LIPs	262
9.4	Lamprophyres, lamproites, and LIPs	272
9.5	Summary	276
Chapter 10:	Geochemistry of LIPs	277
10.1	Introduction	277
10.2	Mantle sources and processes for producing LIPs	277
10.3	Overview of geochemical variations among LIPs	292
10.4	Geochemistry of oceanic LIPs	292
10.5	Geochemistry of continental flood basalts (CFBs)	299
10.6	Geochemistry of the LIP plumbing system	305
10.7	Geochemistry of Archean LIPs	317
10.8	Geochemistry of anorogenic boninite series rocks	321
10.9	Geochemistry of carbonatites, kimberlites, and lamprophyres/lamproites	328
10.10	Geochemistry of associated silicic magmatism	332
10.11	Geochemistry of the LIP as a system	335
10.12	Summary	337
Chapter 11:	LIPs, rifting, and the supercontinent cycle	339
11.1	Introduction	339
11.2	LIPs, continental breakup, and formation of ocean basins	339
11.3	Active/passive rifting and rift classification	341
11.4	Triple-junction rifting	345
11.5	Timing of LIPs and rifting	351
11.6	LIPs that did not result in continental breakup	352
11.7	LIPs and continental breakup	354
11.8	LIPs and supercontinents	356
11.9	Using LIPs to reconstruct supercontinents	363
11.10	Summary	369
Chapter 12:	LIPs and topographic changes	370
12.1	Introduction	370
12.2	Domal uplift associated with LIPs	370
12.3	Mechanisms that control uplift and variation through time	384
12.4	Regional domal uplift prior to LIP magmatism	393
12.5	Uplift changes during LIP magmatism	393
12.6	Post-LIP topographic changes	395
12.7	Summary	398
Chapter 13:	LIPs and links with contractional structures	399
13.1	Introduction	399
13.2	Contractional structures associated with domal uplift	399

13.3	LIPs in a back-arc setting	407
13.4	Convergent zones (orogenic/deformation belts) linked to distal LIPs through the plate-tectonic circuit	409
13.5	Summary	417
Chapter 14:	LIPs and environmental changes and catastrophes	418
14.1	Introduction	418
14.2	Link between LIPs and global extinction events	418
14.3	LIPs and their environmental consequences	419
14.4	Effects of LIPs on climate	432
14.5	Problem of different time scales	443
14.6	Environmental effects of LIPs	443
14.7	HEATT (haline euxinic acidic thermal transgression) model	451
14.8	Summary	457
Chapter 15:	Assessing the origin of LIPs	459
15.1	Introduction	459
15.2	Overview of models for the origin of LIPs	459
15.3	Geochemistry and origin of LIPs	476
15.4	Assessing the origin of LIPs from geometric arguments	485
15.5	Assessing LIP origin from associated carbonatites and kimberlites	493
15.6	Origin of multiple pulses	494
15.7	Evidence from planetary studies	495
15.8	Review of critical parameters related to LIP origin	496
15.9	Summary	497
Chapter 16:	LIPs and implications for mineral, hydrocarbon, and water resources	499
16.1	Introduction	499
16.2	Magmatic ore deposits linked to LIPs	503
16.3	Hydrothermal ore deposits linked to LIPs	523
16.4	LIPs and laterite deposits (secondary enrichment by weathering)	536
16.5	LIPs and supercontinent reconstruction (indirect links between LIPs and metallogeny)	538
16.6	Emplacement of LIPs, extensional pulses, and distal compression/transpression	539
16.7	Implications for the oil industry	539
16.8	LIPs and water resources	543
16.9	Summary	543
	<i>References</i>	545
	<i>Index</i>	641