

Index

Page numbers in *italic* denote figures. Page numbers in **bold** denote tables.

- Adama basin 194, 299, 300
Afar 134
 crustal structure 23, 26, 239–49, 273
 depression
 basalt 83–4, 87
 geology 24–5
 plate kinematics 27–38
 reconstruction
 advanced plate divergence 35–6
 continental break-up 25–7
 initial rifting 33–5
 pre-rifting 24–5, 25, 31–3
 evolutionary 36–7
 rhyolites 121–8
 silicic volcanism
 age 123
 petrology 124
 tectonics 23, 24, 123
 mantle plume 3–4, 23, 51, 57, 84, 86, 87–9,
 95–7, 109, 111–13, 133
 triple junction 2, 23, 24, 25, 25, 36, 43, 123, 133,
 136, 137, 144, 239–40
Afar volcanic province 1, 2, 3
 see also Ethiopia–Yemen plateau, flood
 basalt province
Afro-Arabian rift system 43, 44
 evidence from Gewane earthquake swarm 137, 140
 magmatism 43–52, 88–9
Aisha block 23, 24
 reconstruction 25, 31–2, 34, 35–6
Ali Sabieh block *see* Aisha block
Aluto volcano 147
Aluto–Gedemsa magmatic segment 145, 146, 150,
 159, 317
 faults 147, 149, 153, 154, 155
 see also Koka magmatic segment
Amaro basalts 84–6, 88
Angelele magmatic segment 145, 146, 147
 faults 149, 151, 153, 155, 158
 reflection/refraction profile 273
anisotropy, seismic 18, 19, 57–68, 271, 288
 LPO vs. OMP 58, 59, 63–4
Anza rift 217, 218, 219, 221, 222, 223, 225, 226
Arabian Plate 9, 10
 Arabian–Somalia kinematics 9, 28–29, **30**, 34, 36
 Nubia–Arabia kinematics 9, 27–9, **30**, 31, 34,
 35, 36, 136, 137, 140
Arboye rift border fault 283, 299, 300
Asal–Ghoubbet rift 159–60
Asela fault 193, 197, 198, 199–200, 203, 204
asthenosphere, mantle 82, 310
asthenosphere–lithosphere flow models 18, 20, 66
Ayelu–Amoissa lineament 136, 137, 139

basalt 77–8
 Afar depression 83–4, 86–7
 Ethiopian Rift 86, 98, **99–104**, 105–13
 flood 1, 2, 25, 31, 32, 35, 43
 Ethiopian 1, 83, 84–5, 95–7, 108, 144, 193–4
 magmatism and rifting 43, 121
 Getra–Kele 86
 Kenya rift 81–2, 86–7
 ocean island 81, 82, 87
 southern Ethiopian 84–6, 96
 Turkana 88, 89, 98, 108
 U-series isotope analysis 86–7
 Western rift 80–2
Beseka Lake, uplift 185–186, 189
Bishoftu volcanic chain 146, 147, 263, 294, 299, 301
Boset magmatic segment 145, 146, 261–4
 gabbroic mafic intrusion 285, 300–1, 302, 310, 317
 magnetotelluric survey 293, 299, 300, 301–3
 receiver function analysis 255
 reflection/refraction profiles 273–4, 279, 283,
 285, 310
Boset volcano 96, 97, **101–2**, 106, 144, 148, 150, 156
 intrusions 302, 317
Boset–Kone magmatic segment 150, 159
 faults 147–8, 149, 151–5
 vertical deformation 185–6
Bouguer anomaly
 Afar depression 26
 Main Ethiopian Rift 147
 northern Main Ethiopian Rift 311–15
 Red Sea 26
 Turkana depression 88
break-up, continental
 Afar 25–7
 models 3
Buluk fault zone 213, 214, 223, 224, 226, 228
Butajira lineament 146, 147, 263

Chew Bahir graben 213, 214, 221, 224, 226
Choke volcanic centre 96, 98, 106
cinder cones 156
coupling, viscous 18, 20, 66
crust
 extension 23, 30, 287–8
 lower, anomalous 284–5
 structure
 Afar 26, 239–49
 northern Main Ethiopian Rift
 controlled-source survey 269–89
 gravity survey 307–19
 receiver function studies 253–65

Danakil block 23, 24, 134
 reconstruction 25, 26, 29, 31–2, 34, 35–7
Davie ridge 14, 15, 16–17
Dead Sea transform 29, 31, 43
Debre Zeit lineament 146, 147, 149
 see also Bishoftu volcanic chain
deformation
 brittle 48
 kinematic model 9–20
 vertical, Main Ethiopian Rift 185–9
 Wonji Fault Belt, GPS monitoring 201–4
demagnetization
 alternating field 169–70, 171, 172
 thermal 169, 170, 172

- density model 312–16
 divergence, plate 29–30, 33–6
 Djibouti
 crustal structure 242–9
 GEOSCOPE station ADT 239–49, 240
 Dofan volcano 96, 97, **99–100**, 106, 148, 150, 150, 156–7
 dykes
 magmatic rifting 45–8, 51, 240–1, 317
 propagation 49–50, 159
 Red Sea 34, 44
 straight 48–9
- EAGLE project 156, 168, 308
 controlled-source experiment 136, 270, 272, 273–89
 gravity survey 307–19
 magnetotelluric survey 293–303
 passive experiment stations 254, 256
 seismic anisotropy 56, 57, 63, 65
- earthquakes
 Gewane swarm 133–40
 shear-wave splitting 64–6, 67
 slip vectors 10, 13, 14, 15, 17, 66
- East African plateau 77, 78, 79
 magmatism and rifting 79–82
- East African Rift System 1, 2, 55, 56, 57, 166, 270
 GPS data 11, **12**
 kinematics 9, 14, 14, 15–20
 seismic anisotropy 57–68
- Eastern Rift 15, 18, 19, 20, 196, 197, 202
 see also Kenya Rift
- Ethiopia Afar Geoscientific Lithospheric Experiment
 see EAGLE project
- Ethiopia–Yemen plateau
 flood basalt province 1, 95–7, 96, 253
 see also Afar volcanic province
 volcanism 1–2, 25
- Ethiopian flood basalts 83, 84–5, 107, 193–4
- Ethiopian plateau 77, 78, 79
 magmatism and rifting 78, 83–6
- Ethiopian Rift *see* Main Ethiopian Rift
- Euler poles
 Arabia–Nubia **27, 28, 29, 30, 34**
 Somalia–Arabia **28, 28, 29, 30, 34**
 Somalia–Nubia 9, 10, **28, 29, 30, 34**
 Victoria microplate 14
- extension, crustal
 dynamics 226–31
 initiation 2
 NMER 286–7, 316
 see also rifting
- Fantale magmatic segment *see* Fantale–Dofan magmatic segment
- Fantale volcano 96, 97, **99–100**, 106, 144, 148, 150, 151, 185
- Fantale–Dofan magmatic segment 145, 146, 147, 261, 263
 faults 148, 149, 150, 151–5, 157
 reflection/refraction profile 274, 284
- faults
 detachment 3
 Oligocene 26
- Quaternary
 Main Ethiopian rift 143–60, 146
 down-dip length 155–6
 Wonji Fault Belt 136, 146–60, 196–200, 201
 and stress 45, 48
 Turkana rift 212–13
 fault interaction types 226, 227, 228
- force
 magmatic 45–8
 tectonic 45
- gabbro, mafic intrusion 286, 287, 300–1, 302, 310, 317
- Gademotta formation, aeolian sediment 195
- Gamo basalts 84–5
- garnet 81, 82, 84
- Gedemsa caldera 147
- Gedemsa magmatic segment 147, 274, 283
- geochronology, Main Ethiopian Rift 176, **177**
- geomagnetic poles, virtual 179
- GEOSCOPE station ADT, Djibouti 239–249, 240
- Gewane earthquake swarm 133–40
- Global Positioning System *see* GPS monitoring
- GPS monitoring
 Nubia–Arabia plate boundary 27, 28
 Somalia–Nubia plate boundary 9, 10, 11–12, 14, 15–17
 Wonji Fault Belt 191
- gravity anomaly 311–19
 see also Bouguer anomaly
- gravity survey, northern Main Ethiopian Rift 307–19
- Gugufu volcanic centre 96, 98, 106
- Gulf of Aden
 initiation 2, 23, 26, 28, 123
 magnetic anomalies 30
 reconstruction 25, 29, 34, 36–7
- Gulf of Tadjoura 31, 36, 239, 240, 241, 242, 248
- Hanang volcano, Tanzania 150, 157
- high-field-strength elements, enrichment 80, 81, 82
- HIMU (high μ) signature 84, 88
- hotspots 51, 97
 see also mantle plumes
- HTI *see* isotropy, horizontal transverse
- isotopes, radiogenic,
 analysis
 Afar depression 83–4, 124, **126**, 127–8
 East African plateau 80–2
 rhyolite 124, **126**, 127–8
 U-series, Kenya Rift and Afar 86–7
 Ethiopian rift basalt **99–104**, 105–8, 109–111
- isotropy
 horizontal transverse (HTI) 58
 vertical transverse (VTI) 58, 63, 64, 65, 67
- K–T experiments 172, 174
- Kataboi fault zone 213, 215, 223, 224, 226, 228
- Kenya rift 79–80
 basaltic magma composition 80–2
 U-series isotope analysis 86–7
 see also Eastern Rift
- Kibaran belt 79, 80
- kinematics, plate 9–20
 Afar region 23, 24, 26–38, 196–7
 Wonji Fault Belt 168, 191

- Kino Sogo graben 213
 Kivu province, basalt 81, 82
 Koka magmatic segment 186, 317
see also Aluto–Gedemsa magmatic segment
 Kone volcano 96, 97, **99–102**, 106, 148, 261
 Kone–Gariboldi volcanic complex 187, 189
- lake evolution, Wonji Fault Belt 194–5
 Langano Lake 194, 195
 lava
 felsic, Main Ethiopian Rift 121, 124, 317
 mafic, Ethiopian rift 98–113
 see also gabbro, mafic intrusion
 palaeomagnetic sampling 168–169
 layering, periodic thin (PTL) 57, 58
 lithophile elements, large ion, enrichment 80
 lithosphere
 magmatic rifting 45–8, 50, 51
 mantle 50, 51, 82
 Lothidok–Kino Sogo province 219, 223, 224,
 226, 228, 229
 Love waves 58, 63
 LPO *see* orientation, lattice-preferred
- magma
 alkaline 83, 86
 mafic, Boset magmatic segment 285, 288, 300–301
 silicic, generation 126–128
 magma chamber, size and depth 49
 magmatism
 Afro-Arabian rift system 43–52
 migration 88–9
 basaltic
 East African Plateau 79–82
 Ethiopian Plateau 83–86
 continental flood basalt 121
 Main Ethiopian rift 146–51
 relationship with rifting 121
 relationship with strain 228–230
 see also rifting, magmatic
 magnetization
 anomalies, Gulf of Aden 30
 characteristic remanent 172, 175
 natural remanent 169–170, 172
 Main Ethiopian Rift 13, 14, 15, 28, 79, 165–167
 basalts 86
 composition 97–98, **99–104**, 105–108
 crustal thickness 144
 development 51, 134, 136, 138, 144–145, 271
 fault systems 143–160, 146
 geochronology 176, **177**
 GPS monitoring 191–204
 initiation 2, 28, 123
 magmatic segments 146–151
 northern
 crustal extension 271, 285–287
 crustal structure
 anomalous lower crust 284–285, 287
 controlled-source seismic survey 269–289
 modelling 276–284
 electrical resistivity 293–303
 gravity survey 307–319
 density model 312–316
 receiver function studies 253–265, 301
 gabbroic mafic intrusion 300–301, 302,
 310, 317
 geology 309
 magmatic segmentation 271, 272, 283, 285
 mantle 285, 287–288, 310, 316, 318
 partial melt 284, 287, 301, 302, 310–311, 317
 surface-wave anisotropy 63–64, 66
 tectonic setting 310
 palaeomagnetism 168–181
 plate divergence 29–30, 34–35
 rhyolite 121–128
 strain accommodation 143–160, 167,
 177–179, 199
 tectonic setting 308, 310
 vertical deformation 185–189
 Malawi rift, kinematics 14, 15–17
 mantle
 composition 82, 284
 density 316, 318
 flow 18, 20, 66
 partial melt 284, 287, 301, 302, 310–311, 317
 reflector 284, 287–288
 uplift 45, 287
 upwelling 18, 55, 57, 66, 77
 mantle plumes 77, 78
 Afar 3–4, 23, 51, 57, 84, 85, 86, 87–89, 95–97,
 109, 111–113, 133
 head-tail transition 111–112
 HIMU 84, 88
 Kenya 86, 88, 288
 single vs. multiple plume models 3, 66, 87–89, 96,
 112–113
 Tanzanian 57, 88–89
 Marda lineament 25, 32
 Mekele graben 25, 31
 melt pockets, oriented (OMP) 57, 58, 59, 60, 63–64, 67
 Moho depth
 Afar 240, 241–246, 248, 273
 northern Main Ethiopian Rift 254–5, 261, 263, 264,
 271, 288
 Mozambique belt 60, 79, 81, 273, 288
 Mweru rift 14, 15, 17
- Nazret magmatic segment *see* Boset–Kone magmatic
 segment
 N'Doto–Karisia fault zone 213, 216, 223, 224,
 226, 229
 Nubian Plate 9, 10, 60
 GPS data 11, **12**
 Nubia–Arabia kinematics 27, 28, **28**, 29, **30**, 31, 34,
 35, 36, 137, 139–140
 Rovuma–Nubia kinematics 16–17
 Somalia–Nubia kinematics 9, 10, 13–14, 15–16, 28,
 28, 29, **30**, 34, 168
 Victoria–Nubia kinematics 15
- olivine, crystal LPO 58, 66
 OMP *see* melt pockets, oriented
 orientation, lattice-preferred (LPO) 57, 58, 59, 63, 66, 67
- P-waves
 S-wave conversion 255–7, 263
 velocity 58, 59
 Afar 241–2, 244–5, 246, 247, 248

- palaeomagnetism
 Main Ethiopian Rift (MER) 168–81
 direction 172, 175, 181
- palaeosecular variation studies 179
- Pan-African orogeny 24
 fabric 67–68
- peridotite, olivine crystal LPO 58, 59
- Poisson's ratio
 Afar 241, 242, 243, 246, 247, 248–9
 Main Ethiopian Rift 29, 255, 257, 262–264, 301
- potassium enrichment 80
- PTL *see* layering, periodic thin
- rare earth elements
 fractionation
 East African plateau 80, 81–2
 Ethiopian flood basalts 84
 Ethiopian rift basalts 86, 98, 106
 southern Ethiopian basalts 85
- Rayleigh waves 58, 60, 63, 242, 246, 247
- receiver function analysis 242–248, 255–259, 262, 263, 264, 301
- Red Sea
 constraints 29
 dyke system 34, 44
 initiation 2, 23, 26, 27, 27, 28, 29, 30–31, 34, 36, 37, 123
 reconstruction 25
 rhyolite 121–128
- remagnetization, viscous 172
- resistivity, electrical 293–303
- rhyolite, syn-rift, Afar depression 121–8
- rifting
 Cenozoic 2–3, 25–27
 Turkana rift 219–226, 230
 driving forces 44–8, 57
 magmatic 43, 45–48, 50, 51, 66–67, 79–86, 240–241, 263, 287
 and seismic anisotropy 57–68
 tectonic 45, 46, 48, 51
 transtensional 158–9
- rotation, tectonic 177–9
- Rovuma block, kinematics 14, 15–17, 16, 17
- Ruhuhu graben 15
- Rukwa rift 14, 15
- Rungwe province, basalt 81, 82
- S-waves *see* shear-waves
- Sabure magmatic segment *see* Fantale–Dofan magmatic segment
- sediment
 aeolian, Gademotta formation 194
 lacustrine, Wonji Fault Belt 193, 194–195
- segmentation, magmatic 3, 136, 137, 146–151, 159–160, 167–168, 283, 285
- seismicity 14, 15, 17, 18
- shear-waves
 SKS splitting 18, 19, 57, 58, 59, 60–63, 66, 263, 273
 splitting, in earthquakes 64–6, 67
 velocity 58, 246
- Shukra el-Sheikh fracture zone 26, 30, 34, 36
- Sinai triple junction 27, 29
- slip vectors, earthquake 10, 13, 14, 15, 17, 66
- Somalian Plate 9, 10, 60
 GPS data 11, 12
 Somalia–Arabia kinematics 9, 28, 29, 30, 34, 36
 Somalia–Nubia kinematics 9, 10, 13–14, 15–17, 28, 29, 30, 34, 168
 Victoria–Somalia kinematics 15, 17
- spreading, sea-floor
 Gulf of Aden 26, 30
 Red Sea 37
 Wonji fault belt 167–168
- strain, indicated by volcanoes 156–158
- strain accommodation 3, 57, 137, 143–160, 167–168, 177–179, 199, 249, 263
- stress, extensional 45–47, 48, 50
- Suez rift 29, 43
- Suguta graben 211, 213, 225
- superplume, African 18, 20, 55, 57, 60, 67, 96, 271, 273
- superswell
 African 57, 66, 77, 78
 Ethiopian 84
- surface-waves
 seismic anisotropy 57
 regional anisotropy 60
 Northern Ethiopian Rift 63–64
- susceptibility vs. temperature (K–T) experiments 172, 174
- Tanzanian craton 15, 18, 19, 20, 43, 44, 51, 61–62, 79, 81, 82
 mantle plume 57, 88–89
- Tendaho–Goba'ad discontinuity 134, 136, 145
- thinning, crustal 121, 283–284, 285
- tholeiite 83, 98
- titanium, Ethiopian flood basalts 84–85
- trace element enrichment 80, 81–82
- trachyte 124
- traps *see* basalt, flood
- triple junction *see* Afar triple junction
- Turkana basalts 88, 89, 98, 108
- Turkana rift 209–31
 fault interaction types 226, 227, 228
 geology
 Cenozoic 212, 213, 219–226
 Cretaceous 217, 218, 219
 Proterozoic basement 213, 215, 217
 rifting stages 219–26, 227, 230
 controlling factors 226, 228–30
 strain/magmatism relation 228–30
 transverse fault zones 212–13
- U-series isotope analysis 86–7
- Ukerewe–Nyanza block *see* Victoria block
- underplating 264, 283, 285–286, 287, 301, 302, 318
- uplift
 Lake Beseka 185–186, 189
 mantle 45, 287
- Usangu graben 15
- Victoria microplate, kinematics 14, 15, 17, 17, 18, 20
- Virunga province, basalt 81, 82
- volcanism
 Ethiopian Volcanic Province 95–6, 144
 Ethiopian–Yemen Plateau 1–2, 25–26, 31–32, 77, 97–113

- felsic 2, 121, 124
- mafic 97–113, 211
- Miocene 34–35, 83
- silicic 121–128
- volcanoes, as strain indicators 156–158
- VTI *see* isotropy, vertical transverse

- Western Rift 15, 19, 79–80
 - basaltic magma composition 80–82
 - extension 18

- Wonji Fault Belt 86, 97, 134, 136, 145, 146–147, 158, 167, 192
 - GPS monitoring 191, 193, 201–204
 - lake evolution 194–5
 - mechanism of faulting 196–7, 199–200, 201
 - present-day kinematics 195–6

- Zambezi rift 14, 15
- Ziway Lake 193, 194, 195, 198, 203, 204