

INDEX

- Aar massif 53, 189
 Aar-Gotthard area 87,89
 accretion, of island arcs 143
 accretionary belt, Caledonian 162, 164
 accretionary wedges 11, 23, 26, 141, 143, 152, 184
 Neogene 197
 Penninic 199
 polyphase 192–3
 Saharan 201
 active margins 22, 178, 179
 Adriatic crust 53, 55, 56, 189
 Adriatic margins 124, 183–4, 187
 Adriatic microplate 31, 53, 56, 192, 193, 198, 205, 211, 226
 anticlockwise rotation of 28, 30, 184, 189, 205
 collision
 with Corsica–Sardinia block 225–6
 with Variscan Europe 30
 fragmented 195
 imbrication of upper crustal flakes 186–7
 overriding lower European crust 189
 a rotating indenter 186
 Adriatic Sea 124
 Adriatic–African plate 182
 Adula block 182
 Adula nappe 186, 187, 189
 African craton 200
 African plate, movement relative to Europe 189
 African–Eurasian plate interaction 124
 Aiguilles Rouges massif 189, 190
 Airy-type compensation 132
 Alboran extension site 211
 Alboran Sea 31, 210–11
 Algeria 200, 201, 202
 Alnö volcanic province 93
 Alpine arc, seismicity in 118
 Alpine belt 30–1, 83, 87
 Alpine foreland 173
 Alpine nappes 28, 89, 188
 Alpine orogeny 173–6, 180–90
 Cretaceous convergence 184–6
 foreland volcanic phase 174–5
 Mesozoic rifting phase 181–4
 pre-Triassic evolution 180–1
 Tertiary collision 173, 186–90
 Alpine south front 190
 Alpine–Mediterranean area 4
 heat flow 75–6, 136
 Moho temperature 75
 seismicity in 118–19
 thermal data 73
 Alpine–Penninic basins 214
 Alpine–Zagros chain 32
 Alps 30, 47, 51–5, 68, 78, 136, 209
 compressional regime 190
 crustal core 196
 crustal thickening beneath 102
 geodynamics of 219–24
 lithospheric cross section 107–8
 seismic structure 52
 thrust fronts of 204
 uplift in 131–2
 wedge structure in deep crust of 30
 see also Central Alps; Southern Alps; Western Alps
 amphibolites 99–100, 140, 142, 143, 145, 149
 Anatolian fault system 31–2
 angular unconformities 180, 181, 182, 186
 anorthosite 143, 148
 Apennine deformation front 193
 Apennine foredeep 193
 Apennine orogen 192–3
 Apennine–Betic chain 32
 Apennines 30, 124, 136, 190, 192–3, 204, 211
 see also northern Apennines
 Appalachian–Variscan system, bivergent 214
 Appalachians 27, 181
 applied stress 82
 Aquitaine basin 68
 arc terranes 11, 20, 23
 see also terranes
 Archaean terranes 17, 18, 39, 139, 140–3, 145, 152, 229
 Archaean–Proterozoic palaeoboundary 146
 arcs 24, 229
 see also island arcs; magmatic arcs
 Ardennes 23
 Ardennes–Brabant Massif, detrital zircons 150–1
 Argentera–Mercantour massifs 119
 ‘Armorica’, rifted from Gondwana 26
 Armorican massif 26, 165–6
 asthenosphere 1, 32, 103, 203, 230
 heat advection from 170
 lateral flow in 227
 low-viscosity 129, 131
 mixing by convection 2

- thin, Baltic Shield 226, 227
upwelling of 223
- asthenosphere push 208–9
- Atkanric Ocean 28, 29, 181, 183
- Atlantic Ocean, *see* North Atlantic
- Atlas Mountains 30
- Atlasian foreland 199
- Atlasian system, Algeria 210–11
- Atlasian terrane 60
- Austroalpine nappes 184, 186
- Avalonia 14, 21, 162, 165, 167
docking of 24, 164
- Avalonia–Baltica Suture 21
- Avalonia–Laurussia suture 21, 27, 28
- azimuthal anisotropy 68
- Azores triple junction 204
- BABEL Line A 155, 160, 162
- BABEL reflection profiles 102, 104, 147
- BABEL Working Group 9, 18, 104
marine seismic reflection survey 42, 43–4, 47
- backarc environment 147
- backarc basins 11, 20, 145, 205
expanding 209–11
- backarc spreading 24, 32, 166, 193, 202, 203, 204, 210–11
- backfolds, Penninic nappes 189
- backthrusting 179, 191
- Balearic basin 136
- Balearic extension site 211
- Balearic Islands 31
- Baltic Sea 41, 43–4, 47
- Baltic Shield 4, 11, 20, 64, 73, 102, 132, 227
Archaean nucleus 3
crust
structure in northern Shield 37–9
thick 61, 103
and upper mantle structure 61, 63
electric conductivity 79, 80
faulting 120–1
geoid anomalies 78–9
gravity studies 77
lithosphere
cross section 103–6
mechanically strong 86
thermal lithosphere 75
thick 65
Moho temperature 75
palaeomagnetic data 152
Precambrian drift history 12–13, 13
seismicity 114–17
crustal 88, 114, 116
distribution of with depth 88, 115–16
intraplate 85, 86, 87, 88, 89
stability of 228–30
strength profile 83, 84, 85
stress in 121–2, 122
tectonic evolution 139–50
- Baltic Shield/European thrust boundary 106
- ‘Baltic’ trilobite fauna 22
- Baltic–Bothnian megashear zone 41
- Baltica 19–20, 27, 158–9, 165
anticlockwise rotation of 13, 14, 19, 20
collision with Laurentia 20, 153
banded iron formations 20, 141, 146
- Barents Sea 39, 88
- basalt 142
calcalkaline 134
intra-plate 178
MORB-type 177, 178
ocean floor 99
tholeiitic 143
- base metal mineralisation 147
- basement 162–3, 185
pre-Alpine, Alpine outcrops 180, 181
pre-Mesozoic 176–80
Variscan 166, 167, 173, 179
Proterozoic 177
Precambrian 20, 44, 152, 153, 155, 158, 160
Archaean 37
- basement high (ridges) 59, 184
- basement massifs, Cadomian 21
- basement nappes 58, 191
- basement uplift 189
- basin closure 165
- basin inversion 160–2, 173
- basins
Late Cretaceous–Early Tertiary 160
Triassic 173
Variscan 172
Cambro–Ordovician 165, 166, 168
see also basin types
- batholiths 23, 148, 149, 150
- Bavaria 150, 179
- Belmorian terrane 141–2, 145
- Belmorides 145
- Benioff zones 196, 207, 210–11, 212, 212
- Bergslagen 147
- Bernhard nappe 185
- Betic Codillera 31
- BIRPS (UK) 33
- Biscay–Asturia loop 214
- Black Forest 26, 132, 179
- black shales, conductive 163
- Blekinge, S Sweden 149
- Bohemian loop 214
- Bohemian massif 26, 68, 165–6, 169
- Bohemian terrane 179
- Børglum fault 158
- Bornholm island 45, 149, 160
- Bothnia, Gulf of 43–4, 104, 115
- Bothnian zone 116
- Bouguer gravity anomalies 43, 71, 130, 132, 163, 193–5
positive 153, 161, 172
see also gravity anomalies
- Brabant massif 22, 23, 178
- Bregaglia intrusion 187
- Brenner line 189
- Briançonnais swell 182, 184
- Briançonnais zone 118
- brittle faulting 112

- brittle fracture 81
 brittle regime 82–3
 brittle strength 81–2
 brittle-plastic transition 112, 114, 119
 brittle/ductile transition 175
- Cadomian orogeny 19, 178
 Calabrian arc 61, 135, 212, 212
 Caledonian front 21, 44, 45, 153
 defined 154, 157, 162
 Caledonian orogen 41, 139, 162–4
 Caledonian orogeny 41, 153
 Camargue graben 224
 Campidano graben 58, 136
 Cape Corse 58
 Carpathian north front 204
 Carpathians 30
 Central Alps 51, 220
 zircon, Lepontine area 151
 central European rift system 49
 Central Massif *see* Massif Central
 central and southern Europe, tectonic evolution
 of 150–1
 Central–Viking Graben rift system 23
 channel flow 129, 131, 227
 Chiasso formation 188
 clastic wedges 29
 collision 212
 Tertiary 186–90
 collision tectonics
 Early Proterozoic 143–6, 229
 Variscan belt 101
 see also orogenic cycles, Mediterranean
 collision zones 11–12, 43, 229
 beneath Gulf of Bothnia 42, 43, 228
 collisional belts 149
 Cologne basin 117, 122
 compression 120, 186, 191, 220
 compressional belts 202
 Conrad discontinuity 49, 158
 conserving mass, principle of 217
 Constance, Lake 47, 73, 176
 continent–continent collision 217
 continental break-up 11
 continental crust 61, 103, 182
 continental evolution, and plate tectonics 1
 continental lithosphere 78, 82, 83, 217
 strength profiles 83–4, 85, 86, 87
 convergence
 Alpine, plate paths 203–4
 continental 203–4
 Cretaceous 184–6
 crustal 136
 oblique 186
 see also Europe–Africa convergence; plate
 convergence
 convergence and extension, local vectors of 204
 Corsica 57, 58, 62, 73, 103, 133, 193, 194
 anticlockwise rotation 224, 225
 Corsica–Sardinia block 31, 108, 224–5
 Corsica–Sardinia channel 225–6
- corundum 99
 creep 83, 218, 219
 creep constants 84
 creep strength 84
 critical taper concept 206, 207
 CROP (Italy) 33
 crust 35–60, 78, 170, 224
 Archaean evolution 12
 Cadomian 26
 European 196
 evolution of 17–32
 Moho as base of 61
 Reno–Hercynian 169
 Saxo–Thuringian 169
 Sveco–Fennian 148
 three-layered 43, 45, 154–5
 two-layered 19, 44, 45, 154–5
 see also lower crust; lowermost crust; middle
 crust; upper crust
 crust–mantle boundary 37, 39, 61, 170
 crust–mantle transition 39, 97, 161
 crustal attenuation 183
 crustal densities 78
 crustal extension 23, 26, 158, 166, 197, 229, 230
 crustal flexure 30
 crustal movements, recent 124–32
 crustal reflectors 156
 bivergent 43
 crustal roots 27, 61, 201, 207, 217, 218, 219, 230
 crustal shortening 27, 31, 230
 crustal slab 193
 crustal strength, minima 84
 crustal structures 76
 Precambrian, contrasted 154–6
 crustal thickening 20, 148, 217, 220, 230
 Bothnian collision zone 229
 orogenic 101
 Tunisia 60, 200
 crustal thickness
 and geoid lows 128–9
 sharp changes in 43
 crustal thinning 158, 166
 beneath Norwegian–Danish basin 159–60
 beneath Sardinia Channel 200
 of Precambrian basement 153
 crustal xenoliths 93, 163
 crystalline massifs, aseismic 118
 crystalline plasticity 112
 Cu–Mo–Au deposits 148
 Cu–Pb–Zn deposits 147
 Cu–Zn–Pb–Ag–Au mineralisation 148
 Cu–sulphide deposits 146
 cumulates 100
- Dal Group 150
 Dalsland thrust 150
 Danish basin 44, 106
 Danish foreland 153
 Danish–Scanlan area 27
 Dauphinois–Helvetic shelf 184
 see also Helvetic shelf

- decay of convergence 212
 décollement, basal 145
 décollement zone, mid-crustal 178
 decompression melting 148
 decoupling 132
 intracrustal 89
 in the lower crust 183–4
 of upper crust, Alps 189
 deep flow 129, 131
 deep seismic reflection profiles 33, 34
 deformation 83, 88, 89, 150, 170
 Carboniferous 179
 intraplate 118
 polyphase 180
 Sveco–Norwegian 149
 syn- and post-collisional 148
 Variscan 177
 dehydration melting 148
 DEKORP programmes 8, 33, 49, 51
 DEKORP-1 reflection profiles 171, 178
 DEKORP-2N 106, 163, 178
 DEKORP-2 102
 delamination 101
 of Alpine lower crust 222
 of lithospheric mantle 170
 of thinned European crust 186–7
 density contrasts 217
 depocentres, Permian 172
 detachments 119, 190, 202, 210–11
 base of Aar massif 196
 compressional 201
 deep 193
 intracrustal 206
 mid-crustal 175
 diapirs 201
 granite 147
 mantle 209
 salt 159, 172
 differential strength 81
 Dinaric orogen, compression in 186
 Dinarides 210–11
 Dinarides–Hellenides 196
 diorite 149
 dip slip 208
 discontinuities 102
 dislocation climb 83
 dislocation glide 83
 Dolerite Group 18
 Dolomites, thrusting in 186
 Dora Maira massif 118, 185
 Dorn creep 83
 downward, double 196
 downwelling, Po basin 132
 ductile flow 83
 dyke swarms 18, 27, 153, 158
 dykes
 basic 145, 148, 149
 lamprophyre 148
 Permo–Carboniferous 161
 Earth Science Study Centres 5–6, 98
 earthquakes 118
 Baltic Shield 114–17
 continental, depth of 84–5
 distribution in Europe 112–13, 114
 intraplate 111–12
 lower crustal 119
 Southern Alps 191
 East Avalonia *see* Avalonia
 east European Platform 19–20, 61
 East Silesian massif 163
 eclogite 26, 105, 106, 169, 179, 230
 in lower crust 105
 ECORS (France) 33, 178
 effective elastic thickness (EET) 80, 88, 89–90, 132
 Eger graben 224
 EGT workshops 5, 8
 EGT-S86 33, 34, 102
 EGT-South 33, 34, 51–60, 102
 Eifel region 86, 88, 133
 Eifel volcanic field 94, 224
 crustal structure 96, 97, 100
 regional heat flow 95
 xenoliths 95, 99–100, 164
 elastic properties, of deep crustal rocks 93
 elastic response 80
 Elbe line 106, 163, 173
 Elbe massif 162
 electrical conductivity 79–80, 105
 anomaly, S of Elbe line 163
 high 107, 178, 179
 electromagnetic studies 79
 Embrunais folds 118
 English–North German–Polish Caledonides 21–3, 162
 eo-Alpine chain 28–9
 eo-Alpine orogeny 184–6
 erosion 72
 escape 11
 lateral 189, 203
 strike-slip 20, 26
 escaping material 209
 Eu-anomalies 98, 99, 100
 EUGEMI 33, 34, 47–51, 55, 102, 106
 EUGENO-S 33, 34, 44–7, 102, 106, 150, 153, 155, 158, 160–1, 162
 Eurasian plate 11
 Europe 61
 crustal evolution 17–32
 observed stress distribution 222
 terranes and crustal domains 15–15, 16
 Palaeozoic development 165
 Variscan, plate tectonic affinities 165
 Caledonian 13, 14
 Precambrian, tectonic evolution 139–52
 Proterozoic 17–18, 19
 Archaean 17
 Europe, central 73
 alkaline volcanism 132–3
 Phanerozoic structures and events 164–80

- seismicity in 117–18
- Variscan 4, 79, 83, 86, 88, 90
- Europe, central and southern 150–1
- Europe, northern, seismicity of 115
- Europe–Africa convergence 17, 30, 58–9, 118, 184, 186, 202
 - controls asthenosphere supply 203
 - Neogene, amount of 197–8
- Europe–Africa plate boundary 199, 202
- European Geotraverse (EGT) 3–9
 - central section, xenolith evidence 100–2
 - seismic exploration of upper mantle 60–9
 - seismic structure
 - central segment 47–51
 - northern segment 37–47
 - southern segment 51–60
- European plate, subduction of 55
- European Science Foundation (ESF) 3
- European Science Research councils (ESRC)
 - working group 3, 4, 5–6
- evaporites 159, 172
- extension 189, 202, 217, 220, 226
 - Aegean area 120
 - Apennines 120
 - behind orogens 203
 - by rising viscous pillows 208
 - Devonian to Early Carboniferous 169
 - hanging wall 208
 - high heat flow 136
 - lithospheric 207
 - polyphase 193
 - synorogenic 207
 - and unroofing of Tauern thermal dome 189
 - west Mediterranean 209, 211
 - see also* crustal extension
- extension–compression model 225, 226
- extensional basins 28, 32, 219
- extensional collapse 20

- Faroe–Rockall rift 214
- fault splays 27, 157–9
- fault zones 147, 172, 184
- faulting/faults 150
 - aseismic slip 116
 - listric 106, 158, 178
 - low-angle 189
 - normal 122, 158, 183
 - postglacial 120–1
 - reverse 174, 189
 - strike-slip 26, 27, 32, 47, 102
 - synsedimentary 183
 - transcurrent 170, 182, 189
 - transform 183, 214
- felsic rocks 95, 97
- FENNOLORA 18, 33, 34, 39–44, 61, 102, 104–5, 105, 147, 149
- Fennosarmatia *see* Baltica
- Fennoscandia 128
- Fennoscandian uplift 125, 127, 127–31, 226–7
- ferropicrite 144
- finite element analysis 217

- Fjerritslev fault 117, 158, 159
- flake structure 164
- flexural modelling, of Alpine region 132
- flexural rigidity 227
- flower structures 157, 189
- fluids, in the crust 176
- fluids and fractures, and conductivity 79
- flysch 26, 169, 177, 178–9
- flysch basins 15, 17, 184, 188, 189
- flysch wedge 192–3
- focal depth distribution 118, 119
- focal mechanisms, northern and western Alps 123–4
- fold belts, Alpine 11
- fold-thrust belts 199, 203, 210–11, 211, 212
 - and backarc extension 204
 - Maghrebide 202
 - Numidian-Atlas 200–1
 - physics of 206
 - south-Alpine 191
 - see also* thrust belts
- folds
 - box and open 201
 - overturned 160
 - reclined, large-scale 141
 - recumbent 143
- fore-arc basins 11
- foredeep, Po basin 188
- foreland, common, Alps and Apennines 191
- foreland basement flexure 207
- foreland basins 26, 30, 90, 187–8
 - Silurian 21, 27
- foreland flexure, Molasse basin 89
- fractionation 100
- fracturing 82, 182–3
- Free Air gravity anomalies 128, 129, 131
- Fynen 153

- gabbro 148, 149
- Genova, Gulf of 224
- geodynamic modelling 215–19
- geodynamic processes 228–30
- geoid anomalies 78–9, 125–6
- Germany, eastern 39
- Gibraltar, Straits of 31
- Giudicarie transpressive belt 186
- glaciation 176
 - and deglaciation 127
- Global Positioning Systems (GPS) 124
- Glückstadt graben 158
- gneiss 98, 143, 148
 - alumino-silicate 141
 - calc-alkaline 145
 - leuco-granitic 96
 - mylonitic 143
 - tonalitic 98, 140
- Gondwana 19, 26, 151, 165
- Gondwana–Laurasia (Laurussia) separation 28, 181
- Gonfolite Lombarda group 188
- Gosau basins 186

- Gothian domains 18
 Gothian orogen 41, 139, 149, 154, 229
 Gothian terrane boundary 153
 Gotthard massif 189
 graben areas, high heat flow 136
 graben structures 19, 23, 58, 116, 132, 136, 150, 160, 173, 224
 Early Tertiary 173
 see also named grabens and graben systems
 Grand Paradiso block 185
 granite 41, 193
 alkali 143
 crustal melt 145, 148
 diapiric 147
 post-tectonic 145, 149, 150
 rapakivi 18, 148, 149, 152
 S-type 26
 granite-gneiss terranes 12, 17
 granitoids
 I-type 148, 179
 Late-Variscan 180, 181
 Moldanubian 95, 98
 granodiorite 140
 granulite 95, 97, 98–9, 100
 Granulite Belt of Finland 145
 granulite–eclogite conversion 222–3
 gravity 76–9, 129
 gravity anomalies 105, 117, 132, 217, 219, 220
 see also Bouguer gravity anomalies
 gravity modelling 76, 77
 greenstone belts 141, 142–3, 145
 greenstone terranes 12, 17
 Grenville Front, extension of 150
 Grenville orogeny 18
 Grenville thrust belt 18
 Grimmen Achse (Axis) 160
- Haparanda monzonites 145
 Harz Mountains 173, 177, 178
 Harzburger gabbro 163
 harzburgite 93
 heat flow 18, 170
 positive anomalies 136
 Hegau volcanics 93, 95
 Heldburg Gangschar 93
 crustal structure 96, 97
 regional heat flow 95
 xenolith suite 94, 95
 Hellenic arc 61, 63
 Hellenic trench 204
 Hellenide/Tauride south front 204
 Hellenides 210–11
 Helvetic Dauphinois domain 182
 Helvetic nappes 53
 Helvetic overthrust 55
 Helvetic Shelf 30
 see also Dauphinois-Helvetic Shelf
 Helvetic zone 51, 52–3, 187
 Hesse Basin 172, 173
 Hessian Depression 49, 224
 see also North Hessian Depression
- Hetta granodiorites 145
 High Atlas 30, 211
 hinge advance 209, 212
 hinge retreat 191, 203, 211, 212
 extensional 209
 Holy Cross Mountains, Poland 23, 160, 161
 Horn graben 158, 162
 hydrocarbon traps 172
- Iapetus Ocean, closure of 20
 Iberia 26, 29, 30, 31, 203, 204
 ILIHA experiment 34, 35, 69
 imbrication 102–3, 107, 146, 191, 192, 195, 200, 201, 206
 Inari terrane 37, 39, 77–8, 103, 141, 143, 144
 indentation 26, 203, 205, 212
 and escape 208–9
 Insubric line 51, 53, 55, 188, 189, 191, 196, 209
 intrusions 144, 147, 172, 180, 187
 beneath Silkeborg gravity high 158
 layered 158
 inversion 27, 30, 153
 inversion structures 47
 island arc collision 106, 230
 island arc systems 100
 island arcs 11, 20, 99, 143, 144, 145, 146, 147
 isostatic compensation 125, 129
 isostatic equilibrium, deviation from 131, 132
 isostatic uplift 207
 Ivrea basement block 183
 Ivrea body 132, 193
 Ivrea zone 170, 195
- Jatulian Group 146
 Jatulian shelf 152
 Jeffreys–Bullen model 61
 Joint Programme 4, 6, 7
 Jormua ophiolite 146, 147
 Jothnian basin 116
 Jura Mountain 87, 88, 89, 119
 Jutland 153, 159, 160
- Kalix volcanic province 93
 Karasjok greenstone belt 145
 Karelia 17, 37, 142
 Karelian terrane 142–3, 145–6
 Kattegat 35, 36, 156, 158, 161
 Kattegat platform 44
 Kazakhstan plate 20
 Keiv Group 143
 Keiv–Porosozero suture 143
 Kittilä greenstone belt 142
 Knipovich Ridge 115
 Kola Peninsula 17
 Kola suture zone 143
 see also Polmak–Pasvik–Pechenga belt
 Kola–Karelian orogen 17–18, 139, 140–6, 152, 229
 Kongsbergian orogen 149
 Kraichgau basin 172

- La Galite island 200
 Lapland 115
 Lapland Granulite belt 37, 39, 77–8, 103, 104, 145
 Lapland–Kola orogen 104
 Lapponian Supergroup 142
 Laurentia 14, 165
 Laurentia–Baltic suture 21, 22
 Laurussia 20, 165, 167
 Lausitz 173, 224
 lava plateaux 142
 Leine graben 132
 lenses
 mafic–ultramafic 148
 tectonic, anorthosite 143
 leucogranite, crustal-melt 149
 Lewisian Complex 139
 Ligurian basin 136, 226
 Ligurian coastal zones 194
 Ligurian rift 190, 224
 Ligurian Sea 52, 56, 73, 103, 108, 136, 193, 194
 rifting in 57, 58
 seismic activity 118, 119
 subsidence 220
 Ligurian–Alboran Sea closure 31
 Liguride units 193
 linear magnetic anomaly, negative 143
 lithosphere 1
 depth-dependent rheology of 81–4
 heterogeneities, dynamic role of 217
 modelling of 81–2
 physical properties 71–80
 electric conductivity 79–80
 gravity 76–9
 thermal structure 72–6
 radial convergence of 67, 223
 seismic 2
 stacked slabs of 195–7
 stratification, rheological 194–5
 strength of 83
 structure
 differences in 65, 67
 layered 61, 63, 229
 mechanical 80–91
 thermal 72–6
 subcrustal, strong 84
 subducted 63, 134
 thermal structure along EGT 73–6
 thickening of 217, 230
 thin 62, 136
 three-layered 208
 two-layered response to stress, Baltic Shield 88
 see also continental lithosphere; lower lithosphere; oceanic lithosphere
 lithosphere–asthenosphere boundary 75
 lithospheric collision 114
 lithospheric cooling 160
 lithospheric cross section, integrated 102–9
 lithospheric roots 218, 229, 230
 Alps 65, 103, 119, 136, 219–20
 asymmetrical 61–2, 107–8
 beneath Po basin 67, 220, 222, 223
 displaced 218
 downbuckling over 219
 lithospheric shortening 118
 lithospheric structures, Caledonian 164
 lithospheric tectonics, and the orogenic cycle 211–12
 lithospheric thinning 223
 and stretching 181
 and young volcanism 224
 lithostatic pressure 82–3
 Lizard–Giessen–Harz nappes 24
 loading and unloading, glacial 125, 127, 227
 Loissin well 163
 Loke shear 22–3, 163, 164
 Lombardian basin 183
 Lombardian Flysch basin 186
 Lopian 142
 lower crust 39, 49, 148, 164, 170
 anomalous structure 160, 161
 European, subduction of 53
 layered 41, 170–1
 Lüneburg massif 163
 Rhenó–Hercynian belt 178
 Scandinavia 149
 lower lithosphere 198
 compositional banding 65
 and isostasy 128
 layered structure 64
 S-wave velocity 65
 thickening of 217, 220
 Lower Rhine graben 122, 132, 173
 crustal model for 175–6
 Lower Saxony basin 173
 lowermost crust 43, 47
 Lugano line 183
 Luleå–Kuopiu suture zone 146–7
 Lüneburg massif 21, 24, 162, 163

 Maghreb 30
 Maghrebide fold-thrust belt 202
 magmatic arcs
 Andean-type 24, 143, 144
 calc-alkaline 11, 145
 Sveco-Fennian orogen 147, 152
 magmatic rocks, pre-Devonian 26
 magmatism 99, 133, 136
 arc 11, 178, 191
 late- and post-collisional 170
 post-orogenic 230
 rapakivi granite 148, 149, 152
 Tertiary 175
 Mid-Cretaceous 186
 Permo-Carboniferous 27, 158
 magnetic anomalies 71, 105, 159
 magneto-telluric (M-T) measurements 71, 153
 Mandel–Ustaoset fault 150
 mantle 227
 see also upper mantle
 mantle flow patterns 202

- mantle material, as a Newtonian viscous fluid 220
- mantle xenoliths 93
- Marsili basin 133–4
- Martegnas mélange 183
- mass balance arguments 217–20, 222–3
- Massif Central 26, 93, 150, 224
- Massif Central ocean 166
- mechanically strong crust (MSC) 81, 86, 87, 88, 90, 91
- mechanically strong lithosphere (MSL) 2, 81, 84, 88, 90, 91
- mechanically weak lithosphere 89–90
- Mediterranean 17, 32, 73, 108–9
 - orogenic cycles 211–13
 - orogenic loops 30–1, 32, 213–14
 - tectonics, recent 203–14
- Mediterranean basin 31
- mélange zone 147
- melts 11, 12
- Meseta loop 214
- Messina, straits of 30
- metamorphic core complexes 207–8, 219
- metamorphic haloes 207
- metamorphism 170, 180
 - amphibolite facies 99, 141, 148, 150, 208
 - eclogite facies 20
 - and extension 207–8
 - greenschist grade 178
 - high-pressure 26, 185
 - low-pressure 26
 - mid-Cretaceous 184–5
 - pre-Devonian 26
 - Saxo-Thuringian belt 179
- microplate movements 124
- microplates 28, 169, 217
- mid-Atlantic ridge 115
- mid-German Crystalline high 24, 26, 49, 178–9
- middle crust 49, 56
 - Aar massif 53
 - Baltic Shield 38–9, 87–8
 - Ligurian Sea 58
- middle Rhine graben 173
- Midlands massif 21
- migmatites 140, 141, 143
- Milan fold belt 189
- Mohn's Ridge 115
- Moho 37, 49, 56, 102, 104, 158, 160–1, 191, 208
 - asymmetric 219
 - Atlasian foreland 199
 - beneath the Alps 53–5, 54, 107, 222
 - beneath central Finland 148
 - beneath European Variscan crust 27
 - beneath Norwegian–Danish basin 160
 - changes in velocity contrast at 41, 43
 - mapping of 60–1, 62
 - and P-wave velocity 60
 - reflection at 47
 - rise and fall of 44–5
 - shallow 136
 - structure below European unit 196
 - temperature at 75
 - updoming of 38–9
 - see also* seismic Moho
- Moho offsets 55, 104, 210–11
- Moho overlap 190, 197
- Moho stacking 196, 197, 199
- Molasse basin 30, 47, 49, 51, 52, 87, 88–9, 107, 119, 136
- molasse basins 17, 26
- Moldanubian terrane 230
- Moldanubian zone 93, 166, 169, 177, 179–80
 - see also* Hegau; Urach
- Monferrato complex 197
- Mont-Blanc massif 189, 190
- Moravo–Silesian unit 179–80
- Morcles nappe 189
- mountain belts, geodynamic modelling of 217–19
- Mte Rosa massif 185
- Münchberg Klippe 26
- Murmansk terrane 140–1, 143
- mylonites 143, 145, 191
- nappes 24, 30, 53, 146, 150, 179, 182, 185, 187, 189
 - advancing 184
 - Alpine 89, 188
 - Austroalpine 184, 186
 - basement 58, 191
 - Caledonian 39
 - exotic 26
 - gravitational 20
 - Penninic 186, 188, 189
- NARS portable seismic stations 35, 63, 65, 69
- Navier–Stokes equation 217, 220
- Neiden granitic pluton 141
- Nesouretus* province trilobites 166
- NFP-20 (Switzerland) 8, 33, 51, 52, 102, 107
- Ni–Cu deposits 148
- Norbotten arc 147
- Nördlinger Ries crater 176
- normal incidence seismic reflection techniques 33, 35, 43, 49
- Norrland, Sweden 105
- North Africa 204
- north Alpine crustal front 199
- North America–Greenland continent 18
- North Atlantic, opening of 173
- North Atlantic Ridge 222
- North Cape, Norway 39
- North German Basin 44, 45, 47, 73, 153, 157, 172, 173
- north German foreland 177–8
- north German line 172
- North German–Polish Caledonides 15–16, 162, 165
 - collapse of 24, 164
- North Hessian Depression (NHD) 86, 88, 93, 106, 223
 - crustal structure 96–7
 - regional heat flow 95
 - xenoliths 95, 98–9, 100, 163

- North Sea 30, 114, 115, 173
 North Sea coast, subsidence of 176
 North-Helvetian Flysch 188
 northern Alpine foreland 117, 220
 northern Apennines 55–6, 57, 58, 107, 118, 210–11, 220
 northern Carpathians 210–11
 Northern Phyllite zone 24
 Norwegian Caledonides 115, 229, 230
 Norwegian Sea 114, 115
 Norwegian–Danish basin 30, 116–17, 153, 159–60, 162
 Novate intrusion 187
 Numidian series 201
 Numidian terrane 201
- obduction 20, 193
 ocean spreading 224
 ocean-bottom seismometers 58, 59
 oceanic basins
 local, deep 202
 small, opening of 31
 unrecognised 198
 oceanic crust 100, 164, 190, 193
 Devonian 169
 formation of 136
 Mediterranean basins 61
 subducted 24, 169, 187
 two-layer 224
 oceanic lithosphere 23, 82, 83
 Ionian, subducted 134–5
 juvenile 229
 oceanic regions, structure of 1
 oceanization 56–7
 oceans, Devonian 25–6
 Odenwald 49, 178
 Old Red Continent 20, 24, 156, 167, 169, 177
 olistostromes 24
 olivine, creep in 83
 Onega, Lake 17
 ophiolite 31, 146, 148, 183, 192
 Oran Meseta 200, 201, 202
 Orijärvi island arc 147
 orogenic activity, post-collisional 26
 orogenic belts 210–11, 211–12
 orogenic cycles, Mediterranean 211–13
 orogenic float 23, 164
 orogenic loops 30–1, 32, 213–14
 orogenic plateaux 207
 orogenic regimes, differing 190–3
 orogens, collapse of 15–17, 219
 orthogneiss 141, 143, 145
 Oslo graben 116, 150
 Oslo region 115
 Oslo rift 153
 Oslo-Skagerrak graben system 158
 Outokumpu nappe 146
 overthrusting 55, 101
- P-wave velocities 97, 107, 162
 eclogites/peridotites 101
 Sardinia-Sahara 199, 200
 xenoliths 92–3, 95
 P-waves 33, 41, 52, 60–3
 palaeo-poles, Baltic Shield 12–13
 palaeogeographic misfits 170
 palaeomagnetism 12–15
 Pan-African orogeny 19
 Pangaea 24, 26–7, 28
 Pannonian basin 30, 68, 207, 209, 210–11
 Pantellaria rift 136
 paragneiss 143, 145, 149, 150
 Paris basin 68
 partial melting 98, 99, 148
 passive margins 22, 178, 182–3, 201
 Pävie fault 120–1
 Pechenga Series, thrust bound slices of 143–4
 Pelagian Sea 60
 pelites 143, 144
 peneplane, post-Sveco-Norwegian 19
 Penninic collision suture 191
 Penninic front 55
 Penninic nappes 186, 188, 189
 Penninic zone 53
 Penninic-Austroalpine nappes 30
 perched basins 192
 peridotite, upper mantle 105
 Permian basins 230
 phyllite 143
 phyllite zone 178
 Piedmont zone 118
 Piemont ocean 28, 182, 183
 opening of 183
 pillow lavas, andesite 144
 plastic flow 112
 plastic shearing 112
 plate collision 118
 plate convergence 17, 20, 21, 169, 222
 see also convergence
 plate margins, convergent 134
 plate movements, driving force for 216–17
 plate tectonic processes 104, 112–13, 114
 recent, Mediterranean 202–14
 plate tectonics 1, 11–12
 plate units, Alps–Apennines 195–7
 Alpine unit 196–7
 European unit 196
 Northern Apennines unit 196–7
 Po Plain unit 196
 sub-Monferrato unit 197
 plateau collapse 207, 213
 plutons 141, 145, 148, 149, 179
 Po basin 52, 55–6, 78, 188, 189, 191–2, 220
 Po Plain 51, 55, 75, 118, 125, 131
 Pogallo fault 183
 POLAR profile 33, 34, 37–47, 61, 77, 79, 102, 103, 104
 Polish Trough, inversion of 160
 Polmak–Pasvik–Pechenga (PPP) belt 104
 see also Kola suture zone
 Pomeranian–Kujawic Wall 160
 pop-up structures 189

- pore fluid pressure 83
 pore pressure 83
 postglacial rebound 120, 226–7
 power law creep 83
 pre-collisional shortening 170
 Pritzwalk massif 162
 Protogine zone 116, 150
 Provençal basin 136, 193, 226
 Provençal Sea 194
 pull-apart basins 28, 157, 182
 pull-apart structures 158, 172
 Pyrenean orogeny 30
 Pyrenees 68, 118
- Raahe–Ladoga fault zone 147
 radioactive decay 2, 73
 rapakivi granites 148, 149, 152
 rapakivi massifs 18
 ray tracing 37, 43, 200
 Rayleigh waves 33, 35, 64–5
 reactivation, in Tornquist fan 157, 158
 red beds 18, 181
 reflection, sub-Moho 161
 restites 99, 101–2
 restorations 197, 198, 199
 Rhenish massif 50, 51, 106, 117, 122, 132, 167, 169, 170, 177, 178
 Rheno-Hercynian terrane 230
 Rheno-Hercynian units 26
 Rheno-Hercynian zone 24, 94, 106, 163, 176–8
 base of crust 100
 Ordovician sequences 167
 origin as rift basin 169, 177
 see also Eifel; North Hessian Depression
 rheology
 depth-dependent 81–4
 and intraplate seismicity 84–91
 Rhine graben system 122, 132
 seismicity in 117–18
 see also lower Rhine graben; middle Rhine graben; upper Rhine graben
 Rhön mountains 49, 224
 Rhone–Rhine–Eiger rift system 30
 ridge push 120, 122, 202, 203, 207, 219, 222
 Rif, Morocco 30
 rift basin 90 169, 176–7, 178–9
 rift zones, thinned crust 193
 rifting 19
 active 56–7
 Atlantic 29
 differential, incipient 224
 oceanic, propagation of 226
 Red Sea 32
 Tyrrhenian Sea 226
 Oligocene–Miocene 224
 Tertiary 175
 Jurassic 28
 Mesozoic 27, 159–60, 181–4
 Devonian 167–9, 178
 Silurian 169
- Ordovician–Silurian 25–6
 Cambrian–Ordovician 166
 rifts 148
 aborted 158
 failed 196
 intra-arc 147
 rigidity 2, 227
 Ringkøbing-Fyn high 44, 45, 106, 153, 158, 173
 Rømø fracture zone 158
 Rønne graben, inversion of 160
 rotation, en-bloc 172
 Rotliegend troughs 214
 Russo-Baltic Platform *see* Baltica
- S-wave velocities 65
 S-waves 33, 41, 63–4, 65
 Saar/Nahe basin 171
 sag basins 162
 Sahara Atlas 201, 211
 Sahara platform 60, 199
 Saharan glaciation 19, 25, 26, 166
 salt, Messinian 32
 salt pillows 159
 Saorge-Taggia line 119
 Sardinia 57, 58, 62, 73, 79, 93, 103, 133, 194, 200
 anticlockwise rotation 224, 225
 Sardinia Channel 56–9, 73, 103, 108, 136, 200, 202
 Sardinia rift 224
 Satellite Laser Ranging (SLR) 124
 Savo schist belt 147
 Saxo-Thuringian basin 179
 Saxo-Thuringian terrane 24–5, 230
 Saxo-Thuringian zone 25–6, 93, 166, 177, 178–9
 Saxony 179
 Scandian orogeny 20
 Scandinavian Caledonides 20, 114
 Scania 27, 160
 Scania volcanic province 93
 Schams nappes 182
 schist 148
 Scientific Coordinating Committee (SCC) of ESRC 4, 5–6
 Scottish–Norwegian Caledonide orogeny 165
 sea floor, new 209, 211
 seafloor spreading 11, 25, 208
 Sealand 153, 159
 sedimentary basins 19, 20, 44, 45
 Early Permian 171
 negative geoid anomalies 125
 sedimentation, Norwegian–Danish basin 159
 sediments 19
 Phanerozoic 153
 post-Palaeozoic 60
 Seiland volcanic province 93
 seismic Moho 97, 100–1
 seismic refraction surveys 35, 51
 seismic tomography 34, 61, 202
 seismic wave paths 33–5, 37
 seismic waves 2

- seismicity 111–19
 intra-crustal, Kattegat 162
 intraplate, and rheology 84–91
seismogenic layer 112, 114, 119
serpentinite 146, 183
Sesia-Lanzo block 185
shear waves 37
shear zones 104, 112, 116, 150, 153, 161, 175–6
shears 196
Silesia 26
Silkeborg gravity high 153, 158
sillimanite 96
Silmano nappe 186
Simplon line 189
Sirikka Thrust 145
Skagerrak graben 156
Skagerrak–Oslo rift system 27, 153
Skellefte field, collision zone in 43
Skellefte island arc 146, 147
slab pull 202, 203
small plate-motions, intra-Mediterranean 197
Solway line 21
Sorgenfrei Tornquist zone 44, 106, 115, 117, 153, 158, 160–1
 development of 27–8, 47
Sörvaranger terrane 141, 143
south German basin 173
south-Alpine backthrust (thrustbelt) 187, 196
Southern Alps 56, 75, 191
space geodetic techniques 124–5
Spessart Mountains 178, 179
spinel peridotite 97
spinel-lherzolite 93
spreading 124, 183
spreading sites 203, 212
Steinheim crater 176
STREAMERS 9
strength envelopes 82, 83, 84
strength profiles 83–4, 85, 86, 87
stress 29–30, 90, 124
 compressional 122
 in continental lithosphere 111–12
 deviatoric 222
 compressional 218
 horizontal 217, 218, 219
 horizontal 120, 221
 compressional 172, 173, 219, 220
 extensional 220
 internal 217
 relaxation of 83
 state of 120–4
 tectonic, Baltic Shield 87–8
 tensional 29, 217–18
 vertical 120
stress patterns 225, 226
 regional 120
stress release 120
stress systems 225, 230
stretching and subsidence, post-Variscan 181
strike-slip 209
 Avalonia-Laurussia suture 21
 dextral 173
 sinistral 122, 181, 189
 sinistral systems 28
Strona-Ceneri basement block 183
stylolites 173
subcrustal reflectors 56
subducted slabs 56, 134, 187, 190, 199, 212
 from the African plate 61, 63, 109, 199, 202
 and hinge retreat 203
 of Piemont oceanic crust 185
subduction 11, 104, 114, 180, 211, 229
 A-type 26
 Alpine 196
 Apennine 196
 asymmetric model of 198
 B-type 26, 195
 with backarc spreading 203
 Calabro-Panormide front 211
 crustal 222
 Dinaride 196
 during Tertiary collision 187
 of jagged crustal edge 208–9
 at Kola suture zone 143–5
 of lithosphere 119, 133, 134
 oblique, of Tornquist ocean 164
 of oceanic layering 229
 of Saxo-Thuringian basin 179
 Silurian/Early Cambrian 169–70
 Sveco-Fennian 147
 subduction hinge retreat *see* hinge retreat
 subduction zones 24, 28, 43, 68, 143, 147, 184–5, 196, 202, 206
 subsidence 182, 183
 Ligurian Sea 220
 northern Apennines 220
 Norwegian–Danish basin 160
 Po basin 188, 220
 Po Plain 31, 125
 stepwise 182
 Sumi-Sariola Group 145
 Suretta nappe 186, 189
 surface heat flow 71, 72, 73, 223
 surface heat flow density 72–3
 surface waves 34–5, 64–9
 suspect terranes 15
 sutures 11, 143, 150
 Sveco-Fennian orogen 18, 43, 139, 146–9, 152, 229
 Sveco-Fennian province 104, 105, 154
 Sveco-Norwegian orogen 18, 19, 139–40, 149–50, 154, 229
 Sveco-Norwegian orogeny 18–19
 Swabian Jura 117, 122
 Sweden 39, 121, 122
 earthquakes 115, 116
 Tambo nappe 186, 187
 Tampere island arc 147
 Tanaelv belt 39, 103–4, 145
 Tauern window 189
 Taurides 210–11

- tectonic activity, Permo-Carboniferous 27
- tectonic collage 230
- tectonic processes, driving forces 215–27
- tectonic units complex 30–1
- tectono-metamorphic activity, Devonian to Early Carboniferous 169–70
- Teisseyre Tornquist zone 28, 41, 45, 46, 47, 68, 157, 160
- Telemark supracrustals 150
- telescoping, of terranes 11, 18, 23
- Tell Mountains 30, 118
- Tellian-Numidian terrane 60
- Tellian-Numidian thrust zone 59–60
- Tello-Rifian system 210–11
- Tellorifian fold-thrust belt 211
- temperature field, EGT, modelling of 74–5
- temperature gradients, near Earth's surface 72–6
- terranes 60, 200, 205, 230
 - Archaean 17, 18, 39, 139, 140–3, 145, 152, 229
 - island arc 20, 141
 - tracing origins of 13, 14, 14–15
 - see also* arc terranes; named terranes
- Tethyan basin 182
- Tethyan-Alpine collision suture 196
- Tethys 28, 181
- Teutoburger Wald 173
- thermal activity, Tertiary to Recent 176
- thermal assimilation 198
- thermal conductivity 72–4
- thermal equilibrium 136
- thermal instabilities, mantle 215–17
- thermal softening, of root terranes 207
- thermal updoming 180–1
- thrust belts 162
 - architecture 206
 - bivergent 187
 - Early Proterozoic 39
 - Kola Peninsula 17, 18
 - north German Caledonides, composition of 162–3
 - piggyback 212, 213
 - see also* fold-thrust belts
- thrust sheets, stacked 145, 192–3, 197, 201
- thrust slices, Luleå–Kuopiu suture zone 146
- thrust systems, shallow, internal 210–11
- thrust wedge 145
- thrust zones 59–60, 143, 150
- thrusting
 - Eastern Alps 185–6
 - in-sequence 186–7
 - South Alpine 191
- thrusts 104
 - listric 189
 - post-collisional 145
 - ramped 195, 206
- Thuringia 179
- Thuringian Forest 178
- tillites 26
- Toce-Lepontine area, updoming of 188–9
- Tornquist fan 157–9
- Tornquist Sea 19, 23, 164, 165, 169
- Tornquist zone 27, 30, 106, 120, 153–62, 172
 - Early Permian basins 172
 - see also* Sorgenfrei
 - Tornquist zone; Teisseyre
 - Tornquist zone
- Trans-European fault 21, 27, 28, 44, 65, 106, 153, 157
- Trans-Scandinavian Batholith 149, 150
- transform zone, dextral 181
- transient heat flow 135–7
- transient thermal phenomena 76, 108
- transitional crust 58, 59
 - two-layered 57
- transpression 122, 161, 179, 181, 182
 - dextral 56, 179, 179–80, 184, 188
- transtension 28, 30, 172, 226
- triple junctions 21, 22, 158, 204
- tuffs 142
- Tunisia 59–60, 73, 152, 200–1
 - crust and lithosphere 108–9
 - seismic activity 118
- Tunisian Atlas 201
- turbidites 24, 141, 143, 146
- Tuscan region 134
- Tuscanides 192
- Tuscany geothermal area 136
- Tyrrhenian basin 31, 136
- Tyrrhenian Sea 119, 193, 225–6
 - volcanism in 133, 134, 134
- U-Pb zircon dating 148, 150, 151
- Ukrainian massif 20
- ultracataclases 150
- Umbrian series 192
- unconformities, sub-Permian 160
- underplating 170, 185, 189, 229, 230
- underthrusting 169, 230
- uniform elastic plate concept 80
- uplift 72, 136, 208, 217, 219, 230
 - Alps 125, 220
 - Fennoscandia 125, 127, 127–31, 226–7
 - Late Tertiary 20
 - northern Apennines 220
 - and subsidence, linked 222
 - vertical 188–9
- upper crust 45
 - Aar massif 53
 - Baltic Shield 37, 87–8, 115
 - elastic 217
 - interleaved high- and low-velocity layers 41, 106
 - layering of 58
 - Sveco-Fennian orogen 146
- upper lithosphere, rheologically zoned 81
- upper mantle 199
 - asthenospheric 223
 - exploration of 33–5
 - seismic exploration along EGT 60–9
 - structure beneath Baltic Shield 105–6
 - upper Rhine graben 117, 122–3, 132–3, 136, 173, 175

- upwelling, active 132
- Urach 86, 88
 - xenoliths 107
- Urach field 73
- Urach volcanics 93, 95
- Urach/Hegau 101
 - crustal structure 96, 97–8
 - xenolith suite 94, 95
 - see also* Hegau
- Urach/Hegau province, regional heat flow 95
- Uralides 20, 27
- Urals 20, 181

- Vainospää granite 145
- Valais trough 182
- Valencia, Gulf of 224
- Variscan belt 101
- Variscan
 - central Europe 4
 - crustal seismicity 88, 90
 - electrical conductivity 79
 - strength profile 83, 86
- Variscan domain 15, 16–17
- Variscan evolution, pre-collisional 24–6
- Variscan fold belt, degradation of 27
- Variscan orogeny 26–7, 95
- Variscan region 102, 106–7
- Variscan roots, disappearing 230
- Variscan tectonic front 180
- Vaskojoki anorthosite 145
- Vättern graben system 19
- Vavilov basin 133, 134
- velocity-depth distribution,
 - lithosphere/asthenosphere 37, 39–44, 47
- Very Long Baseline Interferometry (VLBI) 124
- Viking graben 116
- Vinding fracture zone 158
- viscoelastic layer 217
- viscoelastic properties, of Earth's surface 72
- viscoelastic theory 131
- viscosity
 - upper and lower mantle 131
 - variations of with depth 220
- viscous pillows, rising 208, 209
- viscous response 80

- Vogelsberg 224
- volcanic arcs 24
- volcanic provinces, northern EGT 93
- volcaniclastic, Permo-Carboniferous 180, 181
- volcanism
 - alkaline 224
 - bimodal 149, 170
 - calc-alkaline 178
 - intra-plate 172–4
 - island arc 133–4
 - ocean island basalt-type 133
 - Permian 170, 172
 - recent 132–5, 136
 - Sardinia 58
 - young, and upwelling of asthenospheric mantle 224
- volcanoes, active 202
- Voronech uplift 20
- Vosges 26, 132, 179

- Wales 26
- waveform inversion 35
 - techniques 65, 67–8
- websterite 97, 99
- west Mediterranean terranes 205
- Western Alps 118
- Westerwald 224
- White Sea 145
- wide-angle seismic reflection techniques 33, 35
- World Stress Map 120
- wrenching 11, 28, 157
 - dextral 172, 173

- xenolith investigation, conceptual limits of 100
- xenoliths 72, 106–7, 164, 174
 - amphibolite-facies 99–100
 - evidence for lithospheric composition 91–8
 - mafic 99
 - petrology of 95
 - populations along the EGT 93–4

- Zechstein 47, 159
- Zechstein Sea 172
- zircons 26, 141, 146, 150–1