alpine-type peridotite massifs 11–12
localized deformation 13
Anderson–Byerlee frictional fault mechanics 95
brittle–ductile shear zone evolution and fault
initiation at Monte Cugnone, Italy 353–355, 368–372
cross-section 354
elements of structures analysed 356–357
fluid inclusion petrography and microthermometry
363–366
geochemical setting 354, 355–358
kinematics 366–368
microstructures 363, 364
outcrop data 358–363
structural data 360–361
conjugate shearing domain (CSD) 219–221, 220
continental crust, metamorphic signature of
subduction in Corsica/northern Apennine
orogen 321–322, 329–331
structural and metamorphic history of inner
Tuscan metamorphic units 329
structural and metamorphic history of Tenda
Massif
deformation history 324–328, 325, 326, 327
geological outline 323–324, 324
metamorphic history 328–329, 328, 329
tectonic setting 322–323, 322, 323
crenulation-slip development in NW Ireland 337–338, 350
evidence for strike–slip motion in Central Ox
Mountains 344
extensional crenulation cleavages 344
high-strain zones 344
evidence for strike–slip motion in Mayo 339–341
asymmetrical buckle folds 341, 342
crenulation-slip morphologies produced by
oblique foliation-slip 341
extensional crenulation cleavages 341–342
orientation of D3 dextral shear zone 342–344, 343
predicted angular relationships 341
geochemical significance of the Fair Head–Clew Bay
Line 338–339
isotopic dating of crenulation-slip surfaces 344–346
analytical methods 347
$^{40}$Ar/$^{39}$Ar spot fusion data 347
constraining dextral shear in NW Mayo 347–348
constraining sinistral shear in Central Ox
Mountains 348–349
intrusion age of Ox Mountains granodiorite 349
pre-existing age constraints on foliation-slip
fabric 346
Rb–Sr geochronology 349
sampling 346
regional geology 338
dauhpine twinning and misorientation 39, 54, 58–59
microstructural evolution 54–55
microstructural stability 56–57
misorientation angle distributions 57–58
study details
crystallographic misorientation analysis 43–44, 44
grain boundary (mis)orientation analysis 44–45
relationship between crystal slip and boundary
orientation 45
relationships between quartz crystal slip systems
46
relationships between specific quartz crystal slip
systems 45
summary of Loch Torridon shear zone data 43
study results and interpretations
boundary formation 52–54, 53
dauphine twinning and twin boundaries 54
microstructure and LPO 47
misorientation analysis 47–52
petrofabric and misorientation analysis 51
SEM/EBSD analysis of dauphine twin
microstructures 48–49
(sub)grain boundary formation 55–56
defomation in a complex crustal-scale shear zone
229–230, 246–247
Archaeian granitic gneiss 230–231, 233
Errabiddy Shear Zone 230, 231
evolution of Capricorn Orogen 232
felsic gneiss and Erong Shear Area 234–237, 237, 238, 239
kineamic evolution of Errabiddy Shear Zone 244
palaeoproterozoic metasedimentary rocks – Camel
Hills 239
defomation in migmatized pelitic schist and
gneiss 239–241, 240
structural geometry within Errabiddy Shear Zone
234–244
summary 243
temporal and tectonic evolution of Errabiddy
Shear Zone 244–246, 245
ductile shearing 161–162, 173–174
basement lithology on Sikinos 163–164, 164
basement–cover contact on Sikinos 172
gology of cover sequence on Sikinos 162–163
maps 162, 163
high-pressure metamorphic imprint in Cycladic
basement 172–173
pressure–temperature conditions of metamorphism
on Sikinos 170–172, 171
feldspar porphyroclast populations, kinematics and
strain 265–266
application to western Idaho shear zone 277–278, 279
assumptions 279–281
feldspar shape preferred orientation data 281
field conclusions 284
implications for shear zone studies 284
location map 278
model conclusions 283–284
quantification of field data 281–282
study results 282–283, 283
forward model of clast rotation 266–268
construction of fabric ellipsoid 269
three-dimensional description of clast orientation 268–270
model results 270
fabric ellipsoid versus finite strain ellipsoid 277
orientation of fabric ellipsoid to shear sense 276–277, 277
populations of oblate clasts 276
populations of prolate clasts 272–276, 273, 274, 275
rotation of single clasts 270
rotations of populations of clasts 271–272
single oblate clasts 270, 271
single prolate clasts 270, 271
flattening strain 252–253, 253, 253
fluid–rock interactions in West Fissure Zone, Chile 141–142
comparison with San Andreas Fault, California 157–158
description of fault rocks 143–147, 147
sampling profiles 146
fluid sources and fluid composition 156–157
geochemistry of fault rocks 148–149, 149, 150
fluid inclusions 147–148, 148, 155–156
major elements 150–154, 153, 156
oxygen versus distance relationships in monzodiorite 154–155, 154, 155
trace elements 149–150, 150–154, 151, 152, 153, 156, 156
geological setting 142–143
regional map 144–145
regional overview 142
stratigraphy 143
sampling and analytical methods 143
variations in fluid–rock interaction 157

Geographic Information Systems (GIS) applied to deformation patterns 73–76
aeromagnetic dataset 68–70, 69–70
combined and integrated dataset
combination of all available datasets 72–73, 73
combined directional structural data and shaded total magnetic field map 70–72, 71
vertical gradient of total magnetic field, foliation trends and metamorphic data combined 72, 73
database 65
directional structural dataset 66–68, 67
fabric type dataset 68
lithological dataset 65
metamorphic dataset 65–66
proposed indentor model 74, 75
west Greenland case study 64–65, 64, 66
geostatistical analysis

kriging interpolation 305
variogram computation and interpretation 303–305, 304

granulites, instability and deformation localization in the lower crust 25–26, 35–36
Clarke Head megabreccia 26–27, 26
deforation microstructures
cherty ultramylonite 30, 31
host mylonite 27, 28
ultramylonite 27–29, 29, 30

experimental procedures 27
interpretation of microstructures and deformation
deformation environment 31–32
defformation mechanisms 32–33, 33, 34
deforation partitioning and localization 34–35
mechanism transitions 33–34

high-pressure metamorphism 161–162, 173–174
basement lithology on Sikinos 163–164, 164
basement–cover contact on Sikinos 172
geology of cover sequence on Sikinos 162–163
maps 162, 163
high-pressure metamorphic imprint in Cycladic basement 172–173
pressure–temperature conditions of metamorphism on Sikinos 170–172, 171

hydrous fluid channelling 161–162, 173–174
basement lithology on Sikinos 163–164, 164
basement–cover contact on Sikinos 172
geology of cover sequence on Sikinos 162–163
maps 162, 163
high-pressure metamorphic imprint in Cycladic basement 172–173
pressure–temperature conditions of metamorphism on Sikinos 170–172, 171

indentor tectonics 73–76
aeromagnetic dataset 68–70, 69–70
case study in west Greenland 64–65, 64, 66
combined and integrated dataset
combination of all available datasets 72–73, 73
combined directional structural data and shaded total magnetic field map 70–72, 71
vertical gradient of total magnetic field, foliation trends and metamorphic data combined 72, 73
directional structural dataset 66–68, 67
fabric type dataset 68
lithological dataset 65
metamorphic dataset 65–66
proposed indentor model 74, 75

kriging interpolation 305

lattice preferred orientation (LPO) 39, 54, 58–59
dauphine twinning and (sub)grain boundary formation 55–56
dauphine twinning and microstructural evolution 54–55
dauphine twinning and microstructural stability 56–57
misorientation angle distributions 57–58
shear zone grain size reduction model 55
study details
crystallographic misorientation analysis 43–44, 44
grain boundary (mis)orientation analysis 44–45
relationship between crystal slip and boundary orientation 45
relationships between quartz crystal slip systems 46
relationships between specific quartz crystal slip systems 45
samples 39–41, 40, 42
SEM/EBSD technique 41–43, 42
summary of Loch Torridon shear zone data 43
study results and interpretations
boundary formation 52–54, 53
dauphine twinning and twin boundaries 54
microstructure and LPO 47
misorientation analysis 47–52
petrofabric and misorientation analysis 51
SEM/EBSD analysis of dauphine twin microstructures 48–49
low angle normal faults (LANFs) 95–97, 105–109
active versus exhumed LANFs
Altoblerina Fault in Umbria region 97–102, 98
Zuccale Fault in Isle of Elba 102–105, 105
regional setting of Northern Apennines 97
lower crust granulites, instability and deformation localization 25–26, 35–36
Clarke Head megabreccia 26–27, 26
defor mation microstructures
cherty ultramylonite 30, 31
host mylonite 27, 28
ultramylonite 27–29, 29, 30
experimental procedures 27
interpretation of microstructures and deformation
deformation environment 31–32
deformation mechanisms 32–33, 33, 34
deformation partitioning and localization 34–35
mechanism transitions 33–34
microstructure evolution during deformation
lower crust granulites 33
mylonitic quartz simple shear zone 39
study details 39–46
study results and interpretation 47–54
misorientation analysis 39, 54, 58–59
crystallographic relationships 43–44
quartz 44, 45, 46
dauphine twinning and (sub)grain boundary formation 55–56
dauphine twinning and microstructural evolution 54–55
dauphine twinning and microstructural stability 56–57
grain boundary analysis 44–46
microstructure and LPO 47
misorientation angle distributions 57–58
SEM/EBSD technique 41–43, 42
localized dauphine microstructures 48–49
shear zone grain size reduction model 55
study results 47–50
boundary formation 52–54, 53
dauphine twinning and twin boundaries 54
localized dauphine microstructures 48–49
misorientation angle distributions 50
misorientation axis/angle pairs 50–52
petrofabric and misorientation analysis 51
study samples 39–41, 40
Nabarro–Herring creep 81, 81
ophiolite-type peridotite massifs 11–12
localized deformation 13
orthorhombic fabrics, development within a simple
shear sinistral transpression zone 215–216
Arronches gneisses, structural analysis
conjugate shearing domain (CSD) 219–221, 220
grain-size reduction and deformation
mechanisms in fabric formation 221
intermediate sinistral domain (ISD) 221
peralkaline gneisses 216–219
sinistral domain (SD) 221
Arronches Tectonic Unit
regional setting 216
study area 217, 218, 219
conjugate shear band formation 224–226, 225
dynamic recrystallization and development of fabric and texture 221–224, 224, 225
relative timing of orthorhombic and monoclinic fabric formation 224
partially molten rocks (PMR), application of two-phase rheology 79–81, 91
experiments 89–90
development of instabilities 90–91
non-linear effects 90
implications for other two-phase systems 87–89
importance of shear deformation 89
main principles 81–82
schematic map of plastic deformation 81
stress versus strain diagram 82
rheological responses 84–87, 86, 87
rheology of two-phase materials 82–84, 83, 84
pelitic rocks, shear deformation 113, 121–124
composition of sheared clays 116, 116
smectic/illite transformation 116–117, 117
geological framework of Scorciabuoi Fault (SBF) 113–115, 114, 115, 116
gran size analysis 118–119, 118
shear zone fabric 119, 119
fine scale analysis 119–121, 122, 123
meoscale observations 119, 120, 121
peridotite mylonites 16, 17–19
plane strain 252–253, 253, 253
plastic deformation, application of two-phase rheology 79–81, 91
experiments 89–90
development of instabilities 90–91
non-linear effects 90
implications for other two-phase systems 87–89
importance of shear deformation 89
main principles 81–82
schematic map of plastic deformation 81
stress versus strain diagram 82
rheological responses 84–87, 86, 87
rheology of two-phase materials 82–84, 83
pelitic rocks, shear deformation 113, 121–124
composition of sheared clays 116, 116
smectic/illite transformation 116–117, 117
geological framework of Scorciabuoi Fault (SBF) 113–115, 114, 115, 116
gran size analysis 118–119, 118
shear zone fabric 119, 119
fine scale analysis 119–121, 122, 123
meoscale observations 119, 120, 121
peridotite mylonites 16, 17–19
plane strain 252–253, 253, 253
plastic deformation, application of two-phase rheology 79–81, 91
experiments 89–90
development of instabilities 90–91
non-linear effects 90
implications for other two-phase systems 87–89
importance of shear deformation 89
main principles 81–82
schematic map of plastic deformation 81
stress versus strain diagram 82
rheological responses 84–87, 86, 87
rheology of two-phase materials 82–84, 83
plate convergence, shear and fluid flow 127
comparisons and contrasts between the study sites 135
deposition structures with faults 136–137
fault thickness 136
fault-zone margins 137
hydrogeology 137
internal geometry of fault zones 137
lithological influence of propagation 136
summary of features 138
deposition features
Barbados 129–130, 129
Costa Rica 130–131, 130
Nankai 131, 131
fluid transport
Barbados 131–133, 132, 133, 134
Costa Rica 133–134, 135
Nankai 134–135, 136
implications from study sites for other mega-deposition zones 137–138
tectonic settings
Barbados 128, 128
Costa Rica 128–129, 128
Nankai 128, 129

rheology of two-phase materials 79–81, 91
experiments 89–90
development of instabilities 90–91
non-linear effects 90
extrapolating the end-members 83
implications for other two-phase systems 87–89
importance of shear deposition 89
main principles 81–82
schematic map of plastic deposition 81
stress versus strain diagram 82
rheological responses 84–87, 86, 87
thermodynamic considerations 83–84, 83, 84
rigid percolation threshold (RPT) 80
shear zones folds 177–178, 196–197
Caledonian Moine Nappe, Sutherland 179–180, 180, 181
curvilinear fold patterns and evolution 189
fold evolution model 189–194
fold inheritance model 194–195, 195, 196
hybrid fold model 195–196
fold types 178
sheath folds 178–179
synshearing flow folds 179
Melness folds case study 181–185, 183, 185
topological relationships between sheath folds and synshearing folds 186–189, 188, 189,
190–191, 192–193, 194
transsection relationships between shear folds and synshearing folds 185–186, 186, 187
shear zones 1, 8
fault controls and shear zone development 4
anastomosis around low-strain augen 5
grain-scale controls 4
lithospheric-scale controls 4
network geometry-scale processes 4–5
histories 7–8
lithospheric deposition and rheology of shear zones 5–6, 5
occurrence on different scales 1, 2
partitioning processes in shear zones 6–7, 7
strength, strain rate histories and fault rocks at depth 1–4
deposition regimes and typical fault rocks 3
schematic strength profile through crust and upper mantle 4
strain and deposition history in a syntectonic pluton, Roses granodiorite 307–308, 315–318
displacement versus width diagram 318
main lithological units 308
progressive development of structures in Roses granodiorite 308
elongated enclaves of quartz diorite 313
geological setting 309
late brittle fractures 314
leucocratic dykes 313
magmatic fabric and enclaves 308–313
mesoscopic scale structures 311
pre-dyke finite strains 312
qualitative model and structural history 310
shear zones and associated mylonites 313–314
shear strain analysis 317
structural map and strain analysis 316
structure and strain profiles 314
deformation postdating dykes 315
deformation predating dykes 314–315
strain removal within Hercynian Shear Belt, methodology and tectonic implications 287, 287, 300
data processing
 cleavage trajectory model 292–293, 293
domainal distribution of cleavage directions 294–295, 294
geostatistical analysis of cleavage directions 291–292, 292
geological setting 288
lithologies 288–289
structures 289
kinematic data
cleavage and finite strain ellipsoid 289, 290, 291
deformation regime 289–291, 291
model validation and regional implications 296
at the boundaries 298–299, 298
within restored area 296–296, 297
restoration of eastern Central Brittany 295–296, 296
strike–slip deformation 250, 251
tectonites
relative softening
fine grained 16–17
medium-to-coarse grained 16
structures and microstructures
fine grained 15
medium-to-coarse grained 15
transpression terrane boundaries, geometric and kinematic analysis 201–202, 213
fault rocks 203
fault zone deformation mechanisms 211–212
fault zone kinematics 210–211
framework of the Minas fault system 202–203
location of the Minas fault system 202
strain partitioning and localization 212–213
structural elements and geometric relationships 204, 206, 207, 208, 209, 210
crenulation cleavage 208–209
faults 209–210
folds 203
foliations 203–205
lineations 205
S–C fabrics 208
shear bands 209
veins 205–208
transpressional high-strain zones, strain and vorticity analysis 249–250, 262
interpretation at study areas
Brookneal high-strain zone (BHSZ) 258–259, 259
Spotsylvania high-strain zone (SHSZ) 259–260, 259, 260
strain compatibility 260–261
tectonic significance of Piedmont high-strain zones 261–262
kinematic deformation models 249
kinematic vorticity and vorticity analysis 251–253, 252, 253, 253
transpression and general shear 250–251, 251
upper mantle shear zones 11–12, 19–20, 21
features 12
implications for mantle strength 21
possible tectonite and mylonite shear zones 20
relative softening mechanisms 16
fine grained tectonites 16–17
mantle cross-section at Hilti, Oman 17
medium-to-coarse grained peridotite tectonites 16
olivine deformation mechanism map for Othris, Greece 17
peridotite mylonites 17–19
P–T grid 19
SEM image of grain boundary alignments for Turon de Técouère, France 17
SEM images of fine grain production 18
structures and microstructures 12–15
fine grained tectonites 15
localized deformation 13
medium-to-coarse grained tectonites 15
peridotite mylonites 16
photomicrographs 14
variogram computation and interpretation 303–305, 304
vorticity 251–253, 252