

Index

Page numbers in *italics* refer to Figures. Page numbers in **bold** refer to Tables.

- Acerno reservoir 191, **193**, 195
- Algeria *see* Berkine Basin; Hassi Messaoud field; Illizi Basin
- Alleghanian Orogeny 245
- Amonton's law 143, 157
- Andersonian faulting
mechanics 156–159
post-faulting regimes 16, 17, 18
regimes 257, 277
stress system 10, 91
- Appalachian Basin 245
- Appalachian Plateau 245, 246
deformation
modelling 249–250
 application 250–251
 parameter sensitivity 252–253
 parameters 251
 results 252
 results discussed 253–255
 summary 255
seismic sections 247, 248
stratigraphy 246
structural style 247–248
 small-scale features 248–249
- Australia *see* Bowen Basin; Otway Basin; Surat Basin
- Azerbaijan *see* Azeri-Chirag-Guneshly field
- Azeri-Chirag-Guneshly field 274–277
Chirag mud volcano
 geometry 276
 modelling behaviour
 methods 280–281
 results 281–283
 results discussed 284–288
 summary 288–289
stratigraphy 276
tectonic setting 275
- Baram delta 273
- Basin and Range Province 156
fault history study
 methods
 locality example 161–163, 164, 165
 palinspastic structural restorations 160–161
 results
 drain rate 166
 duration of extension 166
 extension timing 167
 fault characteristics **162**, **163**
 fault spacing 166–167
 mean slip magnitude 166
 percentage extension 166
 problems of tilting 165–166, 168
 synextensional magmatism 167
 tilting per unit of slip 166
 results discussed
 interpreting hierarchy of factors 167–169
 synextensional magmatism 169–171
 tilting and spacing 171–172
 timing 172
 summary 173
- beef, hydrofracture 3
- Belgium, Mons Basin chalk 228, 229, **230–231**
- Benevento field 188, 189, 190–194
- Berkine Basin 90, 90
 burial history model 91
 stress conditions 104–106
- Berkine field 105–106
- Biot coefficient 125
- block tilting 155
- bookshelf faulting 155
- borehole breathing 213
- Bowen Basin 33
 domains 34, 37, 39
 mechanical stratigraphy 41–44
 oilfield impacts 44–46
 setting 31, 32
 stress measurements 35–36
 stress model (1D wellbore) 39–41
 stress orientation 36–37, 39
 Raleigh analysis **38**
 wells **37**
- Brazil *see* Santos Basin
- Brent field, stress depletion 20–22
- brittle failure 131, **132**, 157
 extension v. compression 134, 135
 comparative failure conditions 135–136
 contrasts in failure sensitivity 136
 edge of failure 137
 failure loading paths 137–138
 maximum sustainable overpressure 136–137
 results discussed 138–139
- bulk density **278**, **281**, 283
- bulk modulus **278**, **281**, 282
- Buonalbergo seep 192
- Burunga Anticline 34, 39
- Byerlee friction 157
- Byerlee stress states 132–133, 148
- Caprese reservoir **193**, 195–196
- carbon capture and storage (CCS) 181
- carbon dioxide
 capture and storage 181
 characterization of sites 181–182, **182**
 case study for Italy
 carbon dioxide geofluids 182–183
 flow in formations 183, 185
 map of seeps 184
 migration mechanisms 185–186
 seep case studies 186
 geological settings 186–187
 leakage pathways 187–188
 properties modelling 187
 reservoir classification 187
 results 188–190
 Acerno reservoir 191, **193**, 195
 Benevento field 188, 189, 190–194

- carbon dioxide (*Continued*)
 Caprese reservoir **193**, 195–196
 Frigento reservoir *188*, **193**, 194–195
 Monte Taburno reservoir *189*, **193**, 194
 Muscillo reservoir *189*, **193**, 194
 results discussed
 data synthesis 203–207
 leakage and risk management 199–203
 reservoir characteristics, leaking v. sealing
 196–199
 summary 207–208
- carbonates, earthquake nucleation 3
- Catskill delta 245
- cement, impact on strength 22, 23
- chalk reservoirs
 Ockley accumulation (North Sea)
 appraisal data 117
 appraisal wells 118–121
 faults and fractures 122–124, *124*
 geological setting 113–115
 geomechanical analysis
 Biot coefficient and effective stress 125–126
 horizontal stress direction 126
 pore pressure 124–125
 stress magnitudes *in situ* 125
 location *114*
 matrix properties 121–122, *121*
 porosity cycles 115
 seismic section *116*
 stimulation and testing 117–118
 stratigraphy *115*
 structure 115, *123*
 summary and discussion of data 128
 fracture designs 127–128
 fracture propagation 126–127
- chalk, tight
 microtexture variation 227–228
 regional study
 methods of analysis
 petrographic 229, 230, 233
 petrophysical 233
 results
 petrographic 233–234
 petrophysical 235–236, **235**
 results discussed 236
 lithotypes and diagenesis 236–237
 petrophysics/mechanics 237–240
 sampling setting 228–229, **230–231**
 summary 240–241
- Chirag mud volcano
 geometry 276
 modelling behaviour
 methods 280–281
 results 281–283
 results discussed 284–288
 summary 288–289
- coccolith studies 231, 232
- cohesive strength **278**, **281**
- Colombia *see* Cusiana field
- compaction
 causes 7
 curve *280*
- compressional stress studies
 Cusiana field
 stress evolution 19–20
 stress modelling 12, *13*
 stress regime analysis 10–12
- compressive strength tests, tight chalk 233, 234, 237,
 239–240, 239
- Contursi reservoir *191*
- Coulomb failure criterion *148*, 157, *158*, 277
- Cozzette sandstone
 geomechanical parameters **262**
 opening-mode fractures, thermal history 263–264
- Cusiana fault 10, *11*
- Cusiana field
 stress evolution 19–20
 stress modelling 12, *13*
 stress regime analysis 10–12
- Daghinsky Formation 23, *24*
- deformation boundary approach 9–10
- Denison Trough 31
- detachments (low-angle normal faults) (LANF)
 character 143
 first reported 143
 Santos Basin study
 geomechanical modelling 144–145, 147
 numerical simulation 149–150
 parameters 147, 149
 results *146*, *147*, *148*, *149*, *150*, *151*
 results discussed 150–152
- diagenesis index, tight chalk *231*, *232*, 236–237
- differential stress 131
- domino-style faulting 155
- drilling window 213, *214*
- earthquakes, in carbonates 3
- East Texas Basin
 Travis Peak Formation
 geomechanical parameters **262**
 natural fracture pattern 261
 role of overpressure 264
 thermal history 261, 263
 opening-mode fractures, role of overpressure
 265–266
 setting 259–261
- effective normal stress 132
- elastic deformation, causes 7
- elastic properties 282
 values for modelling **278**, **281**
- exhumation
 fault reactivation and fluid flow 107–108
 fault-bounded traps 108
 role in stress history 268
 stress evolution 106–107
- exhumed basins, prospectivity problems 89
see Illizi Basin
- extensional faulting
 Andersonian–Byerlee mechanics 156–159
 fault interactions 159–160
 pore fluid pressure 159
 principal stress trajectories 159
 rock composition variation 159
- facies variation, impact on strength 22, 23, 25
- failure angle 2
- fault blocks, stress estimation 9–10

- fault valving 3
- faulting
 - classification 10, 91, 257, 277
 - geomechanics of 143, 156–159
 - initiation 155, 157
 - stress states driving 132–135
- faults
 - hard v. soft linkage 159
 - interaction of 159–160
- Flamborough Head chalk 228, 229, **230**
- fluid flow
 - mud volcano studies 284–285
 - subsurface 90
- fluid inclusions
 - role in microthermometry of crack-seal quartz 258–259
 - Mesaverde Group 263–264
 - overpressure history 264–265
 - thermoelastic contraction history 265–266
 - Travis Peak Formation 261, 263
- fracture closure pressure (FCP) 92
- fracture development 18–19
 - opening-mode fracture systems 257
 - case study
 - Travis Peak Formation
 - geomechanical parameters **262**
 - natural fracture pattern 261
 - role of overpressure 264, 265–266
 - thermal history 261, 263
 - setting 259–261
 - failure criterion 257
 - microthermometry on quartz 258–259
 - role of shear failure 258
- fracture pressure (FP) 213, **278, 281, 283**
- historical models 214–215
 - Brackles & van Eekelen 216
 - Eaton 215–216, 216
 - Matthews & Kelly 215, 216
- implications for drillability 285–288
- new model 216–219
 - case study testing
 - Gulf of Mexico 222
 - North Sea 222–224
 - Scotian Shelf 219–222
 - summary of performance 224
- France, Cenomanian–Turonian chalks 228, 229, **230–231**
- friction 155, 157
- friction angle **278, 281, 284**
- Frigento reservoir 188, **193**, 194–195
- geofluids, impact of 2
- geomechanics 1
 - chalk studies *see* Ockley accumulation *also* chalk, tight
 - correlation with P-wave velocity 277
 - exhumation effects *see* Illizi Basin
 - role in oil field development 7–8, 8, 9
- geostress *see* stress
- Gippsland Basin 49, 51
- Gjallar Ridge 152, 152
- Griffith–Coulomb failure 148
- Griffith cracks 2
- hard linkage of faults 159
- Hassi Messaoud field 90, 91, 104–105
 - burial history model 91
- Hod Formation, Ockley accumulation
 - appraisal data 117
 - appraisal wells 118–121
 - faults and fractures 122–124, 124
 - geological setting 113–115
 - geomechanical analysis
 - Biot coefficient and effective stress 125–126
 - horizontal stress direction 126
 - pore pressure 124–125
 - stress magnitudes *in situ* 125
 - location 114
 - matrix properties 121–122, 121
 - porosity cycles 115
 - seismic section 116
 - stimulation and testing 117–118
 - stratigraphy 115
 - structure 115, 123
 - summary and discussion of data 128
 - fracture designs 127–128
 - fracture propagation 126–127
- horizontal stress **278, 281**
- Hunter Bowen Orogeny 31
- hydraulic fractures 126
- hydrofractures 3
- hydrostatic pressure **278, 281, 283**
- Illizi Basin
 - burial history model 91
 - exhumation stress characteristics 103–104
 - fluid flow 90–91
 - geomechanics 93, **95**
 - maximum horizontal stress azimuth 97–98
 - maximum horizontal stress magnitude 100–103
 - mechanical properties 93–94
 - minimum horizontal stress magnitude 98, **99, 100**
 - pore pressure 94
 - vertical stress magnitude 96–97
 - location 90
- Indo-Australian Plate 32
- instantaneous shut-in pressure (ISIP) 92
- Italy
 - carbon dioxide geofluids 182–183
 - flow in formations 183, 185
 - map of seeps 184
 - migration mechanisms 185–186
 - seep case studies 186
 - geological settings 186–187
 - leakage pathways 187–188
 - properties modelling 187
 - reservoir classification 187
 - results 188–190
 - Acerno reservoir 191, **193, 195**
 - Benevento field 188, 189, 190–194
 - Caprese reservoir **193, 195–196**
 - Frigento reservoir 188, **193, 194–195**
 - Monte Taburno reservoir 189, **193, 194**
 - Muscillo reservoir 189, **193, 194**
 - results discussed
 - data synthesis 203–207
 - leakage and risk management 199–203
 - reservoir characteristics, leaking v. sealing 196–199
 - summary 207–208

- kerogen, conversion to hydrocarbons 3
- kink bands, Appalachian Plateau 248–249
- modelling 249–250
- application 250–251
 - parameter sensitivity 252–253
 - parameters 251
 - results 252
 - results discussed 253–255
 - summary 255
- Kurdashi–Araz–Deniz structure 279
- Lamé's constant **278, 281, 282**
- leak-off test 213–214
- limit analysis 249
- low-angle normal faults (LANF; detachments)
- character 143
 - first reported 143
 - Santos Basin study
 - geomechanical modelling 144–145, 147
 - numerical simulation 149–150
 - parameters 147, 149
 - results 146, 147, 148, 149, 150, 151
 - results discussed 150–152
- Lunskoye field, case study of strength variations 23–24
- Mackenzie delta 273
- maximum strength theorem 249
- mechanical earth model (1D wellbore stress model) 39–41
- Mesaverde Group
- opening-mode fractures
 - role of overpressure 264–265, 266, 268
 - thermal history 263–264
 - setting 263
- Mexico, Gulf of
- fracture pressure model testing 222
 - East Texas Basin, Travis Peak Formation
 - geomechanical parameters **262**
 - natural fracture pattern 261
 - role of overpressure 264
 - thermal history 261, 263
 - opening-mode fractures, role of overpressure 265–266
 - setting 259–261
- microthermometry, opening-mode fracture systems 258–259
- Mesaverde Group 263
- role of overpressure 264–265, 266, 268
 - thermal history 263–264
 - Travis Peak Formation 265–266
- Mississippi delta 273
- Mohr diagram 157, 158
- low-angle normal faults 148
- Mohr–Coulomb failure criterion 91, 92
- Monte Taburno reservoir 189, **193**, 194
- mud volcanoes
- development 273
 - modelling behaviour
 - Chirag geometry 276
 - methods 280–281
 - results 281–283
 - results discussed 284–288
 - summary 288–289
- Muscillo reservoir 189, **193**, 194
- Niger delta 273
- Nile Delta, fracture pressure gradient 215
- normal faulting
- regimes 131
 - stress system 10, 15, 16, 277
- North Sea
- Brent field, stress depletion 20–22
 - fracture pressure model testing 222–224
- Ockley accumulation
- appraisal data 117
 - appraisal wells 118–121
 - faults and fractures 122–124, 124
 - geological setting 113–115
 - geomechanical analysis
 - Biot coefficient and effective stress 125–126
 - horizontal stress direction 126
 - pore pressure 124–125
 - stress magnitudes *in situ* 125
 - location 114
 - matrix properties 121–122, 121
 - porosity cycles 115
 - seismic section 116
 - stimulation and testing 117–118
 - stratigraphy 115
 - structure 115, 123
 - summary and discussion of data 128
 - fracture designs 127–128
 - fracture propagation 126–127
- numerical modelling
- Cusiana field stress 12
 - sandbox modelling 12–15
- Ockley accumulation
- appraisal data 117
 - appraisal wells 118–121
 - faults and fractures 122–124, 124
 - geological setting 113–115
 - geomechanical analysis
 - Biot coefficient and effective stress 125–126
 - horizontal stress direction 126
 - pore pressure 124–125
 - stress magnitudes *in situ* 125
 - location 114
 - matrix properties 121–122, 121
 - porosity cycles 115
 - seismic section 116
 - stimulation and testing 117–118
 - stratigraphy 115
 - structure 115, 123
 - summary and discussion of data 128
 - fracture designs 127–128
 - fracture propagation 126–127
- oil fields, impacts of development 7
- opening-mode fracture systems 257
- case study
 - Travis Peak Formation
 - geomechanical parameters **262**
 - natural fracture pattern 261
 - role of overpressure 264, 265–266
 - thermal history 261, 263
 - setting 259–261
 - failure criterion 257
 - microthermometry on quartz 258–259
 - role of shear failure 258

- Otway Basin
 geological history 53–54
 setting 49, 51, 57, 53
 stratigraphy 50
 structural elements 52
 study of contemporary stresses 54–55
 basement rocks 71–74
 constraining maximum horizontal stress
 magnitudes 69
 maximum horizontal stress orientation 55–61
 results
 minimum horizontal stress magnitudes 65–69
 neotectonic compressional
 deformation 74–79
 pore pressure magnitudes 61–63
 possible states of stress 69–71
 vertical stress magnitudes 63–65
 results interpreted 79
 conflicts resolved 81
 post-rift setting 80
 syn-rift setting 80–81
 summary 81–82
 overburden stress **278**, **281**, 283
 overpressure 132, 133–135, 213, 285
 generation of 2–3
 role in opening-mode fractures 264–265
- P-wave velocity
 correlation with geomechanical properties 277
 modelling mud volcano properties
 Chirag geometry 276
 methods 280–281
 results 281–283
 results discussed 284–288
 summary 288–289
 relation to depth 280, **281**
 tight chalk 233, 237–238
 passive basins, stress analysis 9
 permeability studies
 chalk **119**, 122
 tight chalk 233, 235, 237, 238
 phyllosilicates, role in faulting 159
 Piceance Basin
 Mesaverde Group
 opening-mode fractures
 role of overpressure 264–265, 266, 268
 thermal history 263–264
 setting 263
 Poisson's ratio 35–36, **278**, **281**, 282
 pore fluid factor 132
 pore fluid pressure 132, 213, **278**, **281**, 283, 284
 chalk **119**
 implications for drillability 285–288
 role in extensional faulting 159
 role in opening-mode fractures 258
 porosity **278**, 283
 chalk 121
 tight chalk 233, 235, 237, 238, 239
 pressure, values for modelling **278**, **281**
 principal stress trajectories, role in extensional
 faulting 159
- quartz
 in chalk 121
- crack-seal 258–259
 relation to thermal expansivity 267
- Raleigh analysis **38**
- reservoirs
 carbon capture and storage 181
 characterization of sites 181–182, **182**
 case study for Italy
 carbon dioxide geofluids 182–183
 flow in formations 183, 185
 map of seeps 184
 migration mechanisms 185–186
 seep case studies 186
 geological settings 186–187
 leakage pathways 187–188
 properties modelling 187
 reservoir classification 187
 results 188–190
 Acerno reservoir 191, **193**, 195
 Benevento field 188, 189, 190–194
 Caprese reservoir **193**, 195–196
 Frigento reservoir 188, **193**, 194–195
 Monte Taburno reservoir 189, **193**, 194
 Muscillo reservoir 189, **193**, 194
 results discussed
 data synthesis 203–207
 leakage and risk management 199–203
 reservoir characteristics, leaking v. sealing
 196–199
 summary 207–208
 pressure depletion during production 19–20
 reshear criterion 157–158
 reverse faulting, stress system 277
 rock strength *see* strength
 rock surface friction coefficient 155, 157
 Roma Shelf 32, 34, 39
 rotational planar normal faulting, alternative names 155
 Russia, Lunskeye field 23–24
- S-wave velocity, relation to depth 280, **281**
- Sabine Uplift 260
- Sakhalin Island, Lunskeye field 23–24
- Salina Group evaporites 245, 246
- salt tectonics
 Appalachian Basin 245, 247, 253, 255
 Santos Basin 145, 151, 152
 sandbox modelling, thrust fault system 12–15
 Santos Basin (Brazil)
 fault system study
 geomechanical modelling 144–145, 147
 numerical simulation 149–150
 parameters 147, 149
 results 146, 147, 148, 149, 150, 151
 results discussed 150–152
 geological setting 144
 location 145
 seismic section 145
 structure 144
- Scotian Shelf, fracture pressure model testing 219–222
- scratch tests 24
- seismic activity, upper crust 131
- seismic waves *see* P-wave; S-wave
- shale, compaction curve 280
- shear failure, role of 258

- shear modulus **278, 281, 282**
 shear wave velocity **278**
 shearing, causes 7
 silica, relation to thermal expansivity 267
 soft linkage of faults 159
 South Caspian Basin 275
 Chirag mud volcano
 geometry 276
 modelling behaviour
 methods 280–281
 results 281–283
 results discussed 284–288
 summary 288–289
 geological setting 274
 stratigraphy 276
 tectonic setting 275
 strain boundary approach 9–10
 strength properties, values in modelling **278, 281**
 strength testing 22–23
 Lunskoye field case study 23–24
 stress
 Andersonian 257
 case studies
 Bowen Basin 35–36
 Brent field 20–22
 Cusiana field 10–12
 Otway Basin
 study of contemporary stresses 54–55
 basement rocks 71–74
 constraining maximum horizontal stress
 magnitudes 69
 maximum horizontal stress orientation 55–61
 results
 minimum horizontal stress magnitudes
 65–69
 neotectonic compressional deformation
 74–79
 pore pressure magnitudes 61–63
 possible states of stress 69–71
 vertical stress magnitudes 63–65
 results interpreted 79
 conflicts resolved 81
 post-rift setting 80
 syn-rift setting 80–81
 summary 81–82
 changes during oil field development 7–8
 defined 131
 description 1, 91, 157, 257
 driver of faulting 132–135
 evolution during production 19–20
 history models 268
 magnitude estimation 9–10
 normal faulting systems 15
 numerical model 12
 passive basins 9
 post-faulting regimes 16, 17, 18
 processes controlling 1–2
 thrust faulting systems 12–15, 16
 trajectories and role in extensional faulting 159
 values for modelling **278, 281**
 stress polygon 15–16, 17, 279
 analysis for mud volcano 285
 strike-slip faulting stress regimes 10, 131, 277
 Surat Basin 32, 33, 34
 domains 34, 37, 39
 mechanical stratigraphy 41–44
 oilfield impacts 44–46
 stress measurements 35–36
 stress model (1D wellbore) 39–41
 stress orientation 36–37, 39
 Sussex, Turonian–Cenomanian chalk 228, 229, **230–231**
 Taroom Trough 31, 33, 34, 39
 Tea Cup porphyry system 161–163, 164, 165
 Terzaghi law 91, 125
 thermal expansivity 267
 thermoelastic contraction, role in opening-mode fractures
 265–266, 268
 thermometry *see* microthermometry
 thrust faulting 10, 131
 Appalachian Plateau 245, 246
 deformation
 modelling 249–250
 application 250–251
 parameter sensitivity 252–253
 parameters 251
 results 252
 results discussed 253–255
 summary 255
 Cusiana field
 stress evolution 19–20
 stress modelling 12, 13
 stress regime analysis 10–12
 sandbox modelling 12–15
 tight chalk *see* chalk
 tilting 157
 controls on 155
 Travis Peak Formation
 geomechanical parameters **262**
 natural fracture pattern 261
 role of overpressure 264
 thermal history 261, 263
 opening-mode fractures, role of overpressure 265–266
 setting 259–261
 unconfined compressive strength (UCS) tests, tight chalk
 233, 234, 236, 237, 239–240, 239
 uniaxial compressive strength **278, 281**
 USA *see* Appalachian Plateau; Basin and Range; East
 Texas Basin; Piceance Basin
 Valley and Ridge Province 245, 246
 veins, role of 3
 vertical stress *see* overburden stress
 vesicles, mechanical strength 2
 viscous deformation 132
 volcanoes, stability of 2
 see also mud volcanoes
 Volga delta 273
 Voring Basin 152
 Walloon Fairway 32, 34
 wellbore stress model (1D) 39–41
 yield strength profile 147
 Yopal fault 10, 11
 Young's modulus 9, 35–36, **278, 281, 282**
 tight chalk 240