

Index

Bold entries are mineral names. Page numbers in bold refer to minerals with detailed descriptions. Page numbers in italics refer to pictures.

- Abbe refractometer, 170, 191
- aberrations in lenses, 172
- absorption, 217
- absorption of light, 186
- absorption spectra, supernovae, 537
- abundance of elements, 16
- acetic acid, structure, 474
- acetone, structure, 474
- acid mine drainage, 533
- actinolite**, 449, 529
- acute bisectrix, 199
- adularia**, 309
 - from Alps, Plate 21a
- African Copper Belt, 374
- agate**, 308
- aggregate, 518
- aggregation, 127
 - of crystals, 127
- Agricola, 5, 481
- Airy's spiral, 202
- Al_2SiO_5 , phase diagram, 276
- alabandite**, 539
- albite**, 301, **310**
 - from New Mexico, Plate 21d
 - Albite twin law, 112, 311
 - Algoma-type iron deposits, 491
 - elite**, 519
 - alkali feldspars**, 301, **309**
 - optical indicatrix, 205
 - phase diagram, 306, 314
 - alkali-silica reaction, 523
 - allanite**, 407
 - aluminosilicates, 301
 - structures, 405
 - aluminum avoidance principle, 464
 - aluminum deposits, 496
 - aluminum ore, 393
 - aluminum, dislocation loops, 255
 - alumosilicates, 301, 462
 - alunite**, 355
 - amalgamation, 534
 - amazonite**, 310
 - from Colorado, Plate 21b
 - American Mineralogist Crystal Structure Database, 143
 - amethyst**, 50, 308, **Plate 2c**
 - amosite**, 529
 - optical micrograph, 532
 - TEM image, 532
 - amphibole**, 445
 - extinction angle, 212
 - minerals and composition, 439
 - optical orientation, 211
 - optical properties, 209
 - quadrilateral, 444
 - structure, 438
 - amphibolite facies, 415
 - analcime**, 469
 - from Italy, SEM image, 465
 - analyzer, 173, 176
 - anatase**, 392
 - from Swiss Alps, Plate 28d
 - structure and symmetry, 104
 - andalusite**, 408
 - optical orientation, 214
 - optical properties, 215
 - porphyroblast, Plate 5c
 - andesine**, 301
 - anglesite**, 355
 - anhedral shape, 49
 - anhydrite**, 355
 - animal nutrition, zeolites, 471
 - aniom, 19
 - anisotropy, 149
 - annabergite**, 352
 - annite**, 429
 - anomalous dispersion, 186
 - anorthite**, 301, **310**
 - APBs, TEM image, 306
 - in lunar basalt, Plate 21f
 - anorthoclase**, 306
 - anorthosites, lunar, 548
 - anthophyllite**, 449, 529
 - anthracene**, structure, 473
 - antigorite**, 426
 - structure, 420
 - antiphase boundary (APB), 115

- apatite, 350, 526**
 - from Mexico, Plate 25b
- aphthitalite, 332**
- applied mineralogy, 481
- aquamarine, 410**
 - blue color, 220
 - gem, 510
- aqueous solutions, 261
- aragonite, 342**
 - composing nacre of abalone, 358
 - from Spain, Plate 24c
 - structure, 337
- aridisols, 435
- armalcolite, 547**
- arsenic deposits, 497
- arsenopyrite, 365**
- arteriosclerosis, Plate 32f
- arvedsonite, 529**
- asbestos, 529
 - in human lung, SEM image, 530
 - asbestosis, 529–30
 - associations of minerals, 54
 - asteroid belt, 538
 - atmosphere, 558
 - atom, 12
 - atomic coordinates x, y, z , 79
 - atomic force microscopy (AFM), 162, 232
 - schematic view, 232
 - atomic number, 12
 - atomic positions, 79
 - atomic structure, 12
 - atomic vibrations, 272
- augite, 441, 448**
- auricupride, 317**
- austenite, 322**
- autoclave, 514
- autunite, 352**
- aventurine, 308**
- awaruite, 317**
- axial angle $2V_y$, 184
- azurite, 342**
 - from Arizona, Plate 24d
- baddeleyite, 343**
 - structure, 382
- BaFe₁₂O₁₉ with magnetic domains, 163
- banded iron formations, 489
- barite, 352**
 - from Germany, 355
 - indicatrix orientation, 195
- basalts, lunar, 548
- base metals, 496
- bastnäsite, 342, 343**
- bauxite, 393, 431**
- bcc (body-centered cubic), 19
- Becke line, 191
- belite, 519**
- belt apparatus for diamonds, 515
- bentonite, 471**
 - structure, 409
- benzene, bonding, 474
- Berezovsk, Russia, 334
- Bergkristall, 4
- Bergmann, Torbern, 4
 - cleavage of calcite, 61
- berlinite-quartz structure, 350**
- Bertrand lens, 173
- beryl, 410**
 - absorption spectrum, 219
 - colors, 50
 - from Pakistan, Plate 30b
 - structure, 409
 - with different colors, Plate 18a–c
- beryllium deposits, 496
- betafite, 392**
- biaxial negative, 200
- biaxial positive, 200
- Big Bang, 536
- biochemical processes, 356
- biogenic carbonates, 347
- biogenic minerals, 356–7
- biopyrboles, 45
 - TEM image, 444
- biotite, 429**
 - pleochroism, Plate 11
 - thin section, Plate 16
- Birch, F., 558
- birefringence, 173–4
- birnessite, 394**
- bischofite, 332, 528**
 - structure, 326
- Black Hills pegmatites, 510
- black smoker, 374
 - chimney, Plate 27c
 - massive sulfide deposits, 488
- Bloch walls, 162
- blödite, 332**
- blueschist facies, 415, 450
- body-centered cubic (bcc), 19
- boehmite, 377**
 - structure, 385
- Bøggild gap, 307
- Bohr model, 12
- bonding, 15
 - properties, 23
- bone, 357, 526
- borates, 336
 - structure, 337

Index**605**

- borax**, 333
- bornite**, **365**
- Bowen, N. L., 454
- Bowen's reaction series, **456**
- Bragg equation, **140**
- Bragg fringes, TEM, **228**
- Bragg, W. H., **135**
- Bragg, W. L., **135**
- Bragg's law, two conditions, **141**
- Bravais lattices (14), **69**
 - 3D, unit cells, **71**
- Bridgman, P. W., **514**
- bridgmanite**, **555**
 - stability, **286**
- brightfield image, TEM, **230**
- brilliance of diamond, **504**
- brilliant-cut diamond, **503**
- brookite**, anomalous dispersion, Plate 12j–l
- brucite**, **393**
 - structure, **384**
- Buerger, M. J., **33**
- Burgers vector **b**, **109**
- burkeite**, **333**
- Bushveld layered intrusion, **490**
- Bushveld, South Africa, **323**, **489**
- bytownite**, **301**
 - cabochon cut, **503**
 - CaCO_3 , phase diagram, **276**
 - calcified tissue in artery, Plate 32f
- calcite**, **340**
 - birefringence, **174**
 - cleavage, **53**
 - crystal forms, **119**
 - deformation twins, Plate 2d
 - dislocations, **255**
 - from Fontainebleau, **126**
 - giant crystals from Alps, **341**
 - habits, **341**
 - in oceans, **345**
 - IR and Raman spectroscopy, **243**, **243**
 - mechanical twinning, **257**
 - optical properties, **213**
 - prismatic-scalenochedral, from Cumbria, Plate 23e
 - structure, **337**
 - tabular, from China, Plate 23f
 - thermal expansion, **156**
 - thin section with twins, Plate 16c
 - tufa, **344**
 - twinnings, **112**, **213**
 - vibrational modes, **244**
 - calcite–aragonite transformation, **275**
 - calcite–wollastonite–quartz phase diagram, **278**
 - calculation of chemical formulas, **37**
 - Callisto, ice, **545**
 - Canada balsam, **169**
 - Cappeller, M. A., law of interfacial angles, **61**
 - Cappeller, quartz and calcite morphology, **1723**, **61**
 - carat, **501**
 - carbohydride minerals, **474**
 - carbon
 - bonding, **473**
 - PT phase diagram, **320**
 - carbonates, **336**
 - composition, tetrahedron, **41**
 - diagnostic properties, **338**
 - dissolution in oceans, **345**
 - isomorphism, **31**
 - phase diagram, **341**
 - silts in Kazakhstan, **347**
 - carbonatites**, **341**, **343**
 - carborundum, growth spirals, **122**
 - Carlsbad Caverns, **343**
 - Carlsbad twin law in orthoclase, **112**
 - carnallite**, **327**
 - carnotite**, **350**, **352**
 - carrier pigeons, magnetite, **359**
 - cassiterite**, **391**
 - habits, Siberia, **269**
 - catalytic processes, zeolites, **471**
 - cation, **19**
 - cation exchange capacity, **432**
 - clay minerals, **433**, **471**
 - cation packing, **382**
 - caves, **343**
 - celestite**, **352**
 - two generations, **267**
 - cement, **341**, **518**
 - microstructures, **521**
 - minerals and abbreviations, **520**
 - plant, schematic, **520**
 - centering of lattices, **72**
 - ceramics industry, **310**
 - cerussite**, **342**
 - chabazite**, **469**
 - structural cages, **464**
 - chain silicates, **397**, **437**
 - diagnostic properties, **446**, **448**
 - stacking, **440**, **445**
 - chalcedony**, **308**, Plate 8b
 - with growth zones, Plate 8c
 - chalocite**, **365**
 - chalcopyrite**, **366**
 - formula, **262**
 - from Germany, Plate 26c
 - with oxidation, Plate 26d
 - chamosite**, **430**
 - charge-transfer transitions, **220**

- charoite**, 398
- chemical analysis, 238
- chemical contamination, 532
- chemical elements, 12
- chemical formulas, 37
 - calculation, 37
- chemical reactions, 271
- chemical vapor deposition, 517
- chemical varieties of minerals, 46
- chemistry, fundamentals, 12
- chesterite**, 444
- chiastolite**, 408
- Chivor, 508
- chlorites**, 430
 - composition, 422
 - structure, 421
 - thin section, Plate 15e,f
- chloritoid**, 408
- chondrites**, 539
 - chemical composition, 546
 - thin section, 539
- chondrodite**, 411
 - Christoffel equations, 158
 - chromatic aberration, 171
- chromite**, 391
 - chromium deposits, 487, 491
 - chromophore elements, 218
 - chrysoberyl**, gem, 510
 - chrysoprase**, 308
 - chrysotile**, 426, 529
 - asbestos, Italian Alps, Plate 31a
 - structure, 420
 - TEM image, 421
- cinnabar**, 366, **Plate 1b**
 - twinning, 112
- citrine**, 50, 308
 - Clapeyron slope, 286
 - classification of minerals, 43
 - classification of silicate structures, 399
 - clathrate cages, 385
 - clathrates, structures, 386
 - Clausius–Clapeyron equation, 276
 - clay minerals
 - cation exchange capacity, 471
 - composition, *d*-spacing, 429
 - structure, 425
 - clays, 431
 - cleavage, 52
 - in minerals, 53
 - climb of dislocations, 256
 - clinker, 519
 - clinochlore**, 430
 - from Swiss Alps, Plate 31b
- clinoenstatite**, 448
- clinohumite**, 406
- clinoptilolite**, 464
 - from Colorado, SEM image, 465
 - structure, 470
- clinopyroxene** with sector zoning, Plate 14e,f
- clinopyroxene**, lunar basalt, TEM image, 442
- clinozoisite**, 415
 - close-packing, 17
 - close-packed structures, interstices, 28
- CO₂, structure, 382
- cobaltite**, 366
 - structure, 365
- coesite**, structure, 299
- cohenite**, in meteorites, 541
- colemanite**, 333
 - colloidal solutions, Yellowstone, 264
- color, 217
 - hand specimens, 50
 - in important minerals, 218
- color centers, 220
- commercial halide deposits, 334
- compensators, 173, 192
 - principle, 193
- Comstock, 497
- concrete, 518
 - microstructure, schematic, 522
 - polished section, 518
 - problems, 522
- concretions, 127
- condenser lens, 172
- congruent repetition, 63
- consumption of ores, 498
- contact metamorphism, 410
- continental carbonate sediments, 346
- continental salt lakes, 333
- convection, 554
- convergent light, 196
 - interference figure, 197
 - convergent margins, 485
- cooperite**, 322
- coordination number, 18
- coordination polyhedra, 24
 - in crystal structures, 26
 - minerals, 28
- copper**, 321
 - atomic coordinates, 79
 - dendritic growth, Plate 4a
 - deposits, 496
 - minerals, phase diagram, 278
- cordierite**, 410
 - blue color, 220
- core of the Earth, 322

Index

607

- Cornwall, 373
- corrosion, 523
- corundum, 385, Plate 1e**
 - color, 217
 - Coulomb attraction, 23
 - Coulomb's law, 20
 - covalent bonding, 21, 317
 - Cripple Creek, 497
 - cristobalite**, structure, 298, 382
 - crocidolite, 450**, 529
 - crossed polarizers, 176, 191
 - crust, composition, 551, 553
 - crystal field transitions, 218
 - crystal forms, important, 102, 103
 - crystal identification, 143
 - crystal structure, 17, 63, 78
 - diffraction, 145
 - crystal synthesis, 512
 - crystal systems (7), 72, 81, 92
 - crystal wedge, 178
 - crystal, definition, 10
 - crystallization
 - during evaporation, 331
 - from a melt, 284
 - of magma, 450
 - crystallographic forms, 100
 - CsCl, structure, 326
 - C—S—H, 520
 - cubic close-packing, 18, 317
 - cuprite, 392**
 - from Namibia, Plate 28e
 - Curie temperature, 163
 - Czochralski apparatus, 513
 - D'' layer, 556
 - Dana, J. W., 42
 - Danakil depression, Ethiopia, 334
 - darkfield image, TEM, 229
 - Dauphiné twin, 113
 - Dead Sea, aragonite, 346
 - Debye rings, 141
 - Deep Springs Lake, 347
 - defects in crystals, 108
 - deformation of crystal, 251
 - deformation twin in calcite, 111
 - dehydration of evaporite minerals, 333
 - dendrites, Plate 19e
 - silver, 321
 - sulfur, 319
 - dendritic growth, 122
 - density, 54, 152
 - of some minerals, 155
 - deuterium, 13
 - diagenesis of carbonates, 348
 - diamagnetic crystals, 160
 - diamond, 319, 322, 508**
 - atomic coordinates, 79
 - bonding, 22
 - dispersion, Plate 23a
 - from India, 505
 - from Kimberlite, Plate 32g
 - in Allende meteorite, 541
 - large, 509
 - luminescence, Plate 23b
 - structure, 317, 320
 - diamond anvil assembly for high-pressure experiments, 235, 235
 - diapiric salt dome at Stassfurt, Germany, 334
 - diaspore, 377**
 - structure, 385
 - diatomite, 309**
 - diatoms, 309, 358
 - diatremes, 323
 - diffraction intensities, 147
 - diffractometer geometry, 141
 - diffusion in minerals, 469
 - diffusion of vacancies, 254
 - dioctahedral unit, 419
 - diopside, 448**
 - ("augite") from Mt. Kilimanjaro, 449
 - congruent melting, 455
 - structure, 440
 - dioptase, 410**
 - dislocation loops, 255
 - dislocation microstructures, 254
 - dislocations, 108, 109, 252
 - dispersion, 185, 201, 222
 - coefficients of minerals, 187
 - curves, 186
 - in biaxial crystals, 187
 - displacive transformation, 34
 - displacive transitions, 35
 - disthen, 408
 - divergent margins, 488
 - dolomite, 342**
 - and calcite with age, 346
 - crystals in thin section, Plate 16d
 - dislocations, TEM, 110
 - from Eugui, Plate 24a
 - optical properties, 213
 - replacing calcite, Plate 24b
 - screw dislocations, 255
 - structure, 337
 - TEM image, 229
 - twinning, 213
 - druses, 127
 - in sericitic gneiss, 369

- Earth**
 chemical composition, 546
 cross-section, 548
 seismic waves, 552
 mantle, 285
 convection, 554
 history, 558
 eclogite facies, 415
eclogite, petrographic thin section, Plate 9
 edge dislocation, 110, 252
 elastic compliance, 152
 elastic deformation, 251
 elastic properties, 155
 elastic stiffness, 158
 metals, 158
 elastic tensor for different symmetries, 157
 elastic waves, 158
elbaite, 409
 electrochemical processes, 375
 electrolytes, 278
 electromagnetic radiation, 166
 electron, 12
 electron configurations, 16
 electron microprobe, 239
 schematic, 239
 electron microscopy, 226
 electron transitions and absorption, 218
 electrostatic attraction, 17
 elemental abundances in solar system, 540
emerald, 410, 508
 absorption spectrum, 220
 trapiche, Plate 32b
 enantiomorphous repetition, 63
 endogenic processes, 266
 endothermic reaction, 286
 energy conversions, 227
 energy minimum, 271
 energy transitions of electrons, 133, 238
 energy transitions producing XRF, 239
enstatite, 448
 in chondrites, 539
 incongruent melting, 455
 enthalpy, 272
 entropy, 270, 272
epidote, 407
 from Swiss Alps, Plate 29e
 minerals, composition, 404
 optical orientation, 214
 optical properties, 214
 thin section, Plate 15e,f, Plate 16e,f
 epitaxial growth, 120
epsomite, 332
 equal-area or Schmidt net, 88
 equal-area projection, 88
 pole figure, 89
 equilibrium, 270
erithrite, 352
 Escher, M. C., symmetry, 65
 ethane, bonding, 473
ettringite, 520
 SEM image, 521
 euhedral crystals, 121
 euhedral shape, 49
 Europa, ice, 545
 eutectic melting in system diopside–anorthite, 285
 eutectic point, 284, 452
 for some mineral pairs, 285
 evaporate minerals in the system $\text{NaCl}-\text{KCl}-\text{MgCl}_2-\text{Na}_2\text{SO}_4-\text{H}_2\text{O}$, 331
evaporites, 329
 crystallization sequence, 331
 deposits in North America, 330
 evaporites on continental shelf, 330
evenkite, 476
 EXAFS, 242
 exogenic processes, 266
 exothermic reaction, 286
 exsolution, 114–15, 289
 in minerals, 291
 extinction, 177
 extinction angle, 194
 face-centered cubic (fcc), 19
fayalite, 405
 fcc (face-centered cubic), 19
 feel, 54
feldspar structures, history, 303
feldspars, 299
 Al/Si distribution, 305
 diagnostic properties, 296
 NMR spectra, 246
 solid solution, 32
 structure, 304, 463
 ternary diagrams, 302
 thin section analysis, 202
 twinning, 112
feldspathoids, 462
ferroactinolite, 449
 ferromagnetic crystals, 161
ferropericlase, 555
 stability, 286
ferrosilite, structure, 445
 fertilizer, 327
 apatite, 352
 fibrolite, 408
 first law of thermodynamics, 270

Index**609**

- fluid effects, 263
- fluid inclusions, 126, 242
- fluorene, 474–5
- fluorescence, 54, 224
 - in minerals, 223
- fluorite, 327**
 - CaF_2 , structure, 326
 - fluorescence, Plate 18d,e
 - from Alps, Plate 20a
 - from Freiberg, 329
 - from Hunan, Plate 23d
 - sector zoning, 126
 - vacancy produces color center, 221
- flux growth of emerald, 513
- fool's gold, 367
- foraminifera, 356
- form, general, 101
- formicaite, 475**
 - structure, 475
- forms, special, 101
- formulas
 - empirical, 37
 - ideal, 37
 - simplified, 38
- forsterite, 405**
- fracture, 53
- framework silicates, 417, 462
 - diagnostic properties, 466
- Frank–Read source, 254
- Frenkel defects, 109
- frequency and wavelength, 167
- fullerene, structure, 321
- gabbro from Risör, 454
- galena, 366**
 - from Germany, Plate 26b
 - morphology, 82
- galvanic cell, 279
- garnets, 406**
 - common form {110}, 102
 - composition and some properties, 404
 - formula, 39
 - from Alps, Plate 29c
 - morphologies, 406
 - Mössbauer spectrum, 248
 - optical properties, 214
 - porphyroblast, 265
 - rotated, Plate 6a
 - structure, 403
 - ternary diagram, 41
 - varieties, 406
- gas environment, 263
- gas pressure phase diagrams, 277
- gaylussite, 333**
- gem deposits, 507
- gem enhancements, 510
- gem refractometer, 506
- gemologist, 504
- gems, 46
- gemstones, 501
 - history, 504
 - with mineral names, 502
- general forms, perspective drawings, 98
- geological rock cycle, 266
- geophagy, 529
- geothermal gradient, 415
- giant crystals, 124
- Gibbs free energy, 281
 - solid solution, 289
- Gibbs potential, 272
- gibbsite, 393**
 - structure, 384
- glaserite, 333**
- glaucanite, 430**
- glaucophane, 450**
 - pleochroism, Plate 11
 - glide plane, 105
- gmelinite, structural cages, 464**
- goethite, 393**
 - biogenic, 357
 - botryoidal morphology, 128
 - from UK, Plate 27f
- gold, 321**
 - deposits, 497
 - map, 498
 - from California, Plate 22b
 - from Romania, Plate 22c
 - nugget, Alaska, Plate 22d
 - octahedral, from California, 321
- Goldschmidt, V., 6
- goniometer, 7
- grain mount, 190
- granite origin, 311
- granite, alteration, Plate 7e,f**
- granulite facies, 415
- graphic granite, 481
- graphic texture with quartz and orthoclase from Kola, Plate 21c
- graphite, 319, 322**
 - structure, 319, 320
- Great Dyke, 489
- Great Mogul diamond, 505
- greenschist facies, 415
- greenstone belts, 489
- gregoryite, 343**
- greisen, 265, 369

- group sulfides, 361
- growth, 120
 - crystals, 78
 - velocities, 121
- grunerite**, 529
- gummite**, 393
- gypsum**, 355
 - cement, 519
 - giant crystals, Plate 5a
 - plate (compensator), 194
 - prismatic, 356
 - Sahara rose, 126
 - structure, 355
 - twinning, 112
 - with swallow-tail twin, 356
- H₂O bonding, 21
- H₂O, phase diagram, 271
- habit, 118, 128
 - in hexagonal minerals, 119
 - half-life, 116
- halide minerals, diagnostic properties, 328
- halides, 325
- halite (NaCl)**, 6, 10, 21, 325, 327
 - atomic coordinates, 79
 - blue zoning, Plate 23c
 - crystal structure, 64
 - cube, Plate 3a
 - diffraction pattern, 142
 - giant crystals, 124
 - in nutrition, 526
 - skeletal growth, 123
 - structure, 147
- Hall process, 516
- Halle, Germany, 334
- Halley's comet, composition, 537
- halloysite**, structure, 426
- halogens, properties, 329
- halos around monazite in cordierite, Plate 2e,f
- halos around zircon in biotite, Plate 2e,f
- Hammersley iron deposit, 489
- hand specimen identification, 49
- hanksite**, 333
- Harding pegmatites, 510
- hardness, 51
 - and color of minerals, 56
- harmotome**, structure, 463
- Haüy, R. J., 5
 - elementary parallelepipeds, 62
 - structure of halite, 1801, 62
- hazards of particulates, 529
- hcp (hexagonal close-packing), 19
- health hazards, 529
- hedenbergite**, 448
- heliodor**, 410
- Helmholtz potential, 272
- hematite**, 387
 - rose, Plate 6c
 - TEM, 115
- Herkimer diamond, 300
- Hermann–Mauguin symbol, 91
- heulandite**, 469
 - hexagonal close-packing (hcp), 17
- hexahydrite**, 332
- high-pressure investigations, 235
- high-resolution imaging, 226
- history of gemstones, 504
- history of X-ray crystallography, 134
- hollandite**, 377
 - structure, 383
- Homestake, 497
- Hooke's law, 157
- hornblende**, 449
 - indicatic orientation, 195
 - pleochroism, Plate 11
- hornfels facies, 415
- howeite**, 438, 444
- human body, 527
- humboldtine**, 476
 - structure, 476
- humite**, 406
 - Huttenlocher gap, 307
- Hutton, J., 266
- Hutton's geological cycle, 559
- Huygens' construction, 138
- hydraulic cement, 518
- hydrochloric acid test, 340
- hydrosphere, 558
- hydrothermal carbonates, 343
- hydrothermal growth of quartz crystals, 514
- hydrothermal solutions, 261
 - with metals, 262
- hydrothermal sulfide deposits, 369
- hydrothermal vein in granite, 369
- hydroxide minerals, diagnostic properties, 390
- hydroxyapatite**, 357
- ice**, 558
- Ih**, structure, 386
- iddingsite**, Plate 22f
- idrialite**, 475
 - structure, 475
- igneous rocks, 450
- illite**, 425, 430
- ilmenite**, 387
 - formula, 38
 - TEM, 115
- immersion method, 191

- immiscible liquids, 368
- incongruent melting, 452
- Indian diamonds, 505
- indicatrix, 180
 - conventions, 186
 - ellipsoid, sections, 183
 - for different symmetries, 184
- inelastic neutron scattering, 236
- infrared (IR) spectroscopy, 240, 506
- inner core, 557
- instruments for gemologists, 504
- interfacial angles, 61
 - derivation, 76
- interference color chart (Michel–Lévy chart), 181, Plate 10a
- interference colors, 179
- interference figures
 - biaxial crystals, 199, 200, Plate 12e–g
 - inclined crystal, 199
 - uniaxial crystals, 197, 198, Plate 12a–d
- interference of light waves, 176
- International Center for Diffraction Data, 143
- International Mineralogical Association, 47
- international symbol, 91
- International Tables for Crystallography, 103, 106
- interplanetary dust, 537
- interstitial, 109
- inversion, 93
- Io, lava flows, 545
- ion microprobe, 240
- ionic bonding, 19, 327
- ionic exchange, 469
- ionic radii, 22
 - with coordination number, 25
- IR experiment, schematic, 241
- iridium**, 322
- iron**, 322
 - cross twin in pyrite, 112
 - d*-orbitals, 219
 - deposits, 495
 - in Gibeon meteorite, Plate 22f
 - in inner core, 557
 - oxides phase diagram, 281
- isochromes, 197
- isoferroplatinum**, 322
- isogyres, 197
- isomorphism, 31
- jade**, 449
- jadeite**, 448
- jennite**, 522
- jimthompsonite**, 444
- Jolly balance, 155
- kainite**, 332
- kamacite** (bcc), 322
 - in interplanetary dust, 537
- kandite**, structure, 426
- kaolinite**, 429
 - in nutrition, 527
 - structure, 419, 425
- kernite**, 333
- K-feldspar** in Colorado gneiss, 306
- K-feldspar**, morphology, 310
- Khibini massif, 352
- kidney stones, 358
- kieserite**, 332
- kimberlite diatreme, 323
- kinetics, 270
- Koh-i-Noor diamond, 505
- Kola Peninsula, 392
- kolumbite**, 392
- komatiites**, 489
- Kramer deposit, 333
- kratochvilite**, 475
 - structure, 475
- kunzite**, gem, 510
- Kursk iron deposit, 489
- kutnahorite**, 343
- kyanite**, 408
 - optical orientation, 214
 - optical properties, 215
- labradorite**, 301, 311
 - schiller colors, 223, Plate 21e
 - TEM image of exsolution, 224
- Lake Superior iron deposits, 489
- lapis lazuli**, 468
- larvikite**, 310
- laterite**, 431
 - distribution, 496
- lattice, 62
 - two-dimensional, 70
- lattice lines, 72, 74
- lattice parameters, 67, 142
 - cubic crystal, 144
- lattice planes, 72–3
 - defined by axis intercepts, 74
 - examples, 75
- lattice planes–lattice lines, 76
- lattice strain during slip and twinning, 257
- lattice vectors, 73
- Laue equation, 138
- Laue indices, 139
- Laue, M. von, 6, 135
- Laves, F., 560
- lawsonite**, 408
- layer structures, 384

- layered intrusions, 489
lazurite, 468
 lead deposits, 497
 Leitz-Jelley refractometer, 191
 lenses, 168
 geometry, 172
lepidochrocite, 393
lepidolite, 429
 lever rule, 284
 light, 166
 light metals, 495
 lime, 519
 limestone, 340
 diffraction pattern, 234
limonite replaces pyrite, 367
limonite, pseudomorph after **pyrite**, Plate 6d
 liquidus, 284, 286
lizardite, 426
 AFM image, 531
 Loewenstein avoidance rule, 303
 longitudinal (P) waves, 158
lonsdaleite, 324
loparite, 392
 from Kola, Russia, Plate 27e
 lower mantle, cross-section, 556
 luminescence, 221
 luster, 50, 222
 of minerals, 55

 mafic plutonic rocks, 451
 magma, 263
 magmatic deposits, 266
 magmatic differentiation, 456
 magmatic metal ore-forming processes, 368, 368
magnesite, 341
 magnetic field, 244
 magnetic minerals, 164
 magnetic properties, 54, 160
 magnetic susceptibility, 162
magnetite, 387
 AFM image with domains, 163
 in interplanetary dust, 536
 in magnetotactic bacteria, TEM image, 359
 magnetism, biogenic, 359
 octahedron, Plate 3b
majorite, 555
malachite, 342, Plate 1c
 from Arizona, Plate 24d
 pseudomorph after **azurite**, Plate 6e
 malignant tumors in rats, 529
 manganese deposits, 491
 manganese oxide, magnetic structure, 162
 manganese oxides, EXAFS, 245
manganite, 394

 mantle, composition, 557
 marble, 341
 with triple junctions, Plate 8a
marcasite, 366
 from Illinois, Plate 25e
marialite, 468
 marine basins, 330
mariocopaita, 398
 Mars
 chemical composition, 546
 cross-section, 548
 meteorites, 546
 X-ray diffraction image, 547
 martensitic transitions, 36
 mass spectrometer, schematic, 240
 mass spectrometry, 239
mazzite, structural cages, 464
 mechanical properties, 51, 251
 mechanical twinning, 254, 299
 in crystals, 258
 Mediterranean basin, evaporites, 329
meionite, 468
 melatope, 197
mellite, 476
 melting and free energy, 455
mercury, 322
 deposits, 487, 497
 from California, Plate 22e
 Merensky Reef, 490
 mesothelioma, 530
 metal deposits, 482
 western USA, 488
 metal production, 489
 metal structures, 19
 metallic bonding, 16
 metallic luster, 364
 metals, world production, 485
 metamorphic carbonates, 344
 metamorphism
 carbonate rocks in Central Alps, 459
 diamonds, 324
 facies, 416
 minerals, 410
 in pelitic schists, Alps, 412
 reactions, 456
 siliceous limestones, 456
 metasomatism, 265
 meteorite impact diamonds, 324
 meteorites, 322, 538
 classification, 539
 unique minerals, 541
 methane, bonding, 473
 micas
 composition, 422

- optical orientation, 212
- optical properties, 211
- structure, 420
- microcline**, 301, **309**
 - cross-hatched twinning, Plate 13e
 - twinning, 305
- microlite**, **392**
- microscope alignment, 190
- microscope, optical, 171
- microscope, petrographic, 7, 171
- microscopic mineralogy, 560
- microstructure and color, 222
- mid-oceanic ridges, 482, 554
- Miller indices (*h k l*), 75
- Miller–Bravais indices, 77
- Minas Gerais iron deposit, 489
- Minas Gerais pegmatites, 510
- mineral deposits, 261, 265
 - genetic types, 266
- mineral genesis, 261
- mineral identification, 49
- mineral names, 47
- mineral species, 42
- mineral, definition, 10, 42
- mineralization in Cornwall, UK, 373
- mineralogical prospecting, 482
- mineralogists, famous, 8
- minerals
 - as health hazards, 529
 - in human body, 527
 - in nutrition, 526
 - in solar nebula, 542
 - used for extraction of elements, 484
 - use and production, 483
- mining contamination, 532
- Miranda, ice, 545
- mirror reflection, 63, 91
- misfit dislocations, 114
- Mississippi Valley type deposit, 374
- Mitscherlich, E., 31–2
- Mogok, 509
- Mohs' hardness, 52
- moissanite**, in meteorites, 541
- Mojave Desert, 333
- molecular orbital transitions, 220
- molecular sieve, zeolites, 471
- mollisols, 434
- mollusk shells, 342, 356
- molybdenite**, **366**
 - from Queensland, Australia, Plate 27b
 - structure, 365
- molybdenum deposits, 495
- monaxial point-groups, 96
- monazite**, **350**
- from Alps, Plate 25a
- montmorillonite**, structure, 426
- Moon, 546
 - chemical composition, 546
 - cross-section, 549
 - minerals, 547
 - moons of outer planets, 545
- moonstone**, 305, 310
 - schiller colors, 223
- MORB, 555
- morganite**, 410
- morion**, **308**
- morphology of crystals, 81
- Mössbauer spectra and energy levels for ^{57}Fe , 247
- Mössbauer spectrometer, schematic, 246
- Mössbauer spectroscopy, 246
- Mother Lode, 374, 497
 - deposit, 485
- mother-of-pearl, 357
- mudstones, 431
- mullite**, **408**
- muscovite**, **429**
 - AFM image, 233
 - from Brazil, 430
 - from Pakistan, Plate 30f
 - giant crystal, 124
 - structure, 420
- Muzo, 508
- nacre, 358
- nahcolite**, 337
- naphthalene, structure, 474
- native elements, diagnostic properties, 318
- native metals, crystal structures, 317
- natrolite**, **469**
 - from Germany, 465
 - structure, 465
- Néel temperature, 161
- nepheline**, **468**
- nephrite**, 449
- neutrons, 12
 - diffraction, 235
 - production, 237
 - scattering, 146
- nickel deposits, 489
- nickel–cobalt deposits, 487
- nickel–iron alloys**, in chondrites, 539
- nickeline**, **366**
- Nicol prism, 174
- Niggli, P., 6
- niningeite**, 539
- nitrates, diagnostic properties, 338
- Nobel Prizes, 6
- nonhydraulic cement, 518

- nontronite**, EXAFS, 245
 nuclear magnetic resonance (NMR), 244
 nuclear spin, 244
 nucleation, 120
 nucleus, 12
 number of minerals, 45
 with specific elements, 46
 nutrition, 526
 nutritional elements, 528
 Nye, J. F., 149
nyerereite, 343
- objective lens, 172
 oceans, carbonates, 345
 octahedral layer, 418
 orientation, 423
 odor, 54
 Ohm's law, 17
oldhamite, 539
 Oldoinyo Lengai, 343
oligoclase, 301
olivine, 405
 axial angle and refractive indices, 210
 from Myanmar, Plate 29a
 in chondrites, 539
 melting phase diagram, 287
 optical properties, 209
 P waves, 159
 phenocrysts in basalt, Plate 14a,b
 real structure, 403
 serpentинized, Plate 14d
 solid solution, 31
 stability, 285
 structure, 403
omphacite, 449
oölite, 127
opal, 223, 309, 523
 from colloidal solutions, 263
 SEM image, 224, 308
 with color, Plate 20g
 opalescence, 309
ophiolites, 323
 optic axis interference figures for different axial angles, 201
 optical activity, 202
 optical analysis by means of interference
 figures, 203
 optical analysis of minerals with parallel light, 196
 optical indicatrix, 180
 optical properties, 166
 ellipsoids, 182
 optical retardation, 176
 orbitals, 15
 of *d*-electrons, 219
 order-disorder transitions, 34
- ordering, 35, 114, 289
 ordering transformation, 34
 ore deposits and geological history, 492
 ore deposits with geological time, 492
 ore deposits, geological environments, 485
 ore production, 494
 ore-bearing hydrothermal deposits, 371
 organic chemistry, 473
 organic compounds, 473
 organic minerals, 473
 origin of minerals, 261
 Orloff diamond, 505
orpiment, 366
 from Alps, Plate 26f
orthoclase, 301, 315
 from Poland, 310
 phenocryst, 125, Plate 5b
 twinning, 112, Plate 13d
orthopyroxene with exsolution, Plate 15a,b
orthopyroxene, Mössbauer spectrum, 248
 orthosilicates, 399
 diagnostic properties, 400
osbornite, 539
osmium, 322
 oxide minerals, diagnostic properties, 388
 oxisols, 434
 oxyorganic compounds, 474
- P waves, 551
 Pala pegmatites, 510
paligorskite, structure, 423
 Pamukale, 344
paracelsian, structure, 463
 paraffin, 476
 paragenesis, 267
 parallelepipeds, 62
 paramagnetic crystals, 161
 particle analysis, 531
 path difference, 136, 138
 Pauling rules for ionic structures, 29
 pedology, 431
pegmatite, 315, 510
 pelitic schists, 411
 thin section, Plate 17c,d
 penetration depths, X-rays and neutrons, 236
pentlandite, 366
periclaste, 392
 periodic system with benevolent and toxic elements, 533
 periodic table, 14
 peristerite gap, 307
peristerites, 311
 peritectic point, 453
perovskite, 392
 antiphase boundaries, 116

Index

615

- formula, 38
- from Kola, Russia, Plate 27d
- structures, 382
- TEM images, 229
- X-ray nanotomography, Plate 19c
- perthites**, 307
 - exsolution, TEM images, 307
- petrographic microscope, 7, 173
- pH, 278
- phase contrast microscope, 531
- phase diagrams, 284
 - alkali feldspars, 314
 - carbon, 516
 - carbonates (CO_2 , Mg, Ca), 346
 - forsterite–silica, 454
 - H_2O , 372
 - iron, 557
 - lower mantle, 555
 - methane–water, 387
 - $\text{NaCl}-\text{KCl}-\text{MgCl}_2-\text{Na}_2\text{SO}_4-\text{H}_2\text{O}$, 332
 - pigeonite-augite, 441
 - reactions in siliceous limestones, 458
 - $\text{SiO}_2-\text{CaCO}_3$, 459
- phase difference, 136
- phase rule, 282
 - for metamorphic rocks, 414
- phase shifts, 146
- phase transformations, 111
 - in mantle, 556
- phase transitions, 32
- phengite** polytypes, TEM image, 425
- phenocryst, 125
- phlogopite**, 429
- phosphates, 350
 - diagnostic properties, 351
- phosphorescence, 221
- phyllosilicates, 418
- physical properties, 149
- picene**, 474
- piedmontite**, pleochroism, Plate 11
- piezocrystals, 308
- piezoelectricity, 159
- pigeonite**, 448
 - exsolution, TEM images, 290
- pirssonite**, 333
- piston cylinder apparatus, 514, 515
- pitchblende, 393
- placer deposits, 482
- plagioclase**, 310
 - Al–Si distribution, 306
 - An content with metamorphic grade, 460
 - axial angle $2V_a$, 209
 - extinction angle, 207
 - extinction angle with composition, 208
- feldspars**, 301
- formula, 39
- in chondrites, 539
- indicatrix stereogram, 207
- melting phase diagram, 288
- orientation of indicatrix, 206
- phase diagram, 307
- refractive indices, 205
- SEM images, Plate 19a
- twinned, Plate 13f
- zoned and twinned, Plate 7a
- planar defects, 110–11
- Planck constant, 134
- plane polarizers, 176
- planets, 542
 - orbits, 538
 - outer, composition, 543
- plaster of Paris, 519
- plastic deformation, 252
- platinum**, 322
 - deposits, 487, 498
- Platonic polyhedra, 103
- pleochroic halos, 350
- pleochroism, 186, Plate 11
 - in minerals, 188
- Pliny the Elder, 4, 481
- pneumatolytic, 370
- pneumoconiosis, 531
- poikilocrystals, 125
- point defects, 109
- point-groups, 92, 96
 - stereograms, 94
- polariscope, 506
- polarization, 173
- polarized light, 174
- polarized light microscope, 531
- polarizer, 173, 176
- polarizing microscope, 189
- Polaroid crystals, 174
- pole figure, 89
- polyaxial point-groups, 96
- polycrystal plasticity, 256
- polygons, surface coverage, 67
- polyhedral sulfide, 361
- polymerization, 397
 - in borates, 337
- polymorphic minerals, aluminosilicates, 411
- polymorphic transformations, 271
- polymorphic transitions, 264
- polymorphism, 32
- polytypism with displacement vectors, 424
- polytypism, sheet silicates, 423
- porphyroblast, 125, 264
- porphyry copper deposits, 372, 486

- Portland cement, 518–19
 clinker, XRD, 521
portlandite, 520
 SEM image, 521
postperovskite, 556
 powder method, 141
 pozzolanic concrete, 519
 Precambrian shields, 488
 precious metals, 497
prehnite, 430
 price for 1 carat gem, 501
 primitive lattices, 70
 prisms, 168
 geometry, 171
 profitability, 491
 prograde reactions, 411
 proton, 12
 pseudomorphs, 127, 264
P-T phase diagrams, 285
 aluminosilicate minerals in Alps, 413
 carbon, 320
 Mg_2SiO_4 , 286
 SiO_2 , 297
pyrite, 367
 common form {210}, 102
 cube, Plate 3c
 dodecahedron, Plate 3d
 frambooidal growth, 128
 striations, 120
 structure, 364–5
 twinning, 112
 X-ray tomography, Plate 19b
pyritohedron, 367
 from Peru, Plate 25d
pyrochlore, 343, 392
 pyroelectricity, 159
pyrolite, 555
pyrolusite, 377, 391
 dedritic growth, Plate 4b
 structure, 383
pyrophyllite, 429
 from Georgia, USA, Plate 30e
pyroxene, 439, 445
 composition, 441
 compositional variations, 443
 extinction angle, 212
 optical orientation, 211
 optical properties, 209
 solid solution, 32
 structure, 438
pyroxenoids, 444
 tetrahedral chains, 445
pyroxferroite, 547
pyroxmangite, structure, 445
pyrrhotite, 367
 from Kosovo, 367
 Q–A–P ternary diagram for granitic rocks, 312
quartz, 307, **Plate 2a**
 ametrine, sector zoning, 221, **Plate 7c**
 Arkansas, 308
 Brazil twin, 113
 color centers, 221
 colors, 50, 217
 common forms, 102
 Dauphiné twins, TEM image, 301
 dislocation networks, 255
 giant crystal, 124
 growth in druse, 121
 growth spirals, 122
 habits, Alps, 268
 IR spectrum, 244
 morphology, 300
 with metamorphic grade, 268
 optical activity, 202
 piezoelectricity, 160
 postage stamp, **Plate 7b**
 quendel growth, **Plate 6b**
 skeletal growth, **Plate 3f**
 smokey, **Plate 2b**
 solubility, 263
 striations, 120
 structure, 300
 α and β , 33, 301
 synthetic crystals, 515
 Tessin habit, 120
 thermal expansion, 156
 thin section analysis, 202
 twinning, 113, 299
quartz prism, interference colors, **Plate 10b**
quartzite, without and with compensator,
Plate 10c–e
 quasicrystals, 116
 radiation defects, 116
 radiation produces color centers, 222
 radioactive decay, 116
 radioactive isotopes, 116
 radioactivity, 54
 radiolaria, 309, 358
 radiometric dating, 240
 radius ratio, 24, 26
 two-dimensional, 27
 Raman experiment, schematic, 241
 Raman spectroscopy, 240, 241, 506
ramsdellite, structure, 383
 Rayleigh scattering, 240
 reactions for metamorphic grade, 416

- realgar, 367**
 - from Alps, Plate 26f
 - from Hunan, China, Plate 26e
 - structure, 365
- reciprocal lattice, 139**
- reconstructive phase transition, 34
- recrystallization, 265
- redox reactions, 279
- reflected light microscopy, 166, 189
- refraction, 169
- refractive index, 168
 - of some compounds, 168
- Regent diamond, 505
- regional metamorphism, 410
- relief, high, positive, negative, 191
- remediation of environmental damage, 534
- replacement processes, 264
- reserves for mineral commodities, 499
- reserves of metal ores, 498
- reserves versus abundance, 499
- retrograde reactions, 411
- Rhine graben, 334
- rhodochrosite, 341, 343**
 - from Argentina, Plate 24e
 - from Colorado, Plate 24f
- rhodonite, 450**
 - structure, 445
- rhombohedral carbonates, 336
- richterite, 529**
- riebeckite, 450, 529**
 - pleochroism, Plate 11
- Rietveld method, 234
- right-handed coordinate system, 67
- ring silicates, 409
 - diagnostic properties, 400
- ringwoodite, 391, 555**
 - stability, 286
- rock salt, 327
- rock-forming minerals, 46
- rocks, important minerals, 553
- Roman cement, 519
- romanechite, 394**
 - structure, 383
- Röntgen, C.W., 133
- rose quartz, 50, 307**
 - from Brazil, Plate 20c
- Rosenbusch, 6
- rotation, 63, 91
- rotation axes, derivation, 67
- rotoinversion axis, 104–5
- rubellite, 409**
- ruby, 50, 387, 509, Plate 1f**
 - absorption spectrum, 220
 - boule, Plate 32d
- color, 217
- rutile, 392**
 - acicular, Alps, Plate 28b
 - epitaxial growth on hematite, Plate 3e
 - inclusions in corundum (star sapphire), 224
 - intergrowth, Alps, Plate 28c
 - on goethite pseudomorphs, Alps, Plate 28a
 - structure, 383
- S waves, 551**
- Sahara rose, 126**
- salammoniac, 326**
- salts of organic acids, 474
- sanidine, 301, 309**
 - high, inclined dispersion, Plate 12h
 - low, horizontal dispersion, Plate 12i
- sanidinite facies, 415
- saponite, SEM image, 433**
- sapphire, 50, 387, 509, Plate 1g**
 - color, 217
 - in cabochon cut, Plate 32a
- saprolite zone, 433
- scalars, 150
- scanning electron microscope (SEM), 230
 - schematic view, 232
- scapolite, 468**
 - structure, 462
- scattering amplitudes, X-rays and neutrons, 237
- scattering factor, 147
 - and diffraction angle, 148
- scheelite, 356**
 - fluorescence, Plate 18f,g
 - from Czech Republic, 356
- schiller color, 311
- Schmid's law, 253
- Schoenflies symbols, 91
- schorl, 409**
- Schottky defects, 109
- schreibersite**
 - in interplanetary dust, 537
 - in meteorites, 541
- Schrödinger equation, 13
- screw axis, 104–5
- screw dislocation, 110, 122
- seafloor spreading, 554
- Searles Lake, 333
- second law of thermodynamics, 270
- sedimentary basins, 489
- sedimentary carbonates, 344
- Seeber, L. A., lattice, 62
- seismic anisotropy Hawaii, 159
- seismic waves, 551
- seismology, 158
- sepiolite, structure, 423**

- sericite**, 369, 429, Plate 7e,f
- serpentine**, 426, 529
 - structure, 419–20
- shales, 431
 - SEM image, 232
- shape of minerals, 49
- sheet silicates, 418
 - diagnostic properties, 427
 - polytypism, 423, 424
 - stacking, 421
- SHRIMP, 240
- siderite**, 341
- siderophyllite**, 429
 - silica in radiolaria and diatoms, 357
 - silica minerals, 295
 - diagnostic properties, 296
 - silica poisoning, 309
- silicates
 - general comments, 396
 - ionic substitutions, 397
 - melt, structure, 264
 - structural classification, 397
 - tetrahedral linkage, 398
- silicon ingot grown from melt, Plate 32e
- silicon tetrahedra in sheet silicates, 419
- silicon tetrahedron, orbitals, 396
- silicosis, 535
- sillimanite**, 408
 - in thin section, Plate 17a,b
 - optical orientation, 214
 - optical properties, 215
- silver**, 322
 - dedritic, from Saxony, 321
 - deposits, 497
 - from Freiberg, Plate 22a
 - SiO₄⁴⁻ tetrahedron, 297
 - sizes of ions, 25
 - Skaergaard, 489
 - skarns, 370
 - skeletal growth, 122
 - skutterudite**, structure, 365
 - slip direction, 108, 252
 - slip planes, 108, 252
 - slip systems in crystals, 253
 - smectite**, structure, 426
 - smithsonite**, 342
 - smoky quartz**, 50, 308
 - from Alps, Plate 20a, Plate 20b
 - Snell's law, 169
 - examples, 170
 - snow, 123
 - snowball garnet, 125
 - snowflakes, 123
- sodalite**, 469
 - structural cages, 464
- soil profile, 434
 - in Gatt region, India, 435
- soil taxonomy, 434
- soils, 431
 - as food supplement, 529
 - typical minerals, 433
- solar nebula, 537, 542
 - condensation, 559
- solid solution, 31
 - cubic metals, 32
 - diagrams, 40
 - melting, 286
 - with a tendency for exsolution, 289
- solid systems, 264
- solidus, 284, 286
- space-group symmetry, 106
- space-groups (230), 102
- spacings between lattice planes, 142
- specific gravity, 54, 152
- specific heat, 154
- spectroscope, 506
- spectroscopic methods, 238
- sperrylite**, 322
- sphalerite**, 367
 - formula, 37
 - from Alps, Plate 25f
 - from Kazakhstan, 367
 - structure, 364
- sphene**, 408
 - spherical aberration, 171
 - spherical projection, 83
 - spherical representations, 81
- spinel**, 387
 - split sphere diamond growth apparatus, 516
- spodosols, 434
- spodumene**, 449
 - giant crystal, 124
- stable isotope distribution, 240
- stacking, 438
 - stacking fault, 109, 110
- staining of carbonates, 340
- stalactites, 343
- stalagmites, 343
- standard potentials, 280
- star sapphire, 223
- Stassfurt evaporites, 330
- state of aggregation, 49
- staurolite**, 408
 - high-resolution TEM image, 231
 - in thin section, Plate 17e,f
 - TEM, crystal structure, 231

- twinning, from Kola, Russia, 408
- twinning, 112
- steel, 322
- steel and ferrous metals, 491
- Steno, N., 5
- Steno angles in quartz, 61
- stereographic projection, 84, 84
 - constructions, 86
- stibnite, 368**
 - from Romania, Plate 27a
 - structure, 365
- stilbite, 469**
- Stillwater, Montana, 323, 489
- stilpnomelane, 430**
 - pleochroism, Plate 11
- stishovite, 297**
 - coordination, 384
- Stokes lines, 241
- strain ϵ , 251
- stratovolcano with porphyry stock, 372
- streak, 50
- stress ellipsoid, 156
- stress σ , 251
- stress-strain, 251
- striations, 119
- strontianite, 343**
- structure factor, 147
- struvite, 358**
- subduction and metal deposits, 488
- subduction metamorphism, 411
- subduction zones, 554
- subgrain boundaries due to climb, 256
- subhedral shape, 49
- sucrose, 10
- Sudbury, Canada, 323, 368
 - nickel contamination, 533
- sulfate attack, 522
- sulfates, 352
 - diagnostic properties, 354
- sulfide genesis, 368
- sulfide minerals, diagnostic properties, 362
- sulfide minerals, morphology, 367
- sulfides, 361
 - oxidation, 374
- sulfohalite, 333**
- sulfur, 319, 322, Plate 1a**
 - dendrites, Plate 19e
 - fumarole, Plate 19d
 - structure, 319
- sulfuric acid, 352
- Sun, 536
- supercritical state of water, 370
- supernova 1987A, 536
- supernova, compositions, 537
- supersaturation, growth of snow crystals, 123
- superstructures in Au–Cu, 35
- surface aqueous solutions, 262
- surface carbonates, 343
- swallow-tail twin in gypsum, 112
- sylvite, 327, 332**
- symmetry, 63
 - and property ellipsoid, 153
- classes, 92
- in art, 64
- in nature, 66
- in space-group, 106
- of second-rank property tensors, 154
- synchrotron X-ray diffraction experiment, 141
- synchrotron X-rays, 234
- synthesis of crystals, 512
- table salt, 327, 526
- taenite (fcc), 322, 541**
- talc, 429**
 - structure, 420
- Talnakh, Russia, 323
- tantalite, 392**
- tarnish, 54
- taste, 54
- TEM, ray diagrams, 230
- temperature–pressure conditions, 411
- tenantite, 368**
- tensors, 149, 151
 - different ranks, 152
 - properties, 154
 - representation, 152
- ternary diagram, 40
 - $\text{CaSiO}_3\text{--MgSiO}_3\text{--Al}_2\text{SiO}_5$, 415
 - granitic rocks, liquidus, 313
- ternary system diopside–albite–anorthite, 451
- ternary system forsterite–anorthite–silica, 453
- terrestrial planets, 546
- terrestrial plates, composition, 547
- tetraferroplatinum, 322**
- tetrahedral framework, 462
- tetrahedral layer, 418
- tetrahedral polymerization, 437
- tetrahedrite, 368**
 - from Germany, Plate 26a
- thenardite, 332–3**
- Theophrastus, 4
- thermal conductivity, 150, 154
- thermal expansion, 154
- thermal properties of some minerals, 156
- thermal vibration, 146
- thermodynamic notations, 273
- thermodynamic potentials, 272
- thermodynamics, 270

- thermofluid, 370
 thin sections, 169, *190*
 thin section analysis, general procedure, 204
***Thiobacillus*, 375**
 third law of thermodynamics, 270
 tiger-eye, 223
 tin deposits, 497
***tincalconite*, 333**
***titanite*, 408**
 from Swiss Alps, Plate 30a
 titanium deposits, 496
***tobermorite*, 522**
***todorokite*, 394**
 tomography, 233
 tooth enamel, 358
 SEM image, 359
 TEM image, 359
***topaz*, 407**
 from Pakistan, Plate 29b
 gem, 510
***torbernite*, 352**
 from Germany, Plate 25c
***tourmaline*, 409**
 from California, Plate 30d
 gem, 510
 growth sectors, Plate 7d
 morphology, Plate 4c,d
 pyroelectricity, *161*
 with hematite from Swiss Alps, Plate 30c
***tranquillityite*, 547**
 transformations, 264
 transition zone, 286, 555
 in mantle, 286
 translation, 63, 91, 102
 transmission electron microscope, 531
 ray path, 228
 transmission electron microscopy (TEM), 226
 transmitted light microscopy, 166, 189
 transverse (S) waves, *158*
 trapiche, 223
 trapiche emerald from Muzo, Plate 32c
***tremolite*, 449, 529**
 in dolomite, 449
 structure, *443*
***trevorite*, in interplanetary dust, 537**
 triangles CaO–MgO–SiO₂, 457
 triangular CO₃²⁻ group, *337*
***tridymite*, structure, 298**
 trioctahedral unit, 419
***triphylite*–olivine structure, 350**
 tritium, 13
troilite
 in chondrites, 539
 in meteorites, 541
***trona*, 333, 337**
Tschermak pyroxene, 442
 tungstates, 352
 diagnostic properties, 353
 tungsten deposits, 495
 tungsten ore, 356
 tunnel structures, 383
***turquoise*, 352, Plate 1d**
 twin axis, 111
 twin laws in minerals, 114
 twin plane, 111
 twinning, 111
 as growth defect, *111*
 typomorphic minerals, 267
***ulexite*, 333**
 ultra-high-pressure growth, 514
 ultramafic plutonic rocks, *451*
 ULVZ, 556
 uniaxial indicatrix, *185*
 unit cell, 18, 62
 constraints, 64
 conventions, 70
 upper mantle, 554
 upwelling, 554
***uraninite*, 393**
 from Germany, 393
***uranium micas*, 352**
***urea*, 477**
 from Saudi Arabia, SEM image, 476
 structure, 476
 urinary and gall stones, 527
 vacancy, *109*
 van der Waals bonding, 22, 319
 Van 't Hoff, J. H., 330
***vanadinite*–apatite structure, 350**
 vanadium deposits, 491
 vector, 150
 vector representation, *150*
***vermiculite*, 430**
 Verneuil furnace, *512*
 vertisols, 435
***vesuvianite*, 407**
 vibrational modes for CO₂, *241*
 Vickers hardness, 52
 visualizations of crystal structures (3D), 20
 Voigt representation, 157
 volcanogenic massive sulfide deposit, 373
***wadsleyite*, 555**
 stability, 285
 water, isotopes, 263
 waves and diffraction, 136

Index**621**

- weathering, 431
and rainfall, 432
Weiss indices m , n , o , 73
wenkite, 398
Werner, A. G., 5, 42, 481
White Pine shale, 374
whitlockite, 526
Widmanstätten pattern, 322, 541
Williston Basin, 334
winchite, 529
witherite, 343
Witwatersrand, 489, 497
wolframite, 355
wollastonite, 450
structure, 445
work-hardening, 252
world map of tectonic units, 486
world production metals, 485
Wulff net, 85
wüstite, in interplanetary dust, 537

XANES, 242
xenotime, zircon structure, 350
X-ray absorption spectroscopy, 242
X-ray absorption, schematic, 245
X-ray crystallography, early history, 134
X-ray diffraction, 531
photograph, first, 135

X-ray fluorescence (XRF), 238
X-ray fluorescence spectrometer, schematic,
238
X-ray tomography, 233
geometry, 233
X-ray tube, 134
X-rays, 6, 133

yellow dwarf, 537

Zechstein Basin, 334
zeolite facies, 415
zeolites, 462, 469
channel structures, 470
economic importance, 471
sorptive properties, 470
structural principles, 464
zinc deposits, 497
zinnwaldite, 429
from Czech Republic, 430
zircon, 407
analyzed with SHRIMP, 240
from Kola, Russia, Plate 29d
structure, 403
zone axis, 73
indices $[u\ v\ w]$, 73
zone indices, 74
zoning, 126