

Index

- Accretion, lunar
 - geochemical constraints, 4
- Age, lunar, 120-123
- Ages, exposure
 - see* exposure ages
- Agglutinates, 41, 71, 169, 230, 236, 237
 - 241, 248, 249, 252, 261-269
 - chemistry, 263-267
 - and darkening of crater rays, 169
 - defined, 261, 263
 - grain size, 230, 267-269, 272, 274
 - origin, 263, 264, 269,
 - shape, 263
- Agglutination dominated stage
 - of soil development, 280
- Alpes Formation, 182
- Al/Si orbital data, 144, 219, 220, 260
 - and mare-highlands boundary, 238, 240
- Altimetry, laser, 119, 120, 135
- Ancient meteoritic component
 - characteristics, 37
- Annular mountains, 145
- Antidunes
 - see* base surge, antidunes
- Apennine Bench
 - Formation, 142-144
- Apennine Front, 47, 48, 207, 208, 257, 260, 261
- Apennine Mountains, 123, 128, 184, 198
- Apenninian Series, 209
- Apollo 11, 42, 181, 245, 251, 271
- Apollo 12, 24, 42, 163, 181, 231, 232, 260
 - 262, 263, 270, 271
- Apollo 14, 136, 137, 140, 181, 182, 184, 185, 186, 241, 243, 245, 246, 251, 257, 258, 259, 260, 261, 272
- Apollo 15, 47, 48, 50, 56, 119, 147, 153, 164, 170, 181, 184, 198, 208, 231, 233, 234, 237, 245, 246, 255, 257, 258, 259, 260, 273, 278
- Apollo 16, 119, 136, 142, 143, 144, 181, 209, 210, 211, 212, 213, 214, 221, 232, 255, 256, 266, 268, 272, 278
- Apollo 17, 56, 58, 119, 136, 170, 171, 181, 255, 256, 260
- Archimedes, 142
- Ariel satellites, 23
- Aristarchus Plateau, 153, 172
- Asteroids, 22, 23, 25, 26, 40
- Asthenosphere, earth's, 7
- Asthenosphere, lunar
 - see* lower mantle
- Authigenic overgrowths
 - on plagioclase grains, 195, 215
 - on pyroxene grains, 196
- Autolycus, 261
- Ballistic ejecta
 - see* ejecta, ballistic
- Basalt, Fra Mauro
 - see* Fra Mauro basalts
- Basalts, continental
 - and mare basalts, 147
- Basalts, Mare, 4, 7
 - ages, 128, 160-164
 - classification of, 166-167
 - clasts in Fra Mauro Formation, 186-188
 - composition of, 164-168
 - and degree of partial melting, 7
 - depth of source, 5
 - distribution of, 148
 - flow fronts, 147, 149
 - in Hadley Rille, 51, 52
 - major element composition, 168
 - modal mineralogy, 164
 - olivine in, 165-166
 - origin of, 166
 - plagioclase in, 164-165
 - pyroxene in, 164
 - seismic velocity, 3
 - and soils, 258-260
 - stratigraphy of, 147-167
 - and terrestrial analogues, 147
 - texture of, 166-167

- young flows of 147-148, 150
- Base surge, 88, 95-114
 - and antidunes, 103, 104, 105, 106, 107, 110, 142, 144, 145, 208
 - and Cayley Formation, 219
 - definition, 95-96
 - distance of travel, 97, 106
 - evolution of gas by hot particles, 98, 99
 - fluidization of, 99, 100-101, 219, 232
 - and the Fra Mauro Formation, 141-142
 - and the Hevelius Formation, 144, 145
 - lubrication by gas, 98, 99, 100, 106, 233
 - and lunar soil, 232-233, 271
 - morphology, 96-101
 - and nuclear explosions, 95-96
 - and soil breccias, 242-244
 - sorting of detrital materials in, 101-102, 271
 - supercritical flow in, 103, 104, 142, 144, 203, 208
 - velocity of, 97, 142, 208
- Base surge sediments, 106-112
 - grain size of, 107-109, 204-205
 - sedimentary structures in, 104, 107, 109-112, 184, 232
- Binary Planet Hypothesis
 - of lunar origin, 11, 15
- Booming sand, 53, 54
- Boulder trails, 45, 47, 50
- Breccias, crystalline
 - Apollo 16,
 - see* Cayley Formation
 - classification of, 184-186, 209-214
 - clasts in soil, 239, 241
 - Fra Mauro, 39, 140, 181-209, 239
 - lenses beneath craters, 79
 - metamorphism in, 140
 - partial melting in, 220-222
 - thermal metamorphism in, 140, 193-201, 212, 218, 219
 - vugs in, 198
- Breccias, soil
 - and base surge, 242
 - clasts in soil, 241-248
 - density, 241
 - grain size of, 245-246
 - lapilli in, 242, 243
 - layering in, 242
 - maturity of, 244-245, 246, 247
 - origin, 241, 242-244
 - porosity, 241
 - roundness of grains, 246-248
 - sintering of, 242, 244
- Bulk ejecta
 - see* ejecta, bulk
- Capture Hypothesis
 - of lunar origin, 11, 14
- Carpathian Mountains, 128
- Cataclysm,
 - lunar, 40, 129, 134
- Cavalerius Formation, 172
- Cayley Formation, 137, 141, 142-144, 181
 - classification of lithologies, 209-214
 - contribution to soils, 239
 - definition, 209
 - distribution of, 143
 - lithic clasts in, 215-218
 - lithology of, 209-218
 - matrix of, 214-215
 - metamorphism of, 212, 218, 219
 - origin of, 218-220
 - petrology, 142, 144, 214-218
 - stratigraphy of, 142-144
- Cayley plains, 209
- Center of mass, lunar, 119
- Chalcophile elements
 - in lunar core, 9
 - in mare basalts, 9
 - as meteoritic index,
 - (*see* volatile elements)
- Chondrules, lunar, 187, 188
- Cinder cones, 56
- Comets, 21, 28, 39, 40
- Comminution by meteoroid impact, 81, 82-87, 244, 267, 277-281
- Compaction by meteoroid impact, 80, 82
- Composition, lunar, 3, 5
- Conductivity, lunar,
 - see* electrical conductivity
- Cone Crater, 181, 182, 183, 184, 204, 205, 245, 246, 272
- Copernican System, 124, 128, 129, 130, 168-173
- Copernicus, 40, 55, 123, 125, 126, 127, 128, 130, 168, 169, 182, 261, 270
 - age, 129
- Cordillera Mountains, 146
- Core, lunar, 8-9
- Cosmic rays, 267
- Crater counting ages, 25
- Crater shape, 31, 32, 70-79
 - macrocraters, 73-79
 - megacraters, 77-79

- microcraters, 71-73
- Cratering rates, 26
- Cratering, secondary, 90-92, 144
- Cratering mechanics, 66-79
 - compression stage, 66-68
 - excavation stage, 69-70
 - jetting, 67, 68, 69, 80, 90
 - modification stage, 70
 - terminal engulfment, 67
- Craters, lunar
 - impact origin of, 19, 65
 - volcanic origin of, 19, 65
- Craters, named lunar
 - Archimedes, 142
 - Aristillus, 261
 - Autolycus, 261
 - Cavalerius, 172
 - Cone, 181, 182, 183, 184, 204, 105, 245, 246, 272
 - Copernicus, 40, 55, 123, 125, 126, 127, 128, 130, 168, 169, 182, 261, 270
 - Dune, 246
 - Elbow, 245, 246
 - Eratosthenes, 124, 125, 126, 168, 182
 - Euler, 150
 - Fra Mauro, 139
 - Marius, 173
 - Mösting C, 106
 - North Ray, 210
 - Prinz, 153
 - Reinhold, 124
 - Shorty, 56
 - South Ray, 210
 - Tycho, 40, 82, 84
- Creep of lunar soil, 52-55
- Crust, lunar, 3-5, 7, 257
 - age of, 121-123
 - rate of formation, 121
 - stratigraphy of, 119-180
 - thickness, 3
 - upper 1 km, 3
- Crystallization
 - of mare basalts, 164-166
- Dark mantle, 56, 169-172, 182
- Deep drill cores,
 - Apollo 15, 231, 233, 234, 273, 274
 - Apollo 16, 232, 256, 268
 - Apollo 17, 256
- Descartes Mountains, 209
 - (see also Apollo 16)
- Differentiation, lunar, 9, 10
- Domes, 172, 173
- Doppelmayr Formation, 170, 172
- Eclogite, 7
- Ejecta
 - ballistic, 89-93, 101, 102
 - bulk, 88, 95
 - fall-back, 85, 147, 219
 - grain size of, 85-87
 - stratigraphy of, 93-95
 - thickness of, 114
 - velocity of, 89-91
- Electrical conductivity
 - in lunar interior, 7
- Electrostatic transport
 - of lunar soil, 19, 43, 59
- Emerald green glass, 257, 258
 - origin of, 56, 57, 170, 258
- Energy
 - meteoritic, 24, 41-42, 79-114
 - solar, 19, 42-45, 59
- Equilibrium soils, lunar, 281
- Eratosthenes, 124, 125, 126, 168, 182
- Eratosthenian System, 124, 128, 129, 147, 168-173
- Escape velocity
 - of earth, 30, 31
 - of moon, 30, 31
 - of solar system, 30, 31
- Erosion rates, 53
- Euler, 150
- Evolution
 - of lunar soil, 277-281
- Explorer satellites, 23, 28
- Exposure ages, lunar
 - and agglutinates, 268, 275, 282
 - from track data, 267
- Facies, 124, 139
- Faults, 150, 160
- Fire fountain
 - origin for dark glass, 170-171
- Fission Hypothesis
 - of lunar origin, 11-14
- Fluidization
 - see base surge, fluidization of
- Folds, 160
- Formations, by name
 - Alpes, 182
 - Apennine Bench, 137
 - Cavalerius, 172
 - Cayley, 137, 141, 142-144, 147, 181, 239
 - Doppelmayr, 169, 170, 172
 - Fra Mauro, 39, 101, 128, 135, 137, 138-142, 144, 147, 163, 171,

- 181-209, 239, 246
- Harbinger, 172
- Hevelius, 144, 147
- Montes Rook, 146
- Reiner Gamma, 172
- Sulpicius Gallus, 169, 170, 171, 172
- Vallis Schroteri, 172
- Fractionation, 14, 15
- Fra Mauro basalts, 4, 5, 259, 260, 262, 270, 271
- Fra Mauro breccias,
 - see* Fra Mauro Formation
- Fra Mauro Crater, 139
- Fra Mauro Formation, 39, 101, 128, 135, 137, 138-142, 171
 - ancient basalt clasts in, 163, 187
 - base surge origin, 142, 198, 203, 204, 206, 208-209
 - and Cayley Formation, 214, 215
 - chondrules in, 187, 188
 - classification of lithologies, 184-186
 - composition of, 186-193
 - contribution to soils, 239
 - definition, 138, 181
 - distribution of, 181, 182
 - grading of, 204
 - grain size of, 140, 204-205
 - and Hevelius Formation, 144
 - hummocky facies, 139, 141
 - jointing in, 183
 - lithic clasts in, 186-191, 201-204
 - lithology of, 140, 181-209, 210, 261
 - matrix, 193-201
 - metamorphism of, 140, 193-201
 - mineralogy of, 186-193
 - and penecomtemporaneous erosion, 203, 205
 - roundness of detrital particles, 188, 190, 203, 205-206, 246
 - smooth facies, 139, 141
 - stratification in, 183-184
 - texture of, 201-206
 - thickness of, 140, 141, 181
 - vapor phase minerals, 198, 199, 200, 208
- Fra Mauro landing site, 40
- Froud numbers, 103
- Galaxy, 41, 283
- Gamma-ray orbital data, 1
 - and Cayley Formation, 144
- Gegenschein, 23
- Geochemical model
 - of lunar evolution, 3-9
- Glasses, lunar, 252-269
 - (*see also* agglutinates)
 - chemical composition, 257-261
 - color, 255-257
 - compositional groupings, 258, 259
 - emerald green, 56, 57, 170, 257, 258
 - and fire fountains, 170, 258
 - form, 253-255
 - impact origin, 253
 - orange, 56, 170-171, 258, 260
 - origin, 261
 - pyroclastic, 255, 256, 257, 258, 260
 - and parent composition, 257
 - refractive index, 255-257
 - spheres, 253-255, 256, 258
- Graded bedding
 - in lunar soil, 232
- Grain flow, 112-114, 232-233
- Granite, in highlands, 259, 261
- Gravitational energy, 45-55, 59
- Gravity, lunar, 122
 - anomalies, 123
 - and mascons, 7, 123
- Green glass
 - see* emerald green glass
- Hadley Rille, 47, 49, 50, 51, 147, 149, 153, 154, 156
- Harbinger Formation, 172
- Heat flow, lunar, 77
- Hevelius Formation, 144, 147
- Highlands breccias
 - see* breccias, crystalline
- Highlands, lunar
 - layering in, 183-184
 - rock types in, 261
- Horizontal glow, 43, 90
- Imbrian System, 47, 124, 125, 136, 137, 138-168, 171, 172
- Impact glasses
 - see* agglutinates
 - see* glasses
- Impact fusion, 24, 80-82, 83, 93, 221, 239, 244, 263, 266, 268, 269, 282
- Impact metamorphism, 133, 140, 193-201, 212, 218, 219
- Interior, lunar
 - internal structure of, 3-9
 - model compositions, 6
 - molten zones in, 7
 - zones of, 3-9
- Jetting
 - see* cratering mechanics
- Jupiter, 21, 22, 25

- Kant Plateau, 209
- Kilaton, definition, 97
- KREEP, 4, 5, 260, 262, 270
- Lampson scaling effects, 77
- Lava channels 150-151, 156, 158
- Lava flows, 158
 - in Mare Imbrium, 147, 149
 - and wrinkle ridges, 161
- Lava lake, 157
- Lava, mare
 - see mare basalts
- Lava tubes, 157, 158
- Lava viscosity, 151
- Layering
 - in highlands, 183-184
- Light plains material units, 138, 141, 142, 181
- Lineations
 - highlands, 45
- Lunar cataclysm
 - see cataclysm, lunar
- Lunar chondrules
 - see chondrules
- Lunar crust
 - see crust
- Lunar interior
 - see interior, lunar
- Lunar material unit
 - definition, 127
- Lunar Orbiter missions, 23
- Lunar soil,
 - see soil, lunar
- Lunar time stratigraphic units, 130
- Magnetic field, lunar
 - intensity, 10
 - origin, 10-11
- Magnetic properties
 - of breccias, 10-11
 - of soils, 10-11, 233
- Mantle, dark
 - see dark mantle
- Mantle
 - lower, 7
 - middle, 7
 - upper, 5
- Mare
 - Cognitum, 182
 - Crisium, 119
 - Fecunditatis, 163, 260
 - Humorum, 162, 169
 - Imbrium, 65, 77, 123, 125, 126, 135, 136, 137, 140, 141, 147, 149, 150, 160, 161, 162, 181, 182, 184, 187, 204, 207, 208, 259, 261
 - Nubium, 182
 - Oriente, 39, 82, 123, 135, 136, 144-147
 - Procellarum, 40, 119, 125, 160, 163, 173, 182
 - Serenitatis, 56, 125, 162, 163, 169, 170, 184, 204, 207, 208, 209, 259
 - Smythii, 119
 - Tranquillitatis, 40, 142, 163, 260
 - Vaporum, 169, 259
- Mare basalts
 - see basalts, mare
- Mare filling, 160-164
- Mare surface features, 151-160
- Marius Group, 172
- Marius Hills, 40, 163, 173
- Marius Hills Rille, 152, 156
- Mars, 25
- Mascons, lunar,
 - and source of mare basalts, 7, 123
 - theories of origin, 7
- Mass wasting, 45-55
- Material units, lunar
 - see lunar material units
- Maturity
 - of crystalline breccias, 206-208
 - of lunar soils, 170, 230, 248, 277, 281-283
 - of soil breccias, 244-245, 246, 247
- Melting, impact
 - see impact fusion
- Metamorphism, impact
 - see impact metamorphism
- Meteor Crater, Arizona, 93, 95, 184
- Meteoroid flux
 - history of, 39-41
 - on lunar surface, 19-41, 54
 - into earth's atmosphere, 28
- Meteoroids
 - composition, 33-35
 - density, 30-32
 - distribution in space, 20-22
 - shape, 32-33
 - velocity, 30, 42
- Meteoritic component
 - ancient, 36, 37
 - in highlands, 36
 - in soils, 33, 36, 42
 - in ocean sediments, 24, 33, 42
 - in polar ice, 24, 33

- Meteoritic energy, 41-42, 59
- Meteors
 photographic, 28, 29
 radio, 22, 24, 25, 28
 shower, 20, 21
 sporadic, 20, 21, 39
- Microcraters, 35
 size, 71
 morphology, 31, 71-73
 on rock surface, 24, 31
- Micrometeoroids
 composition, 33-35
 density, 30-32
 shape, 32-33
- Mixing models
see soils, lunar
- Moment of Inertia
 lunar, 9
- Montes Rook Formation, 146
- Moonquakes
 and the Mantle, 7
 periodicity, 53
 thermal, 53, 54
- Mount Hadley, 48
- Oceanus Procellarum, 3, 40, 119, 160
- Olivine, 7, 8
 in Cayley Formation, 214-218
 in Fra Mauro Formation, 191-197
 in mare basalts, 165-166
 in soils, 249-251
- Orange glass
 age, 171
 composition, 171
 origin, 56, 170-171
 and Sulpicius Gallus Formation, 171
- Orbital Al/Si ratios,
 and Cayley Formation, 144, 219, 220
 and highlands composition, 260
 and lunar soil composition, 238
- Orbital gamma-ray data,
 and Cayley Formation, 144, 219
- Oriente Basin,
 age of, 147
 stratigraphy, 144-147
- Origin, lunar,
 binary planet hypothesis, 11, 15
 capture hypothesis, 11, 14
 fission hypothesis, 11-14
 precipitation hypothesis, 11, 14-15
 sediment ring hypothesis, 11, 15
- Palus Putredinus, 259
- Partial melting,
 in agglutinates, 266-267
 in breccias, 220-222
 and highland petrogenesis, 262
 origin for Fra Mauro basalts, 5
- Patterned ground, 45
- Pegasus missions, 23, 28
- Pioneer missions, 21, 23, 28
- Plagioclase
 in Cayley Formation, 214-218
 in Fra Mauro Formation, 186-198
 in highland lithologies, 5
 in mare basalts, 164-175
 in soils, 249, 250
 in soil breccias, 246
- Plains forming units
 relation to ringed basins, 209, 219
- Planetesimals, 15, 33, 35-38, 39
- Plato II, 156
- Precipitation Hypothesis
 of lunar origin, 11, 14-15
- Pre-Imbrian, stratigraphy, 124, 128, 135-138,
 140, 163, 209, 260
- Prinz Rilles, 152, 156
- Procellarian System, 124, 128
- Pyroclastic materials,
 lunar, 55-56, 57, 59, 170-172, 227, 255,
 256, 257, 258
- Pyroxenes
 in Cayley Formation, 214-218
 in Fra Mauro Formation, 191-198
 in soils, 249
 in soil breccias, 246
 in mare basalts, 164
- Pyroxenite, 7, 258
- Rays, lunar crater, 70, 168, 169
- Regolith, lunar,
see Soil, lunar
- Reiner Gamma Formation, 172
- Rima
see Rilles
- Rille, Hadley
see Hadley Rille
- Rilles, 49, 50, 151-158, 163
 arcuate, 151-152, 161
 sinuous, 151, 152-158, 172, 173
 straight, 151-152, 161
- Ringed basins, lunar,
 ages, 129-135
 ancient, 129, 135
 ejecta thickness, 114
 impacts and mare basalts, 162-163
 origin, 65-66

- relation to Cayley Formation, 218-220
- Roche's limit, 15
- Root-mean-square velocity of meteoroids, 30, 31, 268
- Rook Mountains, 146
- Scaled depth-of-burst, 77
- Schroeters Valley, 155, 156
- Secondary cratering, 144, 219, 220
- Sediment Ring hypothesis
 - of lunar origin, 11, 15
- Sediment flux, lunar, 283
- Seismicity
 - lunar, 7
- Seismic properties
 - regolith, 3, 229
- Seismic signals
 - lunar, 25, 29, 53
 - velocity, 7, 79
- Seismometers,
 - lunar, 25
- Selenopetal structure,
 - in lunar soil, 235-236
- Shock waves and cratering, 67, 69
- Shorty Crater
 - and orange glass, 56
- Siderophile elements
 - depletion in moon, 38
 - in mare basalts, 14
 - as meteoritic index, 33
 - in lunar soils, 34, 36, 37
- Silver Spur, 184
- Sinuuous Rilles
 - see* Rilles, sinuous
- Sinus Aestuum, 169
- Slumping of crater walls, 45
- Soil, lunar
 - ages of 173-174, 229
 - agglutinates in, *see* agglutinates
 - chemical composition of, 237-238, 240
 - and crater morphology, 76, 77, 227, 228
 - cycling of, 275, 276, 280-281
 - and deep drill cores, 231
 - definition, 227
 - density, 236-237
 - evolution of, 277-281
 - exotic component, 238
 - graded beds in, 232
 - grain size, 271-275
 - interclastic soil chip breccias, 235
 - layers in, 227, 231-236
 - local component, 239
 - magnetic properties, 233
 - maturity of, 170, 230, 248, 277, 281-283
 - metallic particles in, 252
 - meteoritic component, 36, 37
 - mixing models, 269-271
 - petrography of, 238-269
 - pyroclastic component, 170-171, 227
 - rate of accumulation, 76, 77, 227-231, 272
 - rate of turnover, 236
 - reworking of, 235, 236, 276, 277, 280-281
 - seismic properties, 3, 229
 - selenopetal structures, 235-236
 - shape of particles, 233, 234, 275-277, 278
 - stratigraphy of, 231-236
 - stratigraphic inversions in, 233, 235
 - thickness, 76, 77, 227-231, 281
- Solar energy, 19, 42-45, 59
- Solar nebula
 - and lunar origin, 11, 12, 13
- Solar wind,
 - sputtering, 44-45
- South Imbrium basin, 163
- Spallation and microcraters, 71
- Stratigraphy, lunar, 123-126
 - of soil, 231-236
 - units defined, 127-129
- Steady state soils, lunar, 281
- Sulfur,
 - in lunar core, 8-9
- Sulpicius Gallus Formation, 169, 170, 171, 172
- Surveyor spacecraft, 24, 43
- Talus slopes, lunar, 50-52
- Taurus-Littrow site,
 - see* Apollo 17
- Terminal engulfment, 67
- Thermal erosion, 43-44
- Thermal moonquakes, 44
- Tides, lunar, 12, 15
- Time-stratigraphic units, lunar
 - see* lunar time stratigraphic units
- Tobias Meyer, 156
- Topography, lunar 119, 120
- Troctolite, 215, 218, 262
- Tycho, 40, 82, 84
- Upper mantle, 5-7
- Vallis Schröteri Formation, 172
- Vapor phase transfer
 - see* Fra Mauro Formation
- Volatile elements,

- in highland rocks, 5
 - in lunar soils, 34, 36
 - in mare basalts, 8
 - and meteoritic contribution, 33, 37
 - in planetesimals, 38
- Volcanism, lunar, 19, 55-56
- Vugs
- in breccias, 198
 - crystals in, 198
- Winnowing of lunar soil, 50
- Wrinkle ridges, 151, 152, 158-160, 161, 173
- in Mare Humorum, 162
- XRF orbital data, 1, 144, 219, 220, 238, 260
- Zodiacal cloud, 22, 23