

**MANUAL FOR
WARD'S COLLECTION
OF
CLASSIC NORTH AMERICAN ROCKS
45 E 7217**

Ward's is indebted to Dr. E. William Heinrich, Professor of Mineralogy, The University of Michigan, for the classification of the rocks in the new collection, for the descriptions of Thin Sections and for editorial assistance in the preparation of the manual that accompanies the collection.

Since the geology of the region in which the rock is found and other relevant data in the literature may be of considerable interest, brief references to pertinent literature is provided for each rock. A bibliography of petrologic literature is also provided.

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WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

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Ward's Collection of Classic North American Rocks

A. Igneous Rocks

I. Granite - Rhyolite Family

Intrusive

- | | |
|-------------------------------|------------------------|
| 1. Biotite Granite | Barre, Vermont |
| 2. Muscovite-biotite granite | Concord, New Hampshire |
| 3. Biotite hornblende granite | St. Cloud, Minnesota |
| 4. Alkalic granite | Quincy, Massachusetts |
| 5. Aplite | Boulder, Colorado |
| 6. Quartz Monzonite Porphyry | Garfield, Colorado |
| 7. Granodiorite | St. Cloud, Minnesota |

Extrusive

- | | |
|-----------------------|---------------------------|
| 8. Obsidian | Lake County, Oregon |
| 9. Pumice | Beaver County, Utah |
| 10. Rhyolite Tuff | Frying Pan Basin, Montana |
| 11. Rhyolite | Castle Rock, Colorado |
| 12. Rhyolite Porphyry | Chaffee County, Colorado |

II. Syenite - Trachyte Family

Intrusive

- | | |
|-----------------------------------|-------------------------|
| 13. Corundum Syenite | Craigmont, Ontario |
| 14. Alkalic Syenite | Cripple Creek, Colorado |
| 15. Trachyte Porphyry (bostonite) | Essex County, New York |

Extrusive

- | | |
|-----------------------|-------------------------|
| 16. Trachyte Porphyry | Cripple Creek, Colorado |
|-----------------------|-------------------------|

III. Foidal Syenite - Phonolite Family

Intrusive

- | | |
|--------------------------|----------------------------|
| 17. Nepheline syenite | Bancroft, Ontario |
| 18. Malignite | Park County, Montana |
| 19. Ijolite | McClure Mountain, Colorado |
| 20. Siderite carbonatite | Iron Hill, Colorado |

Extrusive

- | | |
|---------------|-------------------------|
| 21. Phonolite | Cripple Creek, Colorado |
|---------------|-------------------------|

IV. Monzonite - Latite Family

Intrusive

- | | |
|----------------------|------------------------|
| 22. Quartz Monzonite | Westerly, Rhode Island |
|----------------------|------------------------|

Extrusive

- | | |
|---------------------|---------------------|
| 23. Latite Porphyry | Wolf Creek, Montana |
|---------------------|---------------------|

V. Diorite - Andesite Family

Intrusive

- 24. Tonalite (quartz diorite)
- 25. Diorite
- 26. Andesite Porphyry

San Diego County, California
Los Angeles County, California
Maricopa County, Arizona

Extrusive

- 27. Dacite
- 28. Hornblende andesite

N.W. of Helena, Montana
Mineral County, Nevada

VI. Gabbro - Basalt Family

Intrusive

- 29. Hornblende gabbro
- 30. Norite
- 31. Gabbro
- 32. Hornblende gabbro
- 33. Anorthosite

San Diego County, California
Wollaston Township, Ontario
Duluth, Minnesota
Salem, Massachusetts
Elizabethtown, New York

Extrusive

- 34. Diabase
- 35. Scoria
- 36. Amygdaloidal basalt
- 37. Basalt
- 38. Olivine basalt Porphyry

Jersey City, New York
Klamath Falls, Oregon
Keweenaw County, Michigan
Chimney Rock, New Jersey
Valmont, Colorado

VII. Lamprophyre

- 39. Lamprophyre

Spanish Peaks, Colorado

VIII. Peridotite - Pyroxenite Family

- 40. Pyroxenite (Harzburgite)
- 41. Dunite (olivine peridotite)
- 42. Dunite (olivine peridotite)
- 43. Serpentine

Stillwater Complex, Montana
Balsam, North Carolina
Twin Sisters Range, Washington
San Bernadino County, California

B. Sedimentary Rocks

I. Sandstones and Related Rocks

- | | |
|----------------------------|--------------------------|
| 44. Quartz conglomerate | Fremont County, Colorado |
| 45. Gray sandstone | Berea, Ohio |
| 46. Red sandstone | Potsdam, New York |
| 47. Argillaceous sandstone | Portageville, New York |
| 48. White sandstone | Riverton, West Virginia |
| 49. Siltstone | Near Newhall, California |
| 50. Arkose | Mt. Tom, Massachusetts |
| 51. Graywacke | Grafton, New York |

II. Shales and Related Rocks

- | | |
|------------------------|---------------------------|
| 52. Argillaceous shale | East Bethany, New York |
| 53. Carbonaceous shale | St. Clair, Pennsylvania |
| 54. Oil shale | Garfield County, Colorado |
| 55. Bauxite | Bauxite, Arkansas |

III. Chalcedonic and Related Rocks

- | | |
|------------------------|-----------------------------|
| 56. Chert | Joplin, Missouri |
| 57. Siliceous oolite | State College, Pennsylvania |
| 58. Diatomaceous earth | Lompoc, California |

IV. Limestone and Related Rocks

- | | |
|-------------------------|-------------------------------|
| 59. Encrinal limestone | Lockport, New York |
| 60. Algal dolomite | Huntsville, Ohio |
| 61. Cherty limestone | LeRoy, New York |
| 62. Oolitic limestone | Bedford, Indiana |
| 63. Chalk | Oktibbeha County, Mississippi |
| 64. Calcareous tufa | Mumford, New York |
| 65. Dolomitic limestone | Rochester, New York |

V. Miscellaneous Sedimentary Rocks

- | | |
|------------------------|-----------------------------|
| 66. Dolomitic breccia | Rockingham County, Virginia |
| 67. Hematite limestone | Wayne County, New York |
| 68. Siderite rock | Negaunee, Michigan |
| 69. Rock gypsum | Fremont County, Colorado |
| 70. Rock anhydrite | Hants County, Nova Scotia |

C. Metamorphic Rocks

I. Sandstones and Related Rocks

- | | |
|------------------------------------|---------------------------------|
| 71. Gray hornfels | Lambertsville, New Jersey |
| 72. Marble (Pink) | Tate, Georgia |
| 73. Dolomite marble | Essex County, New Jersey |
| 74. Verde antique | Rochester, Vermont |
| 75. Garnet-wollastonite skarn | Willsboro, New York |
| 76. Quartzite | Baraboo, Wisconsin |
| 77. Slate (gray) | Bangor, Pennsylvania |
| 78. Phyllite | Ely, Orange County, Vermont |
| 79. Mica schist | Manhattan, New York |
| 80. Chlorite schist | Chester, Vermont |
| 81. Stilpnomelane schist | Mendocino County, California |
| 82. Talc-tremolite schist | St. Lawrence County, New York |
| 83. Graphite schist | Warren County, New York |
| 84. Migmatite | Gouverneur, New York |
| 85. Staurolite quartzite | Petaca, New Mexico |
| 86. Kyanite quartzite | Near Ogilby, California |
| 87. Sillimanite-granet skarn | Warren County, New York |
| 88. Cordierite anthophyllite skarn | Guffey, Colorado |
| 89. Augen gneiss | St. Lawrence County, New York |
| 90. Granitoid gneiss | Salisbury, North Carolina |
| 91. Biotite gneiss | Uxbridge, Massachusetts |
| 92. Anthracite coal | Hazleton, Pennsylvania |
| 93. Metaconglomerate | Boulder County, Colorado |
| 94. Cummingtonite schist | Leeds, South Dakota |
| 95. Hornblende schist | Mitchell County, North Carolina |
| 96. White Marble | West Bridgewater, Vermont |
| 97. Hornblende gneiss | Clintonville, New York |
| 98. Epidosite | Texas Creek, Colorado |
| 99. Jaspilite | Negaunee, Michigan |
| 100. Grunerite-magnetite rock | Michigamme, Michigan |

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 1

NAME: Biotite Granite

LOCALITY: Barre, Washington County, Vermont

GEOLOGIC AGE: Devonian

GEOLOGIC NAME: Woodbury Granite

REFERENCE: Dale, T. N. The granites of Vermont: U.S. Geol. Survey Bull. 404, pp. 11, 13-14, 24, 93-105, 1909.

Chayes, F., Composition of some New England granites, Trans. N.Y. Acad. Sci. Ser. 2 Vol. 12 (5), 144-151, 1950.

MEGASCOPIIC DESCRIPTION: A gray, medium-grained rock consisting of feldspar, quartz, biotite, and muscovite.

MICROSCOPIC DESCRIPTION: Predominantly subhedral-granular with euhedral sodic plagioclase whereas quartz and potash feldspar are anhedral. The quartz shows marked undulatory extinction and internal mosaic structure. The zoned plagioclase has slightly sericitized cores. Potash feldspar is mainly orthoclase, some of which has transformed to microcline. The gridiron twinning is fine, patchy and irregularly distributed or may be entirely absent. Biotite, in part chloritized and showing slight muscovitization has conspicuous pleochroic haloes around included zircon grains. Also included are tiny apatite crystals. Magnetite and minor sphene are the other accessories along with a trace of interstitial micropegmatite. In addition to some sericite, a small amount of secondary epidote is present.

In some specimens plagioclase exceeds orthoclase and this variety of rock should be classed as a granodiorite.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 2

NAME: Muscovite-Biotite Granite

LOCALITY: Concord, Merrimack County, New Hampshire

GEOLOGIC AGE: Late Paleozoic

REFERENCE: Dale, T.N., The chief commercial granites of Massachusetts, New Hampshire, and Rhode Island U.S. Geol. Survey Bull. 534, pp. 145-156, 1908.

MEGASCOPIC DESCRIPTION: A light-colored medium-grained rock composed of feldspar, quartz, muscovite and biotite.

MICROSCOPIC DESCRIPTION: A two-mica granite with highly undulatory quartz, microcline and subordinate sodic plagioclase. Quartz grains also display mosaic structure, slight granulation and contain abundant minute rutile needles. The zoned oligoclase grains are subhedral to euhedral, are smaller than the other constituents, and slightly sericitized.

Microcline invariably shows Carlsbad twinning combined with coarse gridiron twinning that may be absent locally in some individuals indicating an almost complete orthoclase-microcline transformation. Examples of all stages of the biotite-muscovite transformation appear, with biotite containing minor interleaved muscovite through muscovite with minute biotite remnants to muscovite plates in which the by-product hematite outlines the cleavage planes. Some of the biotite that remained has been chloritized. Zircon usually centering pleochroic halos in biotite, apatite and magnetite are accessory minerals.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 3

NAME: Biotite-Hornblende Granite

LOCALITY: St. Cloud, Stearns County, Minnesota

GEOLOGIC AGE: Post-Archean (Probably Keweenawan)

GEOLOGIC NAME: "Rockville" Granite

REFERENCE: Thiel, G.A. and Dutton, C.E., The architectural, structural, and monumental stones of Minnesota. Minnesota Geol. Surv. Bull. 25, pp. 65-69. 1935.

MEGASCOPIIC DESCRIPTION: A very coarse-grained granite with large pale pink feldspar crystals that provide the porphyritic character. Small gray feldspar, quartz, biotite and hornblende are readily recognized.

MICROSCOPIC DESCRIPTION: The rock is distinguished by a heterogranular, anhedral to subhedral texture. The largest individuals are subhedral microclines, with small inclusions of plagioclase crystals. Blebs of quartz and what appear to be two generations of perthitic inclusions; a) thin lamellar, cleavage oriented, and b) ramifying veinlets, fracture controlled. The smaller oligoclase crystals are zoned, subhedral to euhedral and locally show sericitized and rarely epidotized parts, particularly their centers. Quartz units are anhedral and show slight undulatory extinction and well-defined "bubble-train" vacuole inclusions. The anhedral biotite includes numerous small apatite crystals, zircon crystals with pleochroic haloes and magnetite grains. Some of it replaces green hornblende, which is anhedral and somewhat less abundant than the biotite.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 4

NAME: Alkalic Granite

LOCALITY: Quincy, Norfolk County, Massachusetts

GEOLOGIC AGE: Carboniferous (probably Mississippian)

GEOLOGIC NAME: Quincy Granite

REFERENCE: Warren, C. H., Petrology of the alkali granites and porphyries of Quincy and the Blue Hills, Mass. Am. Acad. Arts Sci. Proc., Vol. 49, No. 5, pp. 203-331, 1913.

MEGASCOPIC DESCRIPTION: A dark gray granular rock consisting of feldspar, quartz, black amphiboles, and pyroxenes.

MICROSCOPIC DESCRIPTION: The mafics appear in clustered groups tending to be interstitial to the potash feldspar. The somewhat undulatory quartz is anhedral. The potash feldspar is a high albitized microcline perthite in turbid crystals that also are twinned via the Carlsbad law. A few small anhedral albite crystals are interstitial to the composite K-Na feldspar crystals. The original mafic mineral, bright green, slightly zoned aegirine, has been in large part replaced by sodic amphibole, an intensely pleochroic (inky blue to deep brown) riebeckite and a second sodic amphibole, pleochroic in shades of brown. Minute riebeckite needles also are disseminated in feldspars and along fractures across feldspars. Magnetite and brownish, partly metamict zircon which is closely associated with aegirine are the main accessories. Anhedral colorless to pale purple fluorite also is present.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 5

NAME: Aplite

LOCALITY: Boulder County, Colorado

GEOLOGIC AGE: Precambrian

GEOLOGIC NAME: Silver Plume aplite

REFERENCE: Lovering, T. S. and E. N. Goddard, Geology and Ore deposits of the Front Range, Colorado. U.S. Geol. Surv. Prof. Paper 223, p. 29, 1950.

MEGASCOPIC DESCRIPTION: A fine-grained pink rock composed of quartz, glassy feldspar and biotite. Some of the hand specimens have irregular, more coarsely grained stringers and patches.

MICROSCOPIC DESCRIPTION: A rather uniformly grained rock of low mafic mineral content. Undulose quartz, coarsely twinned microcline and sodic plagioclase are essential minerals. The plagioclase grains have narrow, fresh, more sodic rims and turbid and slightly sericitized central parts. Biotite has been largely transformed to muscovite and secondary hematite, and biotite relict from this reaction has been, in part, chloritized. Accessory species are magnetite, apatite, and zircon. Conspicuous secondary hematite-limonite is present along grain boundaries, some feldspar cleavages and in a few thin fracture-fillings that cut the rock.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 6

NAME: Quartz Monzonite Porphyry

LOCALITY: Garfield, Chaffee County, Colorado

GEOLOGIC AGE: Tertiary

GEOLOGIC NAME:

REFERENCE: Crawford, R. D. Geology and ore deposits of the Tomichi Districts, Colorado; Colorado Geol. Survey Bull., No. 4, pp. 80, 84, 155, 159, 170, & 182, 1913.

Dings, M. G. and C. S. Robinson. Geology and ore deposits of the Garfield Quadrangle, Colorado, U.S. Geol. Surv. Prof. Paper 289, 1957.

MEGASCOPIIC DESCRIPTION: A gray porphyritic rock. Phenocrysts of pink feldspar may be an inch long. Small phenocrysts of white feldspar, quartz, hornblende and mica are in a granular groundmass.

MICROSCOPIC DESCRIPTION: The three essential felsic species occur in two sizes. The larger plagioclases are euhedral and zoned and are phenocrysts, in places glomerporphritic. A few large subhedral kaolinized orthoclase grains are present as are large quartz anhedral. These are set in a poorly defined groundmass of variable grained quartz, orthoclase, plagioclase, biotite and hornblende. Of these the mafics are subhedral, the plagioclase is euhedral, the others anhedral. Hornblende, more strongly altered than biotite, is variably colored in pale green, bluish green and buff. It is replaced by chlorite and epidote. Accessories are magnetite, apatite, sphene and zircon.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 7

NAME: Granodiorite

LOCALITY: St. Cloud, Stearns County, Minnesota

GEOLOGIC AGE: Precambrian

GEOLOGIC NAME:

REFERENCE: Thiel, G. A., and Dutton, C. E. The architectural, structural, and monumental stones of Minnesota; Minnesota Geol. Survey Bull. No. 25, pp. 64, 86. 1933.

MEGASCOPIC DESCRIPTION: A medium granular, gray rock, composed of plagioclase, pink potash feldspar, biotite, hornblende and quartz.

MICROSCOPIC DESCRIPTION: Of the essential species only plagioclase is euhedral. The mafics are subhedral and tend to be clustered. The quartz is undulatory. The plagioclase is strongly and complexly zoned with some thin zones selectively sericitized. The subordinate potash feldspar is microcline perthite. Biotite has the accessories, apatite, zircon and magnetite closely associated. The pale green hornblende contains scattered remnants of augite. Coarse sphene is relatively abundant with some grains showing color zoning in shades of orange. Rounded highly altered brown grains may represent completely metamictized allanite.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 8

NAME: Obsidian

LOCALITY: Lake County, Oregon

GEOLOGIC AGE: Tertiary (Miocene)

GEOLOGIC NAME: Glass Buttes Series

REFERENCE: Waters, Aaron, A structural and petrographic study of the Glass Buttes, Lake County, Oregon: Jour. Geology, Vol. 35, pp. 441-452, 1927.

MEGASCOPIIC DESCRIPTION: A jet black glass with conchoidal fracture. Thin edges may show parallel flow bands.

MICROSCOPIC DESCRIPTION: A clear vitreous rock with abundant rod-like crystallites — (longulites and trichites) which are most likely pyroxene. Flow structure is apparent under low magnification. Faint polarization effects are visible over much of the material, which is evidently largely cryptocrystalline, and under high magnification two phases of different refractive index can be distinguished, one probably a potash feldspar (sanidine?); the other a SiO₂ species.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 9

NAME: Pumice

LOCALITY: Beaver County, Utah

GEOLOGIC AGE:

GEOLOGIC NAME:

REFERENCE:

MACROSCOPIC DESCRIPTION: white to grayish orange, very fine grained, vesicular, low density, fibrous glass.

MICROSCOPIC DESCRIPTION:

Plane light: short fibers of glass around vesicles (holes).

X-polars: glass extinct; minor plagioclase, low relief, medium birefringence, some twinned; zircon, high relief; pyroxene, euhedral, prismatic, with approx. 90 degree cleavage, brown.

Pumice is an aggregation of fibrous volcanic glass that rapidly cools trapping air bubbles. The fibers may be cryptocrystalline, glass, or alter to very-fine clay minerals.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 10

NAME: Rhyolite Tuff

LOCALITY: Frying Pan Basin, Beaverhead County, Montana

GEOLOGIC AGE: Early Tertiary

GEOLOGIC NAME:

**REFERENCE: Winchell, A. N. Mining districts of the Dillon quadrangle,
Montana and adjacent areas, U.S. Geol. Survey, Bull. 574,
pp. 43-45, 1914.**

**MEGASCOPIC DESCRIPTION: A medium brown rock with scattered phenocrysts
of glassy quartz and feldspar in a felsitic groundmass with scattered vesicles.**

**MICROSCOPIC DESCRIPTION: A light colored uniformly textured rock consisting
of 70-80% glass shards, a small percentage of which show marginal devitrification. In
this matrix also occur minute angular fragments of quartz and fragments and tablets
of sanidine. Large broken crystals, crystal pieces and some euhedra of sanidine are
scattered through this groundmass. A rare crystal of hornblende appears in some
sections.**



WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 11

NAME: Rhyolite

LOCALITY: Castle Rock, Douglas County, Colorado

GEOLOGIC AGE: Tertiary (Eocene)

GEOLOGIC NAME:

REFERENCE: Richardson, G. B., Description of the Castle Rock
Quadrangle, Colorado: U.S. Geol. Survey, Geol. Atlas,
Castle Rock folio (no. 198), 1915.

MEGASCOPIC DESCRIPTION: A pinkish rock with scattered phenocrysts of glassy quartz in a felsitic and somewhat vesicular groundmass.

MICROSCOPIC DESCRIPTION: The texture is pyroclastic. The larger particles include euhedral, sanidine tablets, biotite euhedra, subhedral to euhedral sodic plagioclase laths, a few magnetite crystals, and angular quartz pieces. These are set in a brownish matrix consisting of devitrified shards and cryptocrystalline dust.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 12

NAME: Rhyolite Porphyry

LOCALITY: Chaffee County, Colorado

GEOLOGIC AGE: Tertiary

GEOLOGIC NAME:

REFERENCE: Cross, C. W., On the occurrence of topaz and garnet in lithophyses of rhyolite: Am. Jour. Sci., 3rd Ser., Vol. 31, pp. 432-8, 1886.

MEGASCOPIC DESCRIPTION: A gray, porphyritic rock, locally vesicular, with prominent phenocrysts of smoky quartz averaging 5mm in width and subhedral to euhedral phenocrysts of glass feldspar averaging 4mm in length. Tiny garnet and topaz crystals occur in some vesicles.

MICROSCOPIC DESCRIPTION: Unaltered phenocrysts of sanidine (Carlsbad twinning), oligoclase, subordinate quartz (in places corroded) and minor biotite are set in a turbid fine-grained equigranular matrix of quartz potash feldspar, and specks of magnetite and hematite. The plagioclase phenocrysts tend to be agglomerated.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 13

NAME: Corundum Syenite

LOCALITY: Craigmont, Ontario, Canada

GEOLOGIC AGE:

GEOLOGIC NAME:

REFERENCE:

MACROSCOPIC DESCRIPTION: aggregate of coarse crystals: corundum, medium-gray, some hexagonal in cross-sections, orthoclase feldspar, pink; lusterous muscovite; and minor white plagioclase.

MICROSCOPIC DESCRIPTION:

Plane light: corundum, clear, high relief, with aligned black inclusions, rhombic partings at 90 degrees; orthoclase and plagioclase, clear, low relief, areas of alteration indicated by inclusions of sericite; muscovite, light, narrow crystals with high relief; opaque mineral.

X-polars: corundum, high relief, first order birefringence, rhombohedral partings, some zoned, aligned opaque inclusions of magnetite; orthoclase, low relief, first order birefringence, some with perthitic texture and mosaic extinction; plagioclase, low relief, twinned, first order birefringence; muscovite, high relief, mosaic extinction; magnetite (?), opaque; sericite, alteration mineral, small crystals, second order birefringence within larger crystals or fractures.

Syenites are quartz-poor sialic igneous rocks dominated by orthoclase and plagioclase, and in this case corundum, in the form of emery – Al_2O_3 with minor magnetite. This rock has been altered, where the corundum and feldspars have been sericitized, resulting in hazy crystals.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 14

NAME: Alkalic Syenite

LOCALITY: Golden Cycle Mine, near Victor, Teller Cty., Colorado

GEOLOGIC AGE: Post-Oligocene

GEOLOGIC NAME:

REFERENCE: Lindgren, Waldemar, and Ransome, F. L., Geology and gold deposits of the Cripple Creek District, Colorado: U.S. Geol. Survey Prof. Paper 54, p. 45, 1906.

MEGASCOPIC DESCRIPTION: A gray, medium-grained rock spotted with black prismatic crystals.

MICROSCOPIC DESCRIPTION: Strongly developed flow texture from the subparallel orientation of slender feldspar laths: clear sodic orthoclase (Carlsbad twinning) and turbid sodic plagioclase (fine albite twinning). A few blocky nepheline grains, and scarce anhedral of sodalite (isotropic) also appear. Pale green augite with narrow bright green (aegirinitic) rims is the main mafic, forming euhedra of varying size with good orientation of the larger crystals. They are in part replaced by brown biotite and include numerous magnetite grains. The other accessories are abundant anhedral sphene and apatite crystals.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 15

NAME: Trachyte porphyry (Bostonite)

LOCALITY: Near Essex, Essex County, New York

GEOLOGIC AGE: Post-Ordovician

GEOLOGIC NAME:

REFERENCE: Buddington, A. F. and Whitcomb, L., Geology of the
Willsboro Quadrangle, New York, N.Y.S. Museum Bull.
No. 325, p. 78-80, 1941.

Kemp, J. F. and Marsters, V. F., the trap dikes in the Lake
Champlain Region, U.S. Geol. Bull. 107: pp. 11-62, 1893.

MEGASCOPIC DESCRIPTION: A reddish-brown, felsitic rock with small feldspar phenocrysts.

MICROSCOPIC DESCRIPTION: Prominent phenocrysts are blocky to subrounded sodic orthoclase, turbid and zoned, some are glomeroporphyritic. The matrix consists predominantly of equigranular tablets of zoned hematitic orthoclase, euhedral and in subparallel (trachytoid) arrangement. A few original mafic grains (pyroxene?) now consist of sericite, calcite, hematite, magnetite, and sphene. Abundant accessory magnetite has been altered to hematite. Interstitial accessories are widespread: anhedral quartz, small zircon euhedra, sericite flakes and grains of calcite. Veinlets of hematite cut the rock.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 16

NAME: Trachyte prophyry

LOCALITY: Near Cripple Creek, Teller County, Colorado

GEOLOGIC AGE: Tertiary (Post-Oligocene)

GEOLOGIC NAME:

REFERENCE: Lindgren, Waldemar and Ransome, F. L., Geology and gold deposits of the Cripple Creek District, Colorado. U.S. Geol. Surv., Prof. Paper 54, p. 77, 1906.

MEGASCOPIC DESCRIPTION: A very fine grained, porphyritic rock, light gray in color.

MICROSCOPIC DESCRIPTION: The rock contains numerous large phenocrysts of feldspar, most of which are strongly kaolinized potash feldspar (probably sanidine originally); others consist of oligoclase, moderately altered to sericite and some epidote. Still others are agglomerated composites of oligoclase and potash feldspar. The mafic phenocrysts (most of which probably were a dark slightly sodic amphibole initially) have been largely converted to a pseudomorphous aggregate of pale green pyroxene, epidote, calcite and chlorite.

The fine grained matrix is an equigranular aggregate of sodic plagioclase, orthoclase and minor quartz dotted with minute crystals of apatite, sphene, pyroxene, pyrite and replaced by irregular aggregates of coarse calcite.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 17

NAME: Nepheline syenite

LOCALITY: Bancroft, Ontario

GEOLOGIC AGE: Precambrian

GEOLOGIC NAME: Grenville

REFERENCE: Allen, J.B., and Charsley, T.J. (1968), Nepheline syenite and phonolite, National Environment & Research Council, Geol. Soc. of Great Britain. pp. 64-75.
Hewitt, D.F. (1960), Nepheline syenite deposits of southern Ontario, Chap. 3, Ont. Dept. of Mines vol. 69, pt. 8.

MEGASCOPIC DESCRIPTION: A fine to medium grained leucocratic rock composed of nepheline and albite with variable amounts of magnetite, biotite, and amphibole. Some specimens show foliation.

MICROSCOPIC DESCRIPTION: Chiefly composed of granular to anhedral aggregates of albite, nepheline and subordinate mafics: biotite and hastingsite. The nepheline is completely anhedral and is readily differentiated from the other felsic species by its lack of twinning, its slightly turbid aspect, its irregular fracture pattern and its alteration to sericite. The albite is subhedral-tabular. Some sections show slightly curved twin lamellae and minor gradation zoning. Biotite, pleochroic from olive green to very dark green, forms scattered subhedral tablets. The less abundant sodic amphibole is very dark green in color and anhedral in form. Accessories can include relatively abundant coarse anhedral interstitial calcite, which is primary, and minor cancrinite, microcline, and sodalite.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 18

NAME: Malignite

LOCALITY: Crazy Mountains, Park County, Montana

GEOLOGIC AGE: Paleocene

GEOLOGIC NAME: Comb Creek Lacolith

REFERENCE: Wolff, J. E., 1938, Igneous rocks of the Crazy Mountains, Montana, G.S.A. Bulletin, vol. 49, p. 1569-1626.

Larsen, L. H. and F. E. S. Simms, 1972, Igneous geology of the Crazy Mountains, Montana - A report of work in progress, Montana Geological Society, 21st. Annual Field Conference, p. 135-139.

MEGASCOPIIC DESCRIPTION: A dark gray mesocratic medium-grained porphyritic rock with abundant long acmite phenocrysts that show a weak preferred orientation. Other phenocrysts include a few biotite plates, rare olivine anhedral, and an occasional zeolite segregation.

MICROSCOPIC DESCRIPTION: Nearly half of the rock is composed of euhedral to subhedral elongated pale brownish-yellow acmite prisms. Simple and lamellar twinning and zoning is present in some crystals, and grains exhibit a somewhat preferred orientation. Low birefringence nepheline and sanidine make up the other essential minerals. Grains are mostly subhedral and commonly intergrown. Nepheline shows a hexagonal outline in some crystals and lacks the cleavage and tabular form of the sanidine. A few percent of pleochroic amber biotite plates are present, in some cases euhedral and zoned. A percent or two of tiny euhedral magnetite makes up the opaques. Occasional large accessory forsterite anhedral are rimmed with biotite. An occasional zeolite segregation may be present.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 19

NAME: Ijolite

LOCALITY: McClure Mts., Colorado

GEOLOGIC AGE: Late Precambrian

GEOLOGIC NAME:

REFERENCE: Parker, R. L. and F. A. Hildebrand, Preliminary report on alkalic intrusive rocks in the northern Wet Mountains, Colorado, U.S. Geol. Surv. Prof. Paper 450-E, pp. E8-10, 1963.

Henirich, E. Wm. and D. H. Dahlem, Carbonatites and alkalic rocks of the Arkansas River area, Fremont County, Colorado, Mineral Soc, India, IMA vol. pp. 37-44, 1966.

MEGASCOPIC DESCRIPTION: A dark gray medium grained rock.

MICROSCOPIC DESCRIPTION: A coarse-grained rock with essential aegirine, biotite and nepheline and accessory orthoclase, sphene (some very large anhedral) and apatite. Some of the biotite replaces aegirine. A dusty red-brown clay (?) mineral has formed as an alteration of the potash feldspar.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 20

NAME: Siderite carbonatite

LOCALITY: Iron Hill, Gunnison County, Colorado

GEOLOGIC AGE: Pre-Jurassic

GEOLOGIC NAME:

REFERENCE: Temple, A. K. and R. M. Grogan, Carbonatite and related alkalic rocks at Powderhorn, Colorado, Econ. Geol. 60, 672-692, 1968.

Heinrich, E. Wm., The Geology of Carbonatites, Rand-McNally & Co., pp. 342-352, 1966.

MEGASCOPIC DESCRIPTION: A dark brown crystalline carbonate rock.

MICROSCOPIC DESCRIPTION: The carbonate is variably-grained; the coarser is apparently the older and the very fine-grained the younger. Some of the coarser is siderite and shows hematite films along cleavages. Associated with fine-grained carbonate (calcite) is chalcedonic quartz. Accessories are barite, pyrite, pyrochlore, chlorite, fluorite and turbid aggregates of a submicroscopic species that may be a rare-earth carbonate.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 21

NAME: Phonolite

LOCALITY: Beacon Hill, Cripple Creek, Teller Cty., Colorado

GEOLOGIC AGE: Tertiary (Post-Oligocene)

GEOLOGIC NAME:

REFERENCE: Lindgren, Waldemar, and Ransome, F. L., Geology and gold deposits of the Cripple Creek Dist., Colo. U.S. Geol. Survey Prof. Paper 54, pp. 57-67, 1906.

MEGASCOPIC DESCRIPTION: The hand specimen is a light gray, earthy-looking rock.

MICROSCOPIC DESCRIPTION: The few phenocrysts are tablets of anorthoclase ("Moire-type" extinction). The trachytic-textured matrix consists of parallel thin orthoclase crystals, stubby nepheline euhedra and aegirine microlites in plumose clusters. Accessories are magnetite, pyrite and analcime.



WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 22

NAME: Quartz Monzonite

LOCALITY: Westerly, Rhode Island

GEOLOGIC AGE:

GEOLOGIC NAME:

REFERENCE:

MACROSCOPIC DESCRIPTION: light pinkish gray, intergrown medium crystals.

MICROSCOPIC DESCRIPTION:

Plane light: quartz, clear, low relief; plagioclase and some orthoclase, "hazy," low relief; biotite, greenish-brown pleochroic; magnetite/hematite, black, opaque.

X-polars: quartz, low relief, mottled extinction, low birefringence, with very fine acicular inclusions of apatite; plagioclase, low relief, Carlsbad twins, altered; orthoclase, low relief, complex extinction with cores altered to sericite; monazite, small, euhedral, high relief.

This is a medium crystalline igneous rock composed primarily of quartz with sodium and potassium feldspars; accessory minerals include apatite, biotite, magnetite, and monazite.

~~WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS~~

NO. 22

NAME: Monzonite

LOCALITY: Near Silverton, San Juan County, Colorado

GEOLOGIC AGE: Tertiary (Miocene)

GEOLOGIC NAME:

REFERENCE: Cross, C. W. and Howe, Ernest. Description of the Silverton
Quadrangle; U.S. Geol. Survey, Geol. Atlas, Silverton folio
(No. 120), 1905.

MEGASCOPIC DESCRIPTION: A purplish-gray rock consisting chiefly of plagioclase, orthoclase and greenish hornblende with small amounts of quartz.

MICROSCOPIC DESCRIPTION: Heterogranular texture with a few large cloudy orthoclase crystals with poikilitic plagioclase and mafic inclusions. Some potash feldspar has rims of granophyre which also forms interstitial patches. Dominant plagioclase ranges in size considerably and shows gradational zoning. Augite is partly or wholly uralitized to very weakly pleochroic green hornblende. Biotite is in part chloritized. Coarse granular magnetite is common; apatite and zircon are rare.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 23

NAME: Latite porphyry

LOCALITY: Wolf Creek, Lewis and Clark Co., Montana

GEOLOGIC AGE: Upper Cretaceous

GEOLOGIC NAME: Two Medicine Formation

REFERENCE: Viele, G. W. and Harris, F. G., III, 1965, Montana Group stratigraphy, Lewis and Clark County, Montana, A.A.P.G. Bulletin, vol. 49, p. 379-417.

Lyons, J. B., 1944, Igneous rocks of the northern Big Belt Range, Montana, G. S. A. Bull. vol. 55, p. 445-472.

MEGASCOPIC DESCRIPTION: A massive medium gray mesocratic porphyry with phenocrysts of plagioclase and pyroxene.

MICROSCOPIC DESCRIPTION: The abundant euhedral to subhedral labradorite phenocrysts show characteristic albite twinning and some incipient alteration. Augite phenocrysts are less common and are typically altered to biotite and or chlorite. Small magnetite and pyrite grains comprise roughly one percent. The groundmass is a granular intergrowth of plagioclase (andesine and labradorite), sanidine, augite, biotite, and tiny cubes of magnetite.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 24

NAME: Tonalite

LOCALITY: San Diego County, California

GEOLOGIC AGE: Upper Cretaceous

GEOLOGIC NAME: Bonsall Tonalite

REFERENCE: Larsen, E. S. Jr., Batholith and associated rocks of Corona, Elsmore and San Luis Rey Quadrangles, Southern California, Geol. Soc. Am. Mem. 29, 1948.

MEGASCOPIC DESCRIPTION: A medium-grained gray rock with quartz, biotite and light gray plagioclase.

MICROSCOPIC DESCRIPTION: The sodic plagioclase and hornblende are subhedral. The other essential species, quartz and biotite, are anhedral. Some of the basal sections of hornblende show twinning. Biotite is partly chloritized. Coarse anhedral epidote and orthoclase, magnetite, apatite and allanite are accessories. Plagioclase is slightly zoned; quartz is undulatory in extinction.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 25

NAME: Diorite

LOCALITY: Near Azusa, Los Angeles County, California

GEOLOGIC AGE: Cretaceous (?)

GEOLOGIC NAME:

REFERENCE:

MEGASCOPIC DESCRIPTION: A dark gray medium grained somewhat gneissoid rock consisting of black hornblende, glassy plagioclase, with occasional yellow brown grains of sphene.

MICROSCOPIC DESCRIPTION: Green hornblende, the dominant species contributes to a moderately well-developed gneissoid foliation in subparallel subhedra, partly replaced by biotite, in both anhedral patches and euhedral tablets. The medium plagioclase in anhedral, slightly zoned gradationally and locally has central parts sericitized. Large sphene euhedra form a conspicuous accessory. Others are epidote, rare allanite, apatite and magnetite.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 26

NAME: Andesite Porphyry

LOCALITY: Maricopa County, Arizona

GEOLOGIC AGE:

GEOLOGIC AGE:

REFERENCE:

MACROSCOPIC DESCRIPTION: pale red groundmass with medium-coarse clear and white euhedral phenocrysts.

MICROSCOPIC DESCRIPRION:

Plane light: groundmass reddish brown, consisting of inclusion-rich quartz and opaque (magnetite?); phenocrysts of pyroxene clear to very pale yellow, square in cross-section; plagioclase, clear and gray due to alteration, prismatic or in clumps; magnetite, black.

X-polars: pyroxene, sharp extinction, second order birefringence, edges corroded; plagioclase, low birefringence, twinned, some zoned, mottled gray due to alteration; feldspar, bladed crystals, altered to sericite; magnetite, euhedral, black.

This is a volcanic rock where the pyroxenes were essentially unstable in the melt, in which they started to dissolve before lithification in a glassy groundmass of small quartz, feldspars, and opaques that is undergoing alteration. The plagioclase reflects changes in melt chemistry evident in the zoning, and later alteration to clay minerals.

WARD'S COLLECITON OF CLASSIC NORTH AMERICAN ROCKS

NO. ~~26~~ 27

NAME: Dacite

LOCALITY: Northwest of Helena, Montana

GEOLOGIC AGE: Late Cretaceous

GEOLOGIC NAME:

REFERENCE: Knopf, Adolph. Geology of the northern part of the Boulder Batholith and adjacent area, Montana: U.S. Geol. Survey Misc. Geol. Investigations Map 1-381. 1963.
Knopf, Adolph. Ore deposits of the Helena mining region, Montana: U.S. Geol. Survey Bull. 527. 1913.
Pardee, J. T. and Schrader, F. C. Metalliferous deposits of the greater Helena mining region, Montana. U.S. Geol. Survey Bull. 842, 1933.

MEGASCOPIIC DESCRIPTION: A gray porphyritic rock with phenocrysts of gray plagioclase and peppered with small to medium size black hornblende crystals in a fine-grained matrix.

MICROSCOPIC DESCRIPTION: A markedly porphyritic rock with a uniformly fine-grained holocrystalline matrix. The phenocrysts are chiefly strongly zoned intermediate plagioclase and a few subrounded, partly resorbed grains of sanidine. The microphenocrysts are brown biotite and green hornblende, the latter showing minor marginal resorbtion rims. The matrix consists chiefly of a very fine-grained quartz-feldspar intergrowth and scattered patches of wispy biotite.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. ~~27~~ 28

NAME: Hornblende Andesite

LOCALITY: Mineral County, Nevada

GEOLOGIC AGE: Triassic

GEOLOGIC NAME: Excelsior formation

REFERENCE: Muller, S.W. and Ferguson, H.G. (1936), G.S.A. Bull. v. 47:241-252

MEGASCOPIC DESCRIPTION: Medium to fine-grained gray andesite with vitreous black amphibole phenocrysts.

MICROSCOPIC DESCRIPTION: Abundant oscillatory-zoned plagioclase with glomeroporphyritic amphibole set in a fine-grained, plagioclase-rich groundmass. Amphiboles show dark reaction rims. Minor amounts of unaltered augite are present. Magnetite is an accessory. 2cx

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. ~~28~~ 29

NAME: Hornblende gabbro

LOCALITY: Escondido, San Diego County, California

GEOLOGIC AGE: Cretaceous

GEOLOGIC NAME: San Marcos gabbro

REFERENCE: Miller, F. S., Petrology of the San Marcos gabbro. Geol. Soc. Am., Bull. 48, pp. 1397-1426, 1937.

Miller, F. S. Hornblendes and primary structures of the San Marcos gabbro. Geol. Soc. Am., Bull. 49, pp. 1213-1232, 1938.

Larsen, E. S. Jr., Batholith and associated rocks of Corona, Elsinore and San Luis Rey Quadrangles, southern California. Geol. Soc. Am., Mem. 29, 1938.

MEGASCOPIIC DESCRIPTION: A dark gray medium-grained rock composed essentially of plagioclase and hornblende.

MICROSCOPIC DESCRIPTION: An equigranular rock consisting of subhedral labradorite tablets and somewhat subordinate mafics (augite, hornblende, magnetite in anhedral clustered grains). The plagioclase shows narrow marginal zoning. The augite is strongly uralitized by olive green hornblende. The opaques are an intergrowth of predominant granular magnetite and subordinate pyrite. Other accessories are biotite, apatite, and chlorite, the last replacing hornblende.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. ~~29~~ 30

NAME: Norite

LOCALITY: Wollaston Twp., Ontario, Canada

GEOLOGIC AGE: Precambrian

GEOLOGIC NAME: Umfraville Gabbro

REFERENCE: Hewitt, D. F., Wollaston Twp., Geological Report No. 11
Ontario Department of Mines. 1962.

MEGASCOPIC DESCRIPTION: A brownish-black, granular rock composed of hypersthene, plagioclase, garnet, and magnetite.

MICROSCOPIC DESCRIPTION: This is a mela-norite, somewhat deformed. The chief mineral, pinkish hypersthene, forms thick subhedra crowded with numerous and varied inclusions: dark elongate rods, thin brown platelets, clouds of minute, short, opaque, parallel rods, and opaque triangular to rectangular sections, probably of magnetite, zonally restricted. Most of these may result from exsolution. The orthopyroxene is slightly uralitized and marginally corroded by biotite. Interstitial calcic plagioclase shows bent twin lamellae, undulatory extinction and local granulation. Magnetite and pyrite are accessory.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. ~~30~~ 31

NAME: Gabbro

LOCALITY: Duluth, Minnesota

GEOLOGIC AGE: Precambrian

GEOLOGIC NAME: Duluth Gabbro complex

REFERENCE: Grout, F.F. (1918), A Type of Igneous Differentiation, J. Geol. v. 26:626-658.

Grout, F.F., Sharp, R.P., Schwartz, G.M. (1959), The Geology of Cook County, Minnesota, Minn. G.S. Bull. v. 39:1-163.

MEGASCOPIC DESCRIPTION: A medium-grained dark to medium-gray gabbro. Plagioclase cleavages are large and abundant.

MICROSCOPIC DESCRIPTION: The gabbro is dominantly subhedral to anhedral labradorite. Anhedral augite is present in the interstices of the plagioclase and is present as reaction rims (corona structure) on altered olivine. Olivine, which is not present in every section, is largely altered to iron-oxides, serpentine, or chlorite in addition to augite. The labradorite is saussuritized.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. ~~31~~ 32

NAME: Hornblende Gabbro

LOCALITY: Salem, Essex County, Massachusetts

GEOLOGIC AGE: Early Paleozoic

GEOLOGIC NAME: Salem Gabbro (Diorite)

REFERENCE: Clapp, C. H., Geology of the igneous rocks of Essex County, Massachusetts; U.S. Geol. Survey Bull. 704, pp. 21-23, 36-42, 1921.

MEGASCOPIC DESCRIPTION: A coarse-textured, dark-colored rock composed of plagioclase, hornblende and biotite.

MICROSCOPIC DESCRIPTION: The plagioclase subhedra are zoned with cores selectively sericitized. Much of the augite has been uralitized and the resulting green hornblende may be overgrown and partly replaced by biotite. Magnetite, apatite, orthoclase and quartz are common accessories. Pyrrhotite is rare. Chlorite replaces some of the mafic species.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. ~~32~~ 33

NAME: Anorthosite

LOCALITY: Near Elizabethtown, Essex County, New York

GEOLOGIC AGE: Precambrian

GEOLOGIC NAME: Adirondack anorthosite (Mt. Marcy type)

REFERENCE: Buddington, A. F., Adirondack igneous rocks and their metamorphism, Geol. Soc. Am. Mem. 7, 1939.

MEGASCOPIC DESCRIPTION: The hand specimen shows a nearly pure aggregate of plagioclase. Larger blue feldspar are conspicuous in a finer granulated, lighter-colored groundmass. Dark silicates are locally present.

MICROSCOPIC DESCRIPTION: The heterogranular calcic plagioclase contains scattered blebs of quartz and is slightly sericitized and veined by calcite stringers. The subordinate mafics consist of augite showing grating structure and considerable overgrowth — replacement by green hornblende. Some augite is replaced by very fine-grained talc and hornblende by chlorite. Magnetite and pyrite are accessories.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. ~~33~~ 34

NAME: Diabase

LOCALITY: Jersey City, Hudson County, New Jersey

GEOLOGIC AGE: Upper Triassic

GEOLOGIC NAME: Palisade diabase

REFERENCE: Walker, F. Differentiation of the Palisade diabase, New Jersey. Bull. Geol. Soc. Am., 51, pp. 1059-1106, 1940.

MEGASCOPIC DESCRIPTION: A medium grained dark gray rock consisting of plagioclase feldspar and pyroxene.

MICROSCOPIC DESCRIPTION: A uniformly grained aggregate of subhedral to chiefly euhedral labradorite laths and anhedral pyroxene in a classic diabasic texture. The augite is colorless with 2V moderately large, (+) and twinned. Some individuals show combinations of twinning and fine (001) lamellae of second exsolved pyroxene phase ("herringbone" structure). Minor biotite replaces pyroxene marginally. Abundant anhedral magnetite and thin plates of ilmenite are accessories. Tiny apatite needles are abundant and chlorite forms small interstitial patches.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. ~~34~~ 35

NAME: Scoria

LOCALITY: Klamath Falls, Klamath County, Oregon

GEOLOGIC AGE: Pleistocene

GEOLOGIC NAME:

REFERENCE: Williams, Howell, The geology of Crater Lake National Park,
Oregon. Carnegie Inst. of Washington Pub. 540, pp. 68-98,
1942.

MEGASCOPIIC DESCRIPTION: A cellular lava that varies in color from reddish brown to brownish black. Tiny glassy crystals of feldspar can be seen with a lens in some specimens.

MICROSCOPIC DESCRIPTION: A highly vesicular rock with calcic plagioclase phenocrysts set abundantly and diversely in a brown hypohyaline matrix. The phenocrysts contain glass blebs, some crystallographically oriented. Compositional zoning is present, and in some a rim may be free of glass inclusions. The matrix contains plagioclase microlites (many also zoned), dark red-brown essentially opaque glass, with local patches of formless devitrified material.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. ~~35~~ 36

NAME: Amygdaloidal Basalt

LOCALITY: Mohawk Mine, Ahmeek, Keweenaw County, Michigan

GEOLOGIC AGE: Precambrian

GEOLOGIC NAME:

REFERENCE: Butler, B. S., Burbank, W. S., and others. The copper deposits of Michigan; U.S. Geol. Survey Prof. Paper 144, pp. 26-47. 1929.

MEGASCOPIC DESCRIPTION: A purplish, compact rock with innumerable amygdules of varying size filled largely with quartz, epidote, calcite, and chlorite.

MICROSCOPIC DESCRIPTION: This strongly altered rock consisted originally of calcic plagioclase, augite and dark glass. The feldspar and pyroxene have been chloritized. Small aggregates of subrounded grains, now altered to a hematite and a brownish cryptocrystalline species, were olivine. The amygdule fillings consist of epidote, quartz, chlorite, zeolites and minor calcite.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. ~~36~~ 37

NAME: Basalt

LOCALITY: Chimney Rock, Somerset County, New Jersey

GEOLOGIC AGE: Upper Triassic

GEOLOGIC NAME:

REFERENCE: Lewis, J. V. Petrography of the Newark igneous rocks of New Jersey; New Jersey Geol. Survey Ann. Report, pp. 148-167. 1907.

MEGASCOPIC DESCRIPTION: A greenish-black rock with aphanitic texture, and local red bands due to iron oxide stain.

MICROSCOPIC DESCRIPTION: Microphenocrysts of augite (some glomerophyritic) are set in a matrix of thin laths of labradorite, granular clinopyroxene and dark, essentially opaque glass which is subordinate and interstitial (interstitial texture). Some of the glass has been altered to a brown iron-rich chlorite; some of the plagioclase to sericite. Skeletal magnetite is a widespread accessory.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NÖ. ~~37~~ 38

NAME: Olivine Basalt Porphyry

LOCALITY: Valmont, Boulder County, Colorado

GEOLOGIC AGE: Eocene

GEOLOGIC NAME:

REFERENCE: Crawford, R. D. Notes on the intrusive rocks of Boulder County, Colorado; Colorado Geol. Survey, 1st. Rept., p. 31. 1909.

MEGASCOPIC DESCRIPTION: A black fine-grained, porphyritic rock with phenocrysts of augite and olivine in a fine crystalline groundmass.

MICROSCOPIC DESCRIPTION: Phenocrysts are pale green augite (slightly zoned), olivine (some partly altered to chlorite and iron oxide) and thin, subparallel calcic plagioclase laths. The matrix is a poorly oriented aggregate of small plagioclase laths, grains of augite, olivine and magnetite and accessory biotite and apatite.

~~WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS~~

~~NO. 38~~

NAME: Diabase porphyry

LOCALITY: Cape Ann, Essex County, Massachusetts

GEOLOGIC AGE: Triassic (?)

GEOLOGIC NAME:

REFERENCE: Dale, T. N., The commercial granites of New England. U.S. Geol. Survey Bull. 738, p. 303, 1923.

MEGASCOPIC DESCRIPTION: Porphyritic with blocky clusters of greenish-gray plagioclase phenocrysts in a matted dark green matrix.

MICROSCOPIC DESCRIPTION: Shows a glomeroporphyritic texture with various sized calcic plagioclase phenocrysts in cluster of three to six. These may show some fracturing and microfaulting, slight sericitization and inclusions of altered mafics. The matrix consists of corroded plagioclase laths and abundant grains and clusters of mafics: pyroxene, hornblende and biotite. The pyroxene has a small 2V and is either pigeonite or subcalcic augite. Much of it has been uralitized to blue-green-hornblende. Accessories are apatite, magnetite, quartz and orthoclase.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 39

NAME: Lamprophyre

LOCALITY: Spanish Peaks, Colorado

GEOLOGIC AGE: Post-Upper Cretaceous (Post Pierre)

GEOLOGIC NAME:

REFERENCE: Blum, V.J. The magnetic field over igneous pipes.
Geophysics 10, 368-375. 1945.

MEGASCOPIC DESCRIPTION: A dark gray uniformly fine-grained rock.

MICROSCOPIC DESCRIPTION: A very fine-grained equigranular rock with a felted fabric. Slightly larger olivine grains are partly rimmed and veined by magnetite. Subhedral grains of pale brownish-green clinopyroxene (titanian augite) may show "hour-glass" zoning. Abundant, strongly pleochroic biotite forms ragged interstitial plates. Slender laths of calcic plagioclase are interlocking. Granular magnetite is abundant; a few crystals of apatite are present.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 40

NAME: Pyroxenite (Harzburgite)

LOCALITY: Nye, Montana

GEOLOGIC AGE: Precambrian

GEOLOGIC NAME: Stillwater complex

REFERENCE: Hess, H. H. Stillwater igneous complex, Montana; Geol. Soc. Americana Memoir 80. 1960.

MEGASCOPIC DESCRIPTION: A dark greenish gray rock with a most commonly rough granular texture. It is largely composed of orthopyroxene (bronzite) and has a glassy appearance.

MICROSCOPIC DESCRIPTION: The rounded olivines are criss-crossed by thin brownish serpentine veinlets. Anhedral enstatite show fine grating exsolution structure. Interstitial anhedral calcic plagioclase and clumps of subrounded chromite grains are accessories. Small amounts of clinopyroxene may be present in some sections.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 41

NAME: Dunite (Olivine Peridotite)

LOCALITY: Near Balsam, Jackson County, North Carolina

GEOLOGIC AGE: Early Paleozoic (?)

GEOLOGIC NAME:

REFERENCE: Hunter, C. E. Forsterite olivine deposits of North Carolina and Georgia. N.C. Dept. Cons. & Devel. Bull. 41, 67-74, 1941.

Lesure, F. G. Mica deposits of the Blue Ridge in North Carolina. U.S. Geol. Survey, Prof. Paper 577, pp. 7-8, 1968.

MEGASCOPIC DESCRIPTION: A light green granular rock composed almost entirely of glassy olivine with small black grains of chromite and a few large flakes of pale mica.

MICROSCOPIC DESCRIPTION: A mosaically-textured aggregate of anhedral olivine. Chromite occurs in scattered subhedra. Accessories that appear in some sections are chlorite, phlogopite, brucite and a fibrous amphibole.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 42

NAME: Dunite [Olivine Peridotite]

LOCALITY: Twin Sisters, Washington

GEOLOGIC AGE:

GEOLOGIC NAME:

REFERENCE:

MACROSCOPIC DESCRIPTION: olivine, medium gray and greenish coarse crystals; ilmenite, fine black crystals

MICROSCOPIC DESCRIPTION:

Plane light: olivine, coarse clear to slightly yellowish crystals, euhedral prismatic opaque crystals

X-polars : olivine, high relief, fractured, second-third order birefringence, parallel banded extinction, and Boehm lamellae of very small bubbles; minor gray areas of alteration, isotropic, often associated with ilmenite crystals; ilmenite, euhedral, prismatic, opaque.

This is a coarse crystalline igneous rock of almost entirely olivine and an iron-rich accessory – ilmenite - that is slightly altered to iddingsite. Dunites represent primitive mantle material that has not undergone significant fractionation.

~~WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS~~

NO. 42

NAME: Lamproite

LOCALITY: Buffalo, Woodson County, Kansas

GEOLOGIC AGE: Late Cretaceous

GEOLOGIC NAME: Hills Pond Lamproite

REFERENCE: Cullers, R. L. et al., 1985, Geochemistry and petrogenesis of lamproites, Late Cretaceous Age, Woodson County, Kansas, U.S.A., *Geochimica et Cosmochimica Acta*, vol. 49, pp. 1383-1402.

MEGASCOPIC DESCRIPTION: A melanocratic greenish-brown porphyritic rock with abundant phlogopite phenocrysts and fewer olivine megacrysts altered to serpentine.

MICROSCOPIC DESCRIPTION: Roughly half of the rock is composed of phenocrysts of subhedral to euhedral phlogopite and anhedral serpentine pseudomorphs after olivine. The phlogopite is commonly deformed and some grains contain poikilitically-included apatite prisms. Colorless diopside grains and slightly pleochroic blades of K-richterite comprise up to 5% of the phenocrysts. Euhedral perovskite, Cr-spinel, and magnetite are the opaques. The groundmass is largely serpentine with minor dolomite and comprises approximately half of the rock.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO.43

NAME: Yellow Serpentinite

LOCALITY: Kaiser Mine, San Bernardino County, California

GEOLOGIC AGE:

GEOLOGIC NAME:

REFERENCE:

MACROSCOPIC DESCRIPTION: variegated very light gray and grayish yellow to moderate yellow crystals; gray is fine to medium crystalline calcite (marble); white to yellow is serpentine developed around dolomite clasts; fractured and calcite filled veins.

MICROSCOPIC DESCRIPTION:

Plane light: calcite/dolomite is drusy, moderate relief, with very small black and red inclusions of hematite; serpentine, pale yellow, low relief; fractures filled with calcite/dolomite.

X-polars: calcite/dolomite, smaller corroded crystals, moderate relief, twinned, second order birefringence; serpentine, mesh texture with mosaic extinction, first order birefringence.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 44

NAME: Quartz Conglomerate

LOCALITY: Fremont County, Colorado

GEOLOGIC AGE: Pennsylvanian-Permian boundary

GEOLOGIC NAME: Fountain formation

REFERENCE: Chronic, John (1958), Pennsylvanian Rocks in Central Colorado, in Symposium on Pennsylvanian Rocks of Colorado and Adjacent Areas, Rocky Mt. Assoc. Geol., Denver, CO, pp 59-63.

MEGASCOPIC DESCRIPTION: A fine to coarse quartz and lithic pebble conglomerate. Sub-angular fragments cemented by quartz. The conglomerate is bedded on a scale of 5 cm down to 0.5 cm.

MICROSCOPIC DESCRIPTION: The large sub-angular to rounded pebbles consist of vein quartz (undulating extinction), quartzite, jasper, and altered potassium feldspar. The sandy matrix consists mainly of sub-angular to sub-rounded, poorly sorted grains of quartz with minor rock fragments.



WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 45

NAME: Gray Sandstone

LOCALITY: Berea, Cuyahoga County, Ohio

GEOLOGIC AGE: Mississippian

GEOLOGIC NAME: Berea sandstone (Berea grit)

REFERENCE: Bownocker, J. A. Building stones of Ohio; Ohio Geol. Survey, 4th Ser., Bull. 18, pp. 72-118. 1915.

MEGASCOPIC DESCRIPTION: A light gray, fine-grained sandstone showing fine parallel bedding lines.

MICROSCOPIC DESCRIPTION: The size distribution is bimodal with the coarser generally subrounded to subangular particles being predominant. These consist mainly of quartz, chert, and the feldspars, microcline, orthoclase and plagioclase. Accessories are zircon, tourmaline, muscovite, pyrite and hematite. The turbid matrix consists of tiny angular quartz, sericite, chlorite and kaolinite aggregates, leucoxene, carbonate, iron oxide specks and bits of carbonaceous material.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 46

NAME: Red Sandstone

LOCALITY: Potsdam, St. Lawrence County, New York

GEOLOGIC AGE: Cambrian

GEOLOGIC NAME: Potsdam sandstone

REFERENCE: Reed, J. D. Geology of the Potsdam Quadrangle; N.Y. State
Mus. Bull. 297, pp. 29-33, 63. 1934.

MEGASCOPIC DESCRIPTION: A fine-grained, red quartz sandstone showing bedding planes.

MICROSCOPIC DESCRIPTION: Subrounded quartz grains are overgrown in crystallographic continuity by secondary quartz to weld this sandstone into a sedimentary quartzite (orthoquartzite). The outlines of the original quartz grains are demarcated by iron oxide films. A subordinate amount of cement is chalcedonic with minute shreds of an illitic clay mineral. A few accessory magnetite grains are present.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

No. 47

NAME: Argillaceous sandstone

LOCALITY: Portageville, Wyoming County, New York

GEOLOGIC AGE: Devonian

GEOLOGIC NAME: Nunda sandstone

REFERENCE: Clarke, J. M., and Luther, D. D. Geologic map and descriptions of the Portage and Nunda Quadrangles; N.Y. State Mus. Bull. 118, pp. 61-63. 1908.

MEGASCOPIC DESCRIPTION: A light greenish-gray, fine-grained sandstone.

MICROSCOPIC DESCRIPTION: Fine-grained angular quartz, orthoclase and plagioclase are cemented by a mixture of sericite, chlorite, clay, carbonate and some iron oxide. Minor constituents are zircon, apatite, tourmaline, leucoxene and magnetite.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 48

NAME: White Sandstone

LOCALITY: Riverton, West Virginia

GEOLOGIC AGE:

GEOLOGIC NAME:

REFERENCE:

MACROSCOPIC DESCRIPTION: white, planar bedded, medium grained, subrounded, quartz arenite with minor feldspar; moldic porosity.

MICROSCOPIC DESCRIPTION:

Plane light: quartz, clear grains; feldspar, cloudy grains; pressure solution textures on grain contacts.

X-polars: quartz, low relief, low birefringence, single and composite grains, undulose extinction, Bohem lamellae and strain shadows; feldspar, isotropic due to alteration to very small clay minerals.

Undulose extinction in quartz indicative of igneous and metamorphic sources, pressure solution and strain shadows indicate deformation; moldic porosity due to dissolution of calcite clasts or calcareous fossils.

~~WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS~~

NO. 48

NAME: Glauconitic Sandstone

LOCALITY: Hazlet, Monmouth County, New Jersey

GEOLOGIC AGE: Cretaceous

GEOLOGIC NAME: Navesink greensand

REFERENCE: Prather, J. K. The Atlantic Highlands section of the New Jersey Cretacic; Am. Geologist, Vol. 36, p. 162. 1905.
Mansfield, G. R. Potash in the greensands of New Jersey. U.S. Geol. Survey Bull. 727, 1922.

MEGASCOPIC DESCRIPTION: A greenish rock with brown seams, the whole showing a texture resembling oolitic. Fossils are present in some specimens.

MICROSCOPIC DESCRIPTION: Largely ovoid to tabular particles of dark brown altered glauconite which show a variety of internal structures; micaceous parallel or fan-shaped massive, and concentrically zoned (oolitic-rare). Many of the altered glauconite pieces are veined or penetrated by thin "fingers" of a slightly lighter colored material. Some of the glauconite pellets are only partly altered; a few are still almost entirely fresh and green. Also present are a few angular grains of chert, feldspar and quartz. The dark subordinate matrix consists of a poorly defined aggregate of carbonate limonite, clay and minor sericite, magnetite and pyrite.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 49

NAME: Siltstone

LOCALITY: Tick Canyon, near Newhall, California

GEOLOGIC AGE: Eocene – Oligocene

GEOLOGIC NAME: Vasquez formation

REFERENCE: Geology of Southern California, Chap. III. Historical Geology, Calif. Div. Mines, Bull. 170, 1954.

MEGASCOPIC DESCRIPTION: A very fine-grained, slightly banded, purple to gray rock with numerous specks of a micaceous mineral visible under a hand lens.

MICROSCOPIC DESCRIPTION: A uniformly fine-grained parallel-oriented aggregate of angular quartz grains, feldspar fragments, chlorite flakes, sericite flakes and shreds, aggregates of submicroscopic clay minerals (chiefly kaolinite), and carbonaceous shreds. Accessory detrital species recognizable are biotite, apatite, zircon, epidote and tourmaline.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 50

NAME: Arkose

LOCALITY: Mount Tom, Hampshire County, Massachusetts

GEOLOGIC AGE: Triassic

GEOLOGIC NAME: Sugarloaf Arkose

REFERENCE: Emerson B.K. Geology of Massachusetts and Rhode Island;
U.S. Geol. Survey Bull. 597, p. 93. 1917.

MEGASCOPIC DESCRIPTION: A reddish-brown feldspathic sandstone composed of sub-angular pebbles and grains of feldspar and glassy quartz in a siliceous, ferruginous cement.

MICROSCOPIC DESCRIPTION: A very poorly sorted aggregate of angular particles of quartz, microcline, perthitic microcline, orthoclase, sodic plagioclase and various rock fragments (granite, quartzite, quartz-sericite schist, quartz-tourmaline schist, etc.). The matrix is angular silty quartz, limonite, sericite, and minor chlorite and secondary albite. Detrital muscovite, epidote, tourmaline and magnetite also are present.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 51

NAME: Graywacke

LOCALITY: Near Grafton, Rensselaer County, New York

GEOLOGIC AGE: Upper Devonian

GEOLOGIC NAME: Rensselaer grit

REFERENCE: Ruedemann, R., Geology of the Capitol District, N.Y. State
Museum Bull. No. 283, Dec. 1930.

MEGASCOPIIC DESCRIPTION: A gray rock with scattered angular grains of quartz and feldspar in a fine-grained matrix.

MICROSCOPIC DESCRIPTION: A very poorly sorted rock with variably sized and angular quartz and feldspar pieces (both plagioclase and orthoclase; some fresh, others sericitized) set in a finer-grained matrix of chlorite, sericite, carbonate, silky quartz, leucoxene, magnetite and pyrite. Matrix chlorite corrodes quartz grains marginally. A few microfragments of rock (quartzite, granite, gneiss) also are present. Accessory detritals include muscovite, sphene, tourmaline and epidote. Most of the quartz pieces are markedly undulatory. A very low degree of incipient metamorphism is indicated by abundant secondary epidote in the matrix which also locally contains minute platelets of stilpnomelane(?).

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 52

NAME: Argillaceous Shale

LOCALITY: Rochester, Monroe County, New York

GEOLOGIC AGE: Silurian

GEOLOGIC NAME: Maplewood Shale

REFERENCE: Alling, H.L. Quantitative petrology of the Genesee Gorge
sediments; Roch, Acad. Sci. Bull. Vol. 9, No. 1, pp. 5-63.
1946.

MEGASCOPIC DESCRIPTION: A smooth, green, fissile shale.

MICROSCOPIC DESCRIPTION: Microscopically mainly cryptocrystalline and merely translucent in shades of gray-brown. Subordinate silty quartz grains, feldspar pieces, sericite flakes, calcite rhombs, and a few particles of pyrite, zircon, magnetite and leucoxene. The dark matrix is composed mainly of an illitic clay mineral.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 53

NAME: Carbonaceous shale

LOCALITY: St. Clair, Pennsylvania

GEOLOGIC AGE: Pennsylvanian

GEOLOGIC NAME: Llewellyn formation

REFERENCE: Wood, G.H., Jr., Trexter, J.P., Soron, J. and Yelenosky, A. (1962),
Geology of Rocks of Pennsylvanian Age in the Southern Half of the
Tremont Quadrangle, Schuylkill County, Pennsylvania, U.S.G.S.
Bull. #1112:181-208.

MEGASCOPIC DESCRIPTION: A dense dark gray carbonaceous shale with abundant white
plant impressions.

MICROSCOPIC DESCRIPTION: A uniformly fine-grained, dark quartzose shale. Abundant
black carbonaceous material obscures much of the section. Rock cleavage is apparent with
subtle suggestions of bedding.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 54

NAME: Oil Shale (Kerogen Shale)

LOCALITY: Garfield County, Colorado

GEOLOGIC AGE: Tertiary (Eocene)

GEOLOGIC NAME: Green River formation

REFERENCE: Bradley, W. H., Origin and microfossils of the oil shale of the Green River formation of Colorado and Utah; U.S. Geol. Survey Prof. Paper 168. 1931.

MEGASCOPIC DESCRIPTION: A blackish-brown stratified shale. It emits a strong bituminous odor when struck with a hammer.

MICROSCOPIC DESCRIPTION: Finely stratified. Layers rich in fine-grained pyrite alternate with pyrite-free or poor layers. Most of the rock consists of a cryptocrystalline reddish-brown formless mixture of organic material and carbonate. Specks of silty quartz, feldspar, sericite, and magnetite can be recognized. Analcime may be present locally in some sections.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 55

NAME: Bauxite

LOCALITY: Bauxite, Saline County, Arkansas

GEOLOGIC AGE: Early Eocene

GEOLOGIC NAME:

REFERENCE: Gordon, M., Jr., V. I. Tracey, Jr., and M. W. Ellis. Geology of the Arkansas bauxite region. U.S. Geol. Survey, Prof. Paper 299. 1959.

MEGASCOPIC DESCRIPTION: An earthy, pisolitic buff to dark brown rock. The pisolitic structures commonly show color zoning.

MICROSCOPIC DESCRIPTION: Consists mainly of red-brown oolites - pisolites in a matrix of smaller ovules, structureless cryptocrystalline material and coarse carbonate. The oolites show concentric layering, color zoning, radial shrinkage cracks and inclusions of carbonate. Most of the material of the oolites, ovules and matrix is translucent to nearly opaque, light to dark brown, cryptocrystalline to isotropic gibbsite. Locally within a few oolites minute patches of microcrystalline gibbsite may be recognized.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 56

NAME: Chert

LOCALITY: Joplin, Jasper County, Missouri

GEOLOGIC AGE: Mississippian

GEOLOGIC NAME: Boone chert

REFERENCE: Giles, A. W. Boone Chert; Geol. Soc. America Bull. 46, pp.
1815-1878. 1935.

MEGASCOPIC DESCRIPTION: A dense, light gray rock; some specimens contain carbonate and may show fossils.

MICROSCOPIC DESCRIPTION: A very fine-grained brownish-gray aggregate of chalcedonic quartz, scattered specks and aggregates of slightly coarser quartz and irregular stringers and blebs of translucent to opaque organic material. Local patches and grains of calcite appear.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 57

NAME: Siliceous Oolite

LOCALITY: State College, Center County, Pennsylvania

GEOLOGIC AGE: Cambrian

GEOLOGIC NAME: Gatesburg formation

REFERENCE: Butts, Charles, Swartz, F. M., and Willard, Bradford. Atlas of Pennsylvania, No. 96. Tyrone Quadrangle, pp. 10-12. 1939.

MEGASCOPIC DESCRIPTION: A light gray rock consisting of small gray siliceous oolites cemented by light gray compact silica.

MICROSCOPIC DESCRIPTION: Chalcedonic quartz forms pseudomorphs after carbonate oolites. Both concentric and radial internal structures are preserved. Where an oolite is sectioned centrally the sandgrain nucleus appears. Both the oolites and scattered quartz sand grains are set in a matrix of fine-grained chalcedonic quartz.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 58

NAME: Diatomaceous Earth

LOCALITY: Lompoc, Santa Barbara County, California

GEOLOGIC AGE: Tertiary (Upper Miocene)

GEOLOGIC NAME: Valmonte diatomite member of Monterey shale

REFERENCE: Woodring, W. P., et. al. Miocene stratigraphy and paleontology of Palos Verdes Hill, Cal: Am. Assoc. Petrol. Geol. Bull. Vol. 20, No. 2, pp. 127-131, 143-145. 1936.

MEGASCOPIC DESCRIPTION: A soft, white chalky rock.

MICROSCOPIC DESCRIPTION: A well-stratified rock consisting of densely packed, brownish translucent to nearly opaque, isotropic diatom tests, which are made up of opal. A few thin layers, streaks and grains of quartz can be noted.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 59

NAME: Encrinal Limestone

LOCALITY: Lockport, Niagara County, New York

GEOLOGIC AGE: Silurian

GEOLOGIC NAME: Lockport dolomite (Gasport member)

REFERNECE: Kindle, E. N. and Taylor, F. B. Description of the Niagara Falls Quadrangle (N.Y.); U.S. Geol. Survey Geol. Atlas, Niagara folio (No. 190). 1913.

MEGASCOPIC DESCRIPTION: A light gray, granular limestone containing abundant crinoid fragments. Many of the crinoids have a pinkish color.

MICROSCOPIC DESCRIPTION: A jumble of broken fossil fragments principally crinoid stem plates, in both longitudinal and cross section and locally complete with central cavity. Also numerous formless angular pieces of coarsely crystalline calcite, doubtless shell fragments. Both are set in a subordinate matrix of more finely comminuted exoskeletal debris, very fine-grained calcite and clusters of small euhedral rhombs of secondary dolomite.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 60

NAME: Algal Dolomite

LOCALITY: Huntsville, Ohio

GEOLOGIC AGE:

GEOLOGIC NAME:

REFERENCE:

MACROSCOPIC DESCRIPTION: laminated light to medium pale brownish gray fine crystalline dolomite with minor pyrite. Mudcracks and/or stromatolitic features may be present.

MICROSCOPIC DESCRIPTION:

Plane light: finely laminated, cloudy, subhedral, fine crystalline dolomite; fenestral porosity and fracture fills; fine opaques and hematite stain.

X-polars: dolomite, cloudy, subhedral, indistinct second order birefringence; clear dolomite in fractures, high birefringence.

This is a fine crystalline secondary dolostone after calcareous mud typical of shallow marine to intertidal sediments in warm climates. Laminations are due to development of microbial mats and low energy deposition.

~~WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS~~

NO. 60

NAME: Limestone

LOCALITY: Garden Park, Fremont County, Colorado

GEOLOGIC AGE: Permian

GEOLOGIC NAME: Lykins formation

REFERENCE: Fenneman, N M. Geology of the Boulder District, Colorado.
U.S. Geol. Survey Bull. 265, pp. 24-26, 1905.

MEGASCOPIC DESCRIPTION: A pale reddish-brown rock composed of angular fragments of limestone and sandy shale in a calcareous cement.

MICROSCOPIC DESCRIPTION: Angular fragments of turbid, fine-grained, distinctly layered limestone are cemented and veined by clear, much coarser grained calcite. The limestone pieces contain uniformly fine-grained calcite, veinlets and patches of hematite, small aggregates of chalcedony, grains of sand and silt-sized quartz and disseminated shreds of opaque carbonaceous debris. Some pieces are so fine-grained that they approach the texture of lithographic limestone.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 61

NAME: Cherty Limestone

LOCALITY: LeRoy, Genesee County, New York

GEOLOGIC AGE: Devonian

GEOLOGIC NAME: Onondaga Limestone

REFERENCE: Sutton, Robert G. Stratigraphy and structure of the Batavia
Quadrangle; Rochester Academy of Sci. Bull., Vol. 9, No.
5-6, pp. 348-408. 1951.

MEGASCOPIIC DESCRIPTION: A compact dark gray rock with numerous irregular
chert areas that are of lighter color.

MICROSCOPIC DESCRIPTION: Chert (minutely to cryptocrystalline chalcedonic
quartz) forms irregular patches and very thin veinlets. Within chert patches euhedral
rhombs of carbonate stand out sharply. The carbonate aggregate that makes up most
of the rock contains fine calcite grains, small calcite euhedra, finely broken shell
debris and a few unbroken brachiopod shells.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 62

NAME: Oolitic limestone

LOCALITY: Bedford, Indiana

GEOLOGIC AGE: Mississippian

GEOLOGIC NAME: Spergen limestone

REFERENCE: Blatchley, R.S. (1907), The Indiana Oolitic Limestone Industry in 1907, Indiana Dept. Geol. Nat. Res. 32nd Ann. Rep., pp 301-460.

MEGASCOPIC DESCRIPTION: A grayish rock showing oolitic texture and an abundance of microfossils.

MICROSCOPIC DESCRIPTION: The rock is composed chiefly of calcitic oolites and microfossils cemented by fine, granular calcite with minor hematite.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 63

NAME: Chalk

LOCALITY: Oktibbeha County, Mississippi

GEOLOGIC AGE: Cretaceous

GEOLOGIC NAME: Selma chalk

REFERENCE: Stephenson, L. W. Cretaceous deposits of the eastern Gulf Region; U.S. Geol. Survey Prof. Paper 81, pp. 15-17, 21, 1914.

MEGASCOPIC DESCRIPTION: A soft, gray rock with an earthy texture.

MICROSCOPIC DESCRIPTION: Numerous foraminiferal shells and fragments of larger fossils occur in a dark brown, cryptocrystalline matrix of calcite. A few detrital quartz grains can be noted.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 64

NAME: Calcareous Tufa

LOCALITY: Mumford, Monroe County, New York

GEOLOGIC AGE: Pleistocene

GEOLOGIC NAME:

REFERENCE:

MEGASCOPIC DESCRIPTION: A buff porous carbonate rock. Plant impressions are present in some specimens.

MICROSCOPIC DESCRIPTION: Numerous irregular cavities of variable shape and size, usually lobate or cusped in outline occur in this spongy rock consisting of light brown to dark grayish brown fine-grained to cryptocrystalline calcite.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 65

NAME: Dolomitic limestone

LOCALITY: Rochester, Monroe County, New York

GEOLOGIC AGE: Silurian (Niagaran)

GEOLOGIC NAME: Lockport dolomite

REFERENCE: Alling, H. L. Quantitative petrology of the Genesee Gorge
sediments; Proc. Rochester Acad. Sci., Vol. 9, No. 1, pp.
53-55. 1946.

MEGASCOPIC DESCRIPTION: A dark gray dolomitic rock with local cavities that
may be filled with crystals of minerals such as dolomite, calcite, fluorite, sphalerite
and selenite.

MICROSCOPIC DESCRIPTION: A uniform equigranular aggregate of dolomite
grains and subhedra mottled turbid gray to light brown. Scattered grains of quartz
and chert appear in some sections.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 66

NAME: Dolomitic Breccia

LOCALITY: Rockingham County, Virginia

GEOLOGIC AGE:

GEOLOGIC NAME:

REFERENCE:

MACROSCOPIC DESCRIPTION: medium gray to grayish black, fine crystalline calcareous dolomite clasts in coarse white saddle dolomitic matrix. Pyrite is metallic secondary mineral on clasts, sphaelerite is adamantine yellowish to brown mineral in matrix.

MICROSCOPIC DESCRIPTION:

Plane light: dolomite, clear to light gray, small and large rhombic crystals with few to numerous inclusions; sphaelerite, brown crystals; discontinuous fractures are filled with fine opaque material.

X-polars: calcareous dolomite clasts, fine crystalline, clear, euhedral and subhedral, high birefringence, disseminated opaque pyrite; dolomite matrix, clear, undulose extinction, moderate birefringence; sphaelerite, isotropic.

This is a breccia formed from angular coarse fine-grained dolomite clasts; between the clasts coarse white dolomite and brown sphaelerite have precipitated.

~~WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS~~

NO. 66

NAME: Phosphorite

LOCALITY: Conda, Idaho

GEOLOGIC AGE: Permian

GEOLOGIC NAME: Phosphoria formation

REFERENCE: McKelvey, V. E. et al. Phosphoria, Park City and Shedhorn formations of the western phosphate fields. U.S. Geol. Surv., Prof. Paper, 313A, pp. 20-31, 1959.

MEGASCOPIC DESCRIPTION: A light brown oolitic rock.

MICROSCOPIC DESCRIPTION: A well-layered rock consisting of ovoids (structureless pellets) of collophane, red-brown to opaque brown in color. Some are squashed or even flattened. The collophane is cryptocrystalline. Some ovoids are color-zoned, with darker cores. They also are specked with minute carbonaceous debris. A small amount of quartz, both chalcedonic and clastic, is present interstitial to the ovoids. A few fine-grained bands consist of about one-third silty quartz and some illite in a poorly defined collophane cement.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 67

NAME: Hematite limestone

LOCALITY: Near Ontario, Wayne County, New York

GEOLOGIC AGE: Silurian

GEOLOGIC NAME: Furnaceville iron ore

REFERENCE: Alling, H. L. Diagenesis of the Clinton hematite ores of New York. Geol. Soc. Am., Bull. 11, pp. 991-1017, 1947.

MEGASCOPIC DESCRIPTION: A highly variable hematite limestone with abundant fossils replaced by hematite and local thin shale.

MICROSCOPIC DESCRIPTION: The rock consists chiefly of fine-grained hematite in which are imbedded numerous small grains and rhombs of carbonate. The hematite is slightly transmitting in red-brown with the accessory condensor and dull red in reflected light. Scattered through the hematite-carbonate matrix are: 1) Scattered rounded to angular quartz, quartz-chlorite, and shale particles which are rimmed by a thick shell of dense hematite. 2) Well zoned ellipsoidal, lenticular and "squashed" oolites of hematite.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 68

NAME: Siderite rock

LOCALITY: Athens Mine Anticline, Negaunee, Michigan

GEOLOGIC AGE: Precambrian

GEOLOGIC NAME: Negaunee Iron Formation

REFERENCE: James, H. S. Sedimentary facies of iron-formation. Econ. Geol. Vol. 40 (No. 3), pp. 235-293, 1954.

MEGASCOPIIC DESCRIPTION: A fine grained, bedded, dark gray rock with thin quartz layers.

MICROSCOPIC DESCRIPTION: There are three essential minerals: siderite, (the most abundant), quartz and chlorite. Small scale stratification is shown by differences in grain size and quartz abundances. Along diagonal fractures veinlets of recrystallized coarsened siderite have been formed. These in turn are cut or offset by small slips generally parallel with the bedding. Some sections show the limonitic weathering crust with limonite veinlets penetrating the fresh carbonate rock.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 69

NAME: Rock Gypsum

LOCALITY: Fremont County, Colorado

GEOLOGIC AGE: Permian-Triassic boundary

GEOLOGIC NAME: Lykins formation

REFERENCE: Argal, G.D., Jr. (1949), Industrial Minerals of Colorado, Quar. Colo. Sch. Min., v. 44:1-426.

MEGASCOPIC DESCRIPTION: A soft, fine-granular, pink to tan gypsum rock with sparse medium to coarse gypsum cleavages.

MICROSCOPIC DESCRIPTION: A generally fine-grained aggregate of gypsum grains in a tightly interlocking fabric. Locally, the gypsum has been coarsely recrystallized, and vein structures are seen in a few places.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 70

NAME: Rock Anhydrite

LOCALITY: Hants County, Nova Scotia

GEOLOGIC AGE: Mississippian

GEOLOGIC NAME: Windsor group

REFERENCE: Bell, W. A. Horton-Windsor District, Nova Scotia; Geol. Survey, Canada, Mem. 155, 1929.

MEGASCOPIIC DESCRIPTION: A light gray fine crystalline rock.

MICROSCOPIC DESCRIPTION: An interlocking aggregate of radial-stellate groups of elongate anhydrite crystals with intervening irregular grains of anhydrite. Small irregular patches of fine-grained carbonate appears locally.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 71

NAME: Gray Hornfels

LOCALITY: Lambertsville, New Jersey

GEOLOGIC AGE:

GEOLOGIC NAME:

REFERENCE:

MACROSCOPIC DESCRIPTION: medium gray, bedded, fine grained clastic rock with very fine crystals – pelletic hornfels.

MICROSCOPIC DESCRIPTION:

Plane light: groundmass fine-grained, brown with small clear, brown, and opaque crystals.

X-polars: groundmass fine-grained, brown; major fine crystals include: quartz with even or mosaic extinction, low birefringence; plagioclase, mottled extinction; magnetite/hematite is opaque. Minor biotite, brown, pleochroic; muscovite, elongate, moderate relief, high birefringence; feldspar, low relief, low birefringence, cleavage.

This was a sedimentary rock - silty shale - that has undergone contact metamorphism from an igneous intrusion that metamorphosed the rock under high temperature and low pressure.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 72

NAME: Pink Marble

LOCALITY: Tate, Pickens County, Georgia

GEOLOGIC AGE: Cambrian

GEOLOGIC NAME: Murphy Marble

REFERENCE: Keith, Arthur. Description of the Nantahala Quadrangle (N.C. - Tenn.); U.S. Geol. Atlas, Nantahala folio (No. 143), p. 5. 1907.

MEGASCOPIC DESCRIPTION: A pinkish rock composed chiefly of granular pink calcite with local bands of mica.

MICROSCOPIC DESCRIPTION: Bands of coarse-grained, heterogranular calcite show complexly interlocking textures. Apatite euhedra and a rare grain of rutile are accessories in these layers. Thinner layers consist of much more fine-grained relatively equigranular calcite with abundant, well aligned phlogopite. Sphene and rare diopside are accessories in these bands.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 73

NAME: Dolomite Marble

LOCALITY: Franklin, Essex County, New Jersey

GEOLOGIC AGE: Precambrian

GEOLOGIC NAME: Franklin Marble

REFERENCE: Widmer, K. (1964), *The Geology and Geography of New Jersey*, Van Nostrand Co., Inc., Princeton, NJ, p. 193.
Hague, J.M., Baum, J.L., Hermann, L.A., and Pickering, R.J. (1956), *Geology and Structure of the Franklin-Sterling Area, NJ*, G.S.A. Bull. v. 67:435-474.

MEGASCOPIC DESCRIPTION: A coarse-granular, gray-white marble with visible graphite and phlogopite flakes with minor sulfide grains.

MICROSCOPIC DESCRIPTION: A coarse-granular aggregate of anhedral dolomite showing twinning in one or two directions. Small flakes of graphite and phlogopite are present as accessory phases. Tremolite is sometimes present and is frequently replaced by carbonate.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 74

NAME: Verd Antique

LOCALITY: Rochester, Windsor County, Vermont

GEOLOGIC AGE: Ordovician

GEOLOGIC NAME:

REFERENCE: Jahns, R. H. Serpentinities of the Roxbury District, Vermont.
pp. 137-160. Ultramafic and related rocks. John Wiley and
Sons, Inc. 1967.

MEGASCOPIC DESCRIPTION: A massive, grayish-green rock with veins of magnesite and fibrous serpentine.

MICROSCOPIC DESCRIPTION: Composed mainly of a variably textured aggregate of antigorite and talc. Some parts are mainly finely interlaces of serpentine; others consist of both serpentine and talc completely intertwined and still other parts are mainly talcose. Veinlets and bands of these minerals, together with some carbonate, are widespread. There is also considerable carbonate which appears in two types of two distinct ages: 1) Corroded patches of an older turbid carbonate and 2) veinlets of a younger, clear magnesite. Streaks and patches of fine-grained magnetite are common throughout.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 75

NAME: Garnet-wollastonite skarn

LOCALITY: Willsboro, Essex County, New York

GEOLOGIC AGE: Precambrian; age of metamorphism - Precambrian - by
Adirondacks diorite dikes.

GEOLOGIC NAME: Contact - metamorphosed Grenville limestone

REFERENCE: Buddington, A. F. Adirondack igneous rocks and their metamorphism. Geol. Soc. Am. Mem. 7, pp. 41-43. 1939.

MEGASCOPIC DESCRIPTION: The rock is composed of white crystalline wollastonite with grains and bands of light to dark brown andradite garnet with a few grains of light green diopside.

MICROSCOPIC DESCRIPTION: Large, irregular poikiloblasts of orange garnet (andradite) include mainly wollastonite and a few grains of diopside. The rest of the rock consists mainly of very coarse wollastonite blades with a few grains of included diopside. The wollastonite is replaced marginally and along cleavages by calcite which also veins the garnet.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 76

NAME: Quartzite

LOCALITY: Baraboo, Wisconsin

GEOLOGIC AGE: Precambrian

GEOLOGIC NAME: Baraboo quartzite

REFERENCE: Weidman, Samuel. The geology of north central Wisconsin;
Wisconsin Geol. and Nat. History Survey Bull. XVI, pp.
381, 382. 1907.

MEGASCOPIIC DESCRIPTION: A finely crystalline, purplish quartzose rock.

MICROSCOPIC DESCRIPTION: Consists almost entirely of quartz with slightly coarser bands alternating with ones of finer grain size. A well developed foliation is shown by parallelism of long axes of grains. The grains show marked wavy extinction. In some, remnants of the original detrital outline are partly preserved by a film of hematite dust. Some contacts are sutured and locally a small amount of mortar structure appears. Sericite is a minor interstitial accessory.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 77

NAME: Gray Slate

LOCALITY: Near Bangor, Northampton County, Pennsylvania

GEOLOGIC AGE: Ordovician

GEOLOGIC NAME: Bangor slate (Martinsburg shale)

REFERENCE: Behre, C. H., Jr. Slate in Pennsylvania; Penna. Geol. Survey,
4th ser. Bull. M 16, pp. 199-223, 1933.

MEGASCOPIC DESCRIPTION: A dark gray fissile rock containing some carbonate.

MICROSCOPIC DESCRIPTION: A dark, partly translucent, very fine-grained rock with abundant opaque particles and aggregates (graphite and a few small magnetite particles). The other essential minerals, all closely intergrown, are sericite, chlorite, carbonate and lesser quartz.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 78

NAME: Phyllite

LOCALITY: Ely, Orange County, Vermont

GEOLOGIC AGE: Middle Ordovician

GEOLOGIC NAME: Orfordville formation

REFERENCE: Hadley, J. B., Stratigraphy, structure and petrology of the Mt. Cube area, New Hampshire; Geol. Soc. Am. Bull., Vol. 53, pp. 113-176, 1942.

MEGASCOPIC DESCRIPTION: A fine-grained, gray, lustrous schistose rock.

MICROSCOPIC DESCRIPTION: This fine-grained rock shows relict bedding (meta-silt vs. meta-clay layers). Both consist of varying proportions of quartz, sericite, chlorite, graphite and magnetite. Both the quartz and the micaceous species show extreme orientation.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 79

NAME: Mica Schist

LOCALITY: Manhattan Island, New York

GEOLOGIC AGE: Precambrian

GEOLOGIC NAME: Manhattan Schist

REFERENCE: Fettke, C. R. The Manhattan schist of southeastern N.Y. State and its associated igneous rocks; N.Y. Acad. Sci. Annals Vol. 23, pp. 194-216. 1914.

MEGASCOPIC DESCRIPTION: A schistose rock composed of muscovite, biotite and quartz with small amounts of feldspar and garnet.

MICROSCOPIC DESCRIPTION: A medium-grained, strongly foliated rock with essential quartz, muscovite, biotite, plagioclase and garnet (almandine). The plagioclase is moderately sericitized. Some muscovite appears to have been formed replacing biotite. Graphite, apatite, magnetite and pyrite are widespread accessories; kyanite may appear in some sections.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 80

NAME: Chlorite Schist

LOCALITY: Chester, Windsor County, Vermont

GEOLOGIC AGE:

GEOLOGIC NAME:

REFERENCE: Gillson, J. L. Origin of the Vermont talc deposits with a discussion of the formation of talc in general. Econ. Geol. Vol. 22, pp. 246-287, 1927.

MEGASCOPIC DESCRIPTION: A green foliated rock composed entirely of chlorite with local fibers of tremolite.

MICROSCOPIC DESCRIPTION: Consists chiefly of a fine-grained chlorite, pleochroic from colorless to pale green. Accessory minerals include ilmenite in skeletal tabular crystals, magnetite, pyrite, quartz, apatite and, in some sections, tremolite.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 81

NAME: Stilpnomelane Schist

LOCALITY: Longvale quarry, Mendocino County, California

GEOLOGIC AGE: Jurassic and Cretaceous

GEOLOGIC NAME: Franciscan formation

REFERENCE: Chesterman, C. W. Guide to Mineralogy of the Laytonville Quarry, Mendocino County, Cal. Field trip G. Bull. 190, Geol. of Norther. Cal. and Geology. 1966.

MEGASCOPIC DESCRIPTION: A dark bronze-brown schistose rock.

MICROSCOPIC DESCRIPTION: A well-banded rock consisting of essential quartz, stilpnomelane and garnet (spessartite - almandine). Quartzose bands alternate with bands rich in stilpnomelane or stilpnomelane plus garnet. The strongly pleochroic stilpnomelane is in very thin plates and sheaf-like clusters of plates. Accessories, particularly in the quartzose bands, are calcite and apatite.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 82

NAME: Tremolitic Talc Schist

LOCALITY: St. Lawrence County, New York

GEOLOGIC AGE: Precambrian

GEOLOGIC NAME:

REFERENCE: Ross, Malcolm, Smith, W. L. and Ahston, W. H. Triclinic talc and associated amphiboles from Gouverneur Mining District, New York. Am. Min. Vol. 53, no's 5 and 6, pp. 751-769, 1968. Engel, A E. J. The Precambrian geology and talc deposits of the Balmat - Edwards District, northwest Adirondack Mountains, New York. U.S. Geol. Surv. Open file. Rep. 1962.

MEGASCOPIC DESCRIPTION: A light-colored schistose rock composed of talc and fibrous tremolite. The tremolite is usually pseudomorphously altered to talc to varying degrees.

MICROSCOPIC DESCRIPTION: Tremolite, the chief original constituent, forms slender subparallel prismatic crystals altered in varying degrees to talc. Much talc also occurs as bands interleaved between altered tremolite layers. Interstitial calcite is an accessory species.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 83

NAME: Graphite schist

LOCALITY: Near Ticonderoga, Essex County, New York

GEOLOGIC AGE: Precambrian (Grenville)

GEOLOGIC NAME: Dixon schist

REFERENCE: Alling, H. L. The Adirondack graphite deposits; N.Y. State
Museum Bull. 199, 1917.

MEGASCOPIC DESCRIPTION: This is a quartz schist with abundant glistening graphite.

MICROSCOPIC DESCRIPTION: This is a well foliated rock with essential quartz, strongly sericitized feldspars (both sodic plagioclase and potash feldspar), graphite and muscovite. The graphite forms slightly curving plates in parallel groups, commonly with parallel intergrown muscovite. In some sections coarse quartz-feldspar augen appear, around which the graphite platelets are deflected in attitude. Pyrite is a very abundant accessory.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 84

NAME: Migmatite

LOCALITY: Gouverneur, St. Lawrence County, New York

GEOLOGIC AGE:

GEOLOGIC NAME:

REFERENCE:

MACROSCOPIC DESCRIPTION: medium gray, indistinctly banded and foliated medium crystals.

MICROSCOPIC DESCRIPTION:

Plane light: orthoclase, plagioclase, and quartz, clear, low relief crystals; muscovite, clear bladed crystals with higher relief; biotite, brown-greenish, pleochroic; magnetite, opaque; small accessory minerals.

x-polars: orthoclase, low relief, low birefringence, tartan twinning resulting in complex extinction; plagioclase, low relief, low birefringence, even to mosaic extinction, some with myrmekitic – wormy intergrowth - texture; muscovite, bladed, high birefringence, moderate relief, mottled extinction; biotite, moderate relief, pleochroic, zircon inclusions with haloes; minor quartz with low relief, low birefringence, and undulose extinction; magnetite, opaque; zircon, small, rounded, high relief, high birefringence.

This rock consists of intergrown crystals of Na and K feldspars with minor quartz and two types of phyllosilicates, as well as accessory minerals, that formed when a gneissic rock, as indicated by the banding and foliation, reached the melting point for the quartz and feldspars – basically a metamorphic rock with igneous characteristics.

~~WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS~~

NO. 84

NAME: Andalusite (Chiastolite) Slate

LOCALITY: Mariposa County, California

GEOLOGIC AGE: Upper Jurassic

GEOLOGIC NAME:

REFERENCE: Best, M. G., 1963, Petrology and Structural Analysis of Metamorphic Rocks in the Southwestern Sierra Nevada foothills, California. Univ. of Cal. Pub., Dept. of Geol, vol. 42, No. 3, pp. 111-158.

MEGASCOPIC DESCRIPTION: A dark gray schistose rock with abundant chiastolites that are up to 3/16" in diameter.

MICROSCOPIC DESCRIPTION: The rock is studded by porphyroblasts and twinned porphyroblasts of andalusite (var. chiastolite). These have been to a very large degree replaced by fine-grained sericite. The matrix is an exceedingly fine-grained, dark, well foliated aggregate of graphite, biotite, quartz, feldspar and muscovite, with the first three predominating. Also conspicuous are rounded to elongate bodies somewhat lighter in color (less graphite), consisting of coarser muscovite blades in the centers of rims of biotite-quartz.



WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 85

NAME: Staurolite quartzite

LOCALITY: Big Rock, Petaca, Rio Arriba County, Mexico

GEOLOGIC AGE: Precambrian

GEOLOGIC NAME: Petaca schist

REFERENCE: Corey, A. F. (1960) Kyanite occurrences in the Petaca district, Rio Arriba County, New Mexico. New Mexico Bur. Mines Bull., 47.

Schreyer, W. and G. A. Skinner. (1966) Staurolite-quartzite bands in kyanite quartzite at Big Rock, Rio Arriba County, New Mexico. Contrib. Mineral & Petrology, Heidelberg 12, 223-244.

MEGASCOPIC DESCRIPTION: Mottled gray-brown medium to coarse-grained rock with grains of staurolite as long as 10 mm. The rock has little megascopic foliation and is characterized by a high specific gravity.

MICROSCOPIC DESCRIPTION: Consists chiefly of quartz, staurolite and magnetite and accessory hematite, muscovite, chlorite (after biotite) and chloritoid. Rare grains of apatite, rutile and monazite appear in some sections. The quartz is variable in grain size and habit and shows relict bedding. Staurolite forms large anhedral poikiloblasts with an unusual radial texture resulting from its replacement of chloritoid. The magnetite appear in globular aggregates up to 3 mm. across.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 86

NAME: Kyanite quartzite

LOCALITY: Near Ogilby, Imperial County, California

GEOLOGIC AGE:

GEOLOGIC NAME:

REFERENCE: Sampson, R. J. and Tucker, W. B. Feldspar, silica, and cyanite deposits of California. Calif. Bur. Mines, Report 27, pp. 455-464, 1931.

Campbell, Ian and Wright, L. A. Kyanite paragenesis at Ogilby, California. Geol. Soc. Am. Bull. Vol 61, pp. 1520-1521, 1950.

MEGASCOPIIC DESCRIPTION: A gray rock with blades of light blue kyanite in gray quartzite. Small grains of magnetite are easily observed with 10x magnification.

MICROSCOPIC DESCRIPTION: A coarse-grained, essentially non-foliated aggregate of quartz and kyanite. The kyanite forms clusters of thick blades. The outer parts of the clusters are markedly poikiloblastic with abundant minute quartz inclusions. The kyanite shows abundant multilamellar twinning and only very minor sericitization. Also present is andalusite in poikiloblastic tablets, which show lower relief and lower birefringence than the kyanite and a higher degree of sericitization. A few scattered patches of very fine-grained chlorite-sericite (pinite) probably have replaced cordierite. Quartz is variably grained, in a mosaic texture. Accessories are large anhedral magnetite grains and small rounded rutile grains.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 87

NAME: Sillimanite Garnet Gneiss

LOCALITY: Near Hague, Warren County, New York

GEOLOGIC AGE: Precambrian

GEOLOGIC NAME: Hague gneiss

REFERENCE: Alling, H. L. The Adirondack graphite deposits; N.Y. State Mus. Bull. 199, pp. 44-55, 1918.

MEGASCOPIIC DESCRIPTION: A compact, granular rock with poor gneissic structure. It has a mottled color; dark red due to garnet and pale green apparently due to quartz and feldspar.

MICROSCOPIC DESCRIPTION: Garnet (Almandine) porphyroblasts contain inclusions of magnetite and quartz. These are set in a well-foliated aggregate of quartz, microcline, plagioclase and coarse (i.e., non-fibrolitic) sillimanite. Accessories are magnetite, ilmenite (now leucoxene), graphite, pyrite, biotite, and zircon. The feldspars, particular plagioclase are sericitized and some sericite chlorite aggregates may represent completely altered cordierite.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 88

NAME: Cordierite - anthophyllite skarn

LOCALITY: Betty mine, Guffey, Park County, Colorado

GEOLOGIC AGE: Precambrian

GEOLOGIC NAME: Idaho Springs formation

REFERENCE: Lovering, T. S. and E. N. Goddard (1950) Geology and ore deposits of the Front Range, Colorado, U.S. Geol. Survey, Prof. Paper 225, 69-70.

Bever, J. E. (1954) Geology of the Guffey area, Colorado, Univ. Mich. Ph.D thesis.

MEGASCOPIIC DESCRIPTION: A dark blue-gray non-foliated rock showing areas of glassy to subvitreous blue and gray cordierite and coarse prisms of brownish-green anthophyllite.

MICROSCOPIC DESCRIPTION: A coarse-grained aggregate of cordierite and anthophyllite with accessory muscovite, magnetite, chlorite, apatite, and rutile. The cordierite, in large anhedral is fresh and relatively free of inclusions save for minute rutile grains and a few muscovite flakes. The anthophyllite forms ragged and disordered prismatic aggregates which, in part, appear to replace the cordierite, and in turn, are locally replaced by coarse isolated flakes of muscovite.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 89

NAME: Augen gneiss

LOCALITY: Near Grass Lake, St. Lawrence County, New York

GEOLOGIC AGE: Precambrian

GEOLOGIC NAME:

REFERENCE: Buddington, A. F., Adirondack igneous rocks and their metamorphism, Geol. Soc. Am., Mem. 7, 1939.

MEGASCOPIIC DESCRIPTION: A pink to dark gray banded rock with lenticular augen of pink coarse crystalline feldspar in subparallel bands with biotite, quartz and light gray plagioclase.

MICROSCOPIC DESCRIPTION: The various-sized augen are subhedral to ellipsoidal crystals or coarsely granular aggregates of feldspars, either orthoclase or sodic plagioclase, the latter with some antiperthite. These are set in and enveloped by a subordinate fine-grained matrix of granulated quartz, shredded biotite, anhedral of dark green hornblende and aggregates of magnetite. Thin veinlets of very fine-grained quartz transect the augen usually at a moderate angle to their elongation. Accessories are apatite, rare monazite and zircon.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 90

NAME: Granitoid gneiss

LOCALITY: Salisbury, Rowan County, North Carolina

GEOLOGIC AGE:

GEOLOGIC NAME:

REFERENCE: Watson, T. L. Granites of the southeastern Atlantic States;
U.S. Geol. Survey Bull. 426, pp. 137-143. 1910.

MEGASCOPIIC DESCRIPTION: A flesh colored rock consisting principally of feldspar and quartz. There are scattered specks of magnetite and other dark minerals. There is some evidence of grain orientation, but banding is not pronounced.

MICROSCOPIC DESCRIPTION: Larger grains of microcline-perthite (in part showing transformation to orthoclase), and sodic plagioclase show undulatory extinction, twin-curvature, and local veining by quartz. The quartz is much finer grained and forms foliated aggregates of somewhat elongate, sutured grains with wavy extinction. Irregular, elongate mafic aggregates consist of spongy garnet masses, partly replaced by rosettes of biotite and with intergrown sphene and some epidote. Magnetite is the other accessory.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 91

NAME: Biotite gneiss

LOCALITY: Uxbridge, Worcester County, Massachusetts

GEOLOGIC AGE: Precambrian

GEOLOGIC NAME: Northbridge gneiss

REFERENCE: Emerson, B. K. Geology of Massachusetts and Rhode Island;
U.S. Geol. Survey, Bull. 597, pp. 155, 156. 1917.

MEGASCOPIC DESCRIPTION: A banded rock. Thin bands of black mica alternate with those of quartz and feldspar.

MICROSCOPIC DESCRIPTION: The foliation results mainly from the subparallel alignment of biotite in short stringers. Larger and less abundant, highly irregular poikiloblastic crystals of green hornblende lie with their long axes oblique to the foliation. Intergrown with the biotite are numerous grains of epidote and accessory sphene and zircon. Most of the leucocratic part of the rock consists of quartz with small amounts of microcline and accessory plagioclase and a few minute garnet crystals.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 92

NAME: Anthracite Coal

LOCALITY: Hazelton, Pennsylvania

GEOLOGIC AGE:

GEOLOGIC NAME:

REFERENCE:

MACROSCOPIC DESCRIPTION: shiny grayish-black, low density, suggestion of bedding, conchoidal fracture.

MICROSCOPIC DESCRIPTION:

Plane light: black, numerous small holes – coke pores.

X-polars: black, no pleochroism.

Metamorphosed coal of coking grade, approximately 95 % carbon, few preserved structures.

~~WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS~~

NO. 92

NAME: Eclogite

LOCALITY: Near Healdsburg, Sonoma County, California

GEOLOGIC AGE: Upper Jurassic

GEOLOGIC NAME: Franciscan group

REFERENCE: Switzer, George (1945) Eclogite from the California
glaucophane schists. Am. Jour. Sci. 249, 1-8.

MEGASCOPIC DESCRIPTION: Deep green dotted with red garnets; non-foliated,
granoblastic, with a specific gravity of 3.4.

MICROSCOPIC DESCRIPTION: A granoblastic aggregate of euhedral garnet and
pyroxene (omphacite). Most of the pyroxene has been replaced by a very pale
greenish amphibole (actinolitic hornblende), so that for many sections, the rock is
properly called an amphibole eclogite. Other secondary species are chlorite, which
replaces amphibole, garnet cores and also forms veinlets; sphene in small abundant
subhedra; tablets of muscovite; and a few anhedral patches of pyrite. In addition the
following have been reported and may appear in minor amounts in some sections:
clinozoisite, glaucophane, pumpellyite, lawsonite, albite, quartz and rutile.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 93

NAME: Metaconglomerate

LOCALITY: Boulder County, Colorado

GEOLOGIC AGE:

GEOLOGIC NAME:

REFERENCE:

MACROSCOPIC DESCRIPTION: white and pink subrounded to rounded quartz and lithic pebbles in yellowish gray coarse quartz sand matrix; pebbles are imbricated and graded; foliation has developed.

MICROSCOPIC DESCRIPTION:

Plane light: clear and colored clasts; opaque minerals; pale yellowish fibrous crystals with small green chlorite crystals.

X-polars: quartz, low relief, polycrystalline, low birefringence, undulose extinction, pressure solution contacts; lithic fragments, colored, isotropic; magnetite, black, opaque; hematite, reddish, opaque; chlorite/sericitized feldspar, fibrous, moderate relief, second order birefringence; muscovite, crystals are long, narrow, contorted, light, moderate relief, second order birefringence.

This arkosic, quartz, and lithic pebble conglomerate has undergone metamorphism where the clay-rich portions are altered feldspars and/or mud matrix, which has developed a foliation fabric.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 94

NAME: Cumingtonite schist

LOCALITY: Rockford, Pennington County, South Dakota

GEOLOGIC AGE: Precambrian

GEOLOGIC NAME:

REFERENCE: Gustafson, J. K. Metamorphism and hydrothermal alteration of the Homestake gold-bearing formation. *Econ. Geol.* 28, 133. 1933.

Wayland, R. G. Cumingtonite from the Black Hills, South Dakota. *Am. Mineral*, 21, 607-610, 1936.

MEGASCOPIC DESCRIPTION: A dark gray schistose rock with radiating cumingtonite and occasional pyrrhotite.

MICROSCOPIC DESCRIPTION: Cumingtonite forms conspicuous radiating aggregates of blades and fibers. Biotite, pleochroic in shades of olive green, is in spongy interstitial aggregates with much admixed finely divided graphite. Quartz, also liberally sprinkled with graphite forms lensoid masses. Some younger quartz pods are clear. A few small garnets, some chlorite and carbonate form the accessories.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 95

NAME: Hornblende schist

LOCALITY: Mitchell County, North Carolina

GEOLOGIC AGE: Precambrian

GEOLOGIC NAME: Roan gneiss

REFERENCE: Lesure, F. G. (1968) Mica deposits of the Blue Ridge in North Carolina. U.S. Geol. Surv., Prof. Paper 577, pp. 4-5.

MEGASCOPIC DESCRIPTION: A medium-grained schistose, greenish black rock. Hornblende needles are the predominantly visible species with fine-grained quartz, feldspar and epidote recognizable in some bands with the hand lens.

MICROSCOPIC DESCRIPTION: A strongly foliated, well-banded rock. The essential species are green hornblende, epidote, quartz and intermediate plagioclase. Small amounts of pyrite, apatite and magnetite are present and traces of secondary hematite and a clay mineral also may be noted. The bands are of various compositions: 1) nearly entirely coarse-grained hornblende, 2) hornblende-epidote-plagioclase-quartz, 3) hornblende-plagioclase, 4) quartz-hornblende, 5) hornblende-epidote and 6) epidote-quartz-hornblende.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 96

NAME: White Marble

LOCALITY: West Bridgewater, Vermont

GEOLOGIC AGE:

GEOLOGIC NAME:

REFERENCE:

MACROSCOPIC DESCRIPTION: white medium-coarse crystalline calcite marble.

MICROSCOPIC DESCRIPTION:

Plane light: calcite, coarse clear intergrown crystals; quartz, rounded; muscovite, bladed crystals.

X-polars: calcite, medium relief, twinned, second order birefringence; quartz, low relief, low birefringence, undulose extinction; muscovite, elongate, high relief, high birefringence, undulose extinction.

High-grade metamorphosed carbonate – pelitic material forms muscovite; quartz is detrital sand; organic material has been oxidized leaving a relatively pure calcium carbonate.

~~WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS~~

NO. 96

NAME: Glaucophane schist

LOCALITY: Sonoma County, California

GEOLOGIC AGE: Upper Jurassic

GEOLOGIC NAME: Franciscan Group

REFERENCE: Switzer, G. Mineralogy of the California glaucophane schists.
Calif. Division of Mines. Bull. 161, 51-70, 1951.

MEGASCOPIC DESCRIPTION: A bluish-black crystalline rock consisting chiefly of slender prismatic aggregates of glaucophane.

MICROSCOPIC DESCRIPTION: The most abundant mineral is the conspicuously colored glaucophane pleochroic from colorless to purple, which occurs in stubby to slender, subparallel prismatic crystals. Some grains have parts, particularly margins, pleochroic in shades of inky blue (riebeckite). Hornblende, pleochroic in shades of olive green is a subordinate amphibole. Garnet porphyroblasts are altered, in part to chlorite, in part to epidote. Interstitial to the amphiboles are abundant anhedral aggregates of dirty very fine-grained carbonate. A few large pyrite crystals are rimmed by magnetite.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 97

NAME: Hornblende gneiss

LOCALITY: Clintonville, Clinton County, New York

GEOLOGIC AGE: Precambrian

GEOLOGIC NAME:

REFERENCE: Kemp, J. F. and Alling, H. L. Geology of the Ausable
Quadrangle; N.Y. State Mus. Bull. 261, pp. 11-16, 29-31,
1925.

MEGASCOPIC DESCRIPTION: A dark-colored, coarse-grained rock with a well
marked gneissic structure. It is composed of hornblende and feldspar.

MICROSCOPIC DESCRIPTION: Hornblende, the most abundant species forms
stubby anhedral, pleochroic in shades of brown. Small grains of pale greenish-gray
augite occur interstitially and locally as remnants in the amphibole. Plagioclase, of
intermediate composition, forms anhedral that are slightly sericitized. Biotite, sphene
and magnetite are accessories.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 98

NAME: Epidosite

LOCALITY: Lookout Mt., Fremont County, Colorado

GEOLOGIC AGE: Precambrian

GEOLOGIC NAME: Idaho Springs formation

**REFERENCE: Lovering, T. S. and Goddard, E. N. Geology and ore deposits
of the Front Range, Colorado. U.S. Geol. Survey Prof.
Paper 223, p. 19-20, 1950.**

MEGASCOPIC DESCRIPTION: A dense fine-grained green epidote rock.

MICROSCOPIC DESCRIPTION: This rock is composed almost entirely of finely granular epidote with accessory interstitial plagioclase and a few thin veinlets of plagioclase. Other accessories are magnetite, ilmenite and fine-grained aggregates of sphene.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 99

NAME: Jaspilite

LOCALITY: Ishpeming, Michigan

GEOLOGIC AGE: Precambrian

GEOLOGIC NAME: Negaunee iron formation

REFERENCE: Snelgrove, A. K., Seaman, W. A., and Ayres, V. L. Michigan
Dept. Conserv. Geol. Surv. Div. Prog. Report 10, pp. 31,
32, 34, 1944.

MEGASCOPIC DESCRIPTION: A rock consisting of wide, wavy bands of red jasper, red-brown hematite, and occasional thin bands of specular hematite. Veinlets of milky quartz criss-cross the rock.

MICROSCOPIC DESCRIPTION: A well banded rock with wavy thinner opaque bands of specular hematite alternating with thicker bands that consist of quartz and very fine-grained "dusty" hematite. Both are cut by sharp veinlets of coarser grained quartz. In the quartzose bands, the exceedingly minute, slightly translucent hematite platelets form ovoid clusters with thin clear quartz shells.

WARD'S COLLECTION OF CLASSIC NORTH AMERICAN ROCKS

NO. 100

NAME: Grunerite - magnetite rock

LOCALITY: Michigamme, Michigan

GEOLOGIC AGE: Precambrian

GEOLOGIC NAME: Bijiki schist

REFERENCE: Richarz, S. Note on grunerite from the Lake Superior region.
Am. Mineral, 17, 437-442, 1932.

MEGASCOPIC DESCRIPTION: This black granular magnetite-rich rock contains abundant, partly radiating aggregates of the gray amphibole, grunerite.

MICROSCOPIC DESCRIPTION: Grunerite forms radiating aggregates of needles. Intergrown are irregular clumps of magnetite grains. The amphibole is replaced by aggregates of fine-grained, bright green chlorite. Accessories include apatite, quartz, biotite and carbonate.