CALCITE

$CaCO_3$

A very common and widespread rock-forming mineral. Calcite is the chief constituent of limestone and marbles and is also widespread as a hydrothermal (gangue) mineral in veins, lodes, and replacement deposits of a great variety of metallic mineralizations. In Michigan, outstanding calcite occurrences are of the following main types: 1) As exceptionally fine and complex crystals in cavities and veins in the Keweenaw native copper lodes. It is the most widespread mineral of the ore-forming period. This is a deservedly famous occurrence for this mineral, and its specimens grace mineral collections all over the world. 2) As crystals in cavities and veins in iron ores. 3**)** As vein-filling, concretion, and vug crystals in various limestone and shale formations. 4) In marls of glacial lakes. Northern and Southern Peninsulas.

Figure 42: Calcite crystals with native copper inclusions from the Franklin mine, Hancock, Houghton County. 5.5 x 8.5 cm. A. E. Seaman Mineral Museum specimen No. JTR 320, Jeffrey Scovil photograph.

Calcite is also the major mineral constituent of Petoskey stones, masses of fossil colony coral (Hexagonaria percarinata) that occur abundantly in the Devonian reef limestones of the Gravel Point Formation (Traverse Group) in Charlevoix, Emmet, Cheboygan, Presque Isle, and Alpena Counties. Coral groups weathered out of the limestone were widely scattered by Pleistocene glacial action, and are readily found on beaches as pebbles and cobbles rounded by wave abrasion. Dietrich (1983) provides a concise description of the fossil and its occurrence.

Figure 43: Calcite crystals with native copper inclusions from the Quincy mine, Hancock, Houghton County. 3.5 x 5.5 cm. A. E. Seaman Mineral Museum specimen No. DCG 1159, Jeffrey Scovil photograph.

Copper Country Calcites

In mines and on mine dumps in the three Counties of Michigan's Copper Country (Keweenaw, Houghton, and Ontonagon) calcite crystals constitute one of the most sought after and desirable of mineral specimens for the collector. Palache (1898, page 161) states, "after native copper calcite easily comes first in the interest and beauty of its specimens." Crystals from 5 to 10 centimeters long are fairly common; the largest known to Palache (1898) measured 15 centimeters in length. They are usually colorless, but may be pale to deep wine-yellow or grayish lavender. Others appear pinkish or red, owing to inclusions of native copper (Figures 42, 43 & 45) or cuprite. In some, the copper inclusions are so finely divided and widely disseminated that they give an adventurine effect. Many show phantoms indicating two distinct growth periods. In some cases, the core crystal has a different habit from that of the external crystal.

Figure 44: Type 1 twinned crystals of calcite from the Quincy mine, Hancock, Houghton County. 8 x 11 cm. A. E. Seaman Mineral Museum specimen No. JTR 1706, Jeffrey Scovil photograph.

Figure 45: Type 2 twinned crystals of calcite with native copper from the Quincy mine, Hancock, Houghton County. 4 x 6 cm. A. E. Seaman Mineral Museum specimen No. JTR 389, Jeffrey Scovil photograph.

Copper Country calcites have complex crystal forms and habits. Palache (1898) lists the following habits:

1. Negative scalenohedral. Probably more than half of the Copper Country calcite crystals are dominated in habit by negative scalenohedra.
2. Positive scalenohedral.
3. Intermediate (1 and 2 about equally represented).
4. Prismatic (rare).
5. Rhombohedral (rare).

Twinning is common, and is principally by two laws: 1) twin and composition plane {0001}, and 2) twin and composition plane {01\s\up6(–2} (Figures 44 & 45). A common form of the type 1 twinning is one in which a relatively narrow band through the center (or equator) of the crystal is alone twinned, with the parts above and below in their normal relationship. This twinned part may be so thin as to appear only as a hairline seam across the crystal surface, or the twin lamella may be of appreciable thickness. In some crystals, several lamellae in alternating twin positions may occupy this central zone. The presence of this type of central twin band or seam is a characteristic feature of calcite crystals from the Michigan copper deposits. Palache (1898, page 181) stated it is "not known elsewhere." Twinning of type 2 is not rare and commonly takes the form of distortions of the planes of (\s\up6(–\s\up6(–41) faces. Calcites of this type are chiefly from the Quincy mine.

Copper Country calcites abound with crystal faces! Palache (1944) found an astounding 138 forms on nearly 200 crystals measured. In an earlier work (Palache, 1898) 87 forms were found on 150 crystals. The most common forms are {35 \s\up6(–4}, {21\s\up6(–1}, {40\s\up6(–1}, {10 \s\up6(–1}, {13\s\up6(–1}, and {0001}. The negative scalenohedron {35\s\up6(–4}, developed as flat and lustrous surfaces, and the scalenohedron {1•11•\s\up6(–\s\up6(–•8}, whose development results in crystals of nearly cubical shape, are noteworthy. Peculiarly characteristic for these calcites
are the forms {35\s\up6(–4}, {40\s\up6(–1}, {10•4•\s\up6(–\s\up6(–•3}, {12•4•\s\up6(–\s\up6(–•11}, {08\s\up6(–7}, and {10•1•\s\up6(–\s\up6(–•0}. Figures 42 to 45 illustrate some typical crystals.

Compositionally, Copper Country calcites are relatively pure $CaCO_3$ (98.96-99.64%) with very minor amounts of Mg, Fe, Mn (Charlewood, 1935). Notes by Palache for the Calumet and Hecla Consolidated Copper Company in 1920 state that calcite "occurs in every flow or clastic rock and in every vein or fracture." It also is found in cavities, veins, and as a replacement of minerals in both amygdaloids and conglomerates. Common

associates are native copper, datolite, epidote, chlorite, microcline, and pumpellyite. It also is found in pegmatoidal lenses in some thick traps. Another variety, called cave pearls, is formed in recent mine waters.

Figure 46: A 3 cm-tall twinned calcite crystal showing phantoms from Five Mile Point, Keweenaw County. Pam and Jerry Hall collection, John Jaszczak photograph.

Arenac County: **1.** Au Gres: Nodules and geodes associated with chert in the Bayport Limestone of Mississippian age (Dorr and Eschman, 1970). **2.** Griffin and Burt limestone quarries at Omer: Brown concretions and crystals associated with chert (Poindexter et al., 1939; Dorr and Eschman, 1970). Brown crystals up to 15 cm in diameter have been reported. **3.** Arenac Quarry on M-23 near Omer: Brown crystals that fluoresce in UV light (*Rocks and Minerals*, 29, page 23, 1954).

Baraga County: **1.** Zellen's area, section 9, T52N, R30W: Concretions in Jacobsville Sandstone (L. L. Babcock, personal communication). **2.** N ½ section 10, T52N, R30W, about 5 km west of mouth of main branch of Huron River, on the shore of Lake Superior: Old adit in cupriferous vein and copper-stained bleached joints in Jacobsville Sandstone. Vein contains malachite, chalcocite, and calcite. The latter occurs in two generations, the older of which fluoresces red in UV light (L. L. Babcock, personal communication).

Calhoun County: Battle Creek, 16 km north of the west side of Battle Creek River: Dogtooth-type crystals associated with marcasite.

Charlevoix County: Old Antrim Shale quarry, section 3, T33N, R7W: Large calcite and siderite concretions.

Chippewa County: Neebish Island, approximately 32 km southeast of Sault Sainte Marie: Crystals in the Trenton Limestone (Mandarino, 1948).

Figure 47: Calcite with hematite stains from the Vulcan mine, Vulcan, Dickinson County. Field of view 4 x 6 cm. A. E. Seaman Mineral Museum specimen No. DM 8909, George Robinson photograph.

Delta County: Limestone quarry south of Bark River: As gray-white, steep rhombohedral crystals to 2 cm on dolomite in vugs in limestone (M. J. Elder, personal communication, 2003).

Dickinson County: **1.** Menominee iron range: In iron formation commonly found as cleavage masses, but small crystals with rhombohedral or scalenohedral faces also occur (Brower, 1968a). **2.** *Vulcan mine*: In iron formation with pyrite. In large, attractive plates of iron-stained scalenohedral crystals to 5 cm, sometimes associated with pyrite crystals. **3.** *West Vulcan mine*: In iron formation. Three habits of euhedral crystals up to 2 cm in length and 5 mm in diameter have been described by Bayley (1904): l) steeply scalenohedral, 2) steeply rhombohedral, 3) combination of 1 and 2. Associated are dolomite, pyrite, and chalcopyrite. In addition to well-crystallized calcite specimens, attractive white coralloid growths of calcite replacing fungus (probably Armillaria rhizomorphs) were found on the east end of the 8th level. **4.** Groveland mine: Calcite crystals combining prism and negative rhombohedron forms are overgrown by crystallographically

oriented pyrite (epitaxy) (Zimmer, 1966). **5.** Bradley mine, Iron Mountain: In small, etched, iron-stained white crystals lining cavities in iron formation. **6.** Roadcut on Highway 69, just west of Felch: Uncommonly as etched prismatic pale yellow crystals in cavities in a quartz/carbonate rock. **7.** *Loretto mine*, Loretto: In well-formed white scalenohedral crystals associated with pyrite, similar to those from the Vulcan mine. **8.** *Chapin mine*, Iron Mountain: White scalenohedral and prismatic crystals similar to those from the Vulcan mine. **9.** Briar Hill mine, north of Norway: As small, flat, rhombohedral crystals with pyrite, and in coralloid growths from a spring deposit north of the mine. **10.** Curry mine: white crystals in vugs in hematite, similar to those from Vulcan mine. **11.** Walpole mine: As colorless shallow rhombohedra to 1 cm on dolomite in cavities in earthy hematite.

Eaton County: *Cheney limestone quarry* at Bellevue: Scalenohedral white crystals up to 5 cm occur in vugs in the Bayport (Mississippian) Limestone with pyrite and marcasite. Two other types of crystals, tiny white and glassy dark brown, also have been found (Rexin, 1961; *Rocks and Minerals*, **37**, page 378, 1962; Dorr and Eschman, 1970; Squire, 1972).

Gogebic County: **1.** *Penokee mine* (as well as the Cary and Montreal mines in bordering Wisconsin): With goethite, aragonite, and manganite (Rexin, 1959). Some occur as white hemispherical mushroom-like growths. **2.** *Plymouth mine*, Wakefield: As attractive pink botryoidal coatings on brecciated hematite, and as white, shallow rhombohedral crystals to 1 cm in cavities in dolomite. **3.** *Norrie mine*: As thick, pale pink-white botryoidal coatings on brecciated hematite ore; fluorescent cream-white in longwave UV light.

Houghton County: **1.** *Quincy mine*: Remarkably perfect complex crystals, a high percentage having negative scalenohedral habit. Many are twinned. Some enclose or are perched on copper, while others have phantoms. Also fissure veins of calcite, 0.5 to 1 meter wide, are found. **2.** *Isle Royale mine*: Fine scalenohedral crystals often associated with quartz and barite; some are complexly twinned. Some have native copper inclusions. A few occur with inclusions of native silver (may be gray to black) (Spiroff, 1938). Lane (1911) also reports red calcite. **3.** *Franklin mine*: Large gray-lavender crystals. **4.** Centennial mine: Crystals with native copper, some showing basal twinning. **5.** *Tamarack mine*: Beautiful crystals, some exceedingly complex (Palache, 1944). **6.** *Pewabic mine*: Fine, lustrous crystals of negative scalenohedral habit, some with milky cores and colorless outer shells. "Biggest and best" of the Copper Country (K. Spiroff, personal communication). **7.** Painesdale mine: Calcite crystals associated with copper and epidote. **8.** Trimountain mine: Similar occurrence (Mihelcic, 1954). **9.** Calumet and Hecla mine: Occurs as amygdules and fracture fillings in cupriferous parts of the Osceola lode with copper, microcline, epidote, chlorite, and pumpellyite (Weege and Schillinger, 1962). Analyses of calcites from this mine are reported by Charlewood (1935). **10.** Kearsarge mine: Additional analyses of calcite from this deposit are recorded by Charlewood (1935). **11.** Osceola mine: Red calcite, owing to minute inclusions of copper (Rominger, 1895). **12.** Turunen Brothers limestone quarry, near Pelkie: A few small vugs lined with colorless prismatic calcite crystals up to 5 mm associated with octahedral pyrite have been found in a hydrocarbon-bearing stratum. **13.** Naumkeag mine: Cave pearls, some of which show the form {21\s\$\bar{u}$p6(–1} (Spiroff, 1950). **14.** Fine specimens also have been found in the Champion, Hancock, Laurium, Osceola, Huron, and Wolverine mines.

Huron County: Wallace Stone Company quarry between Pigeon and Bay Port: Nodules and geodes in the Bayport Limestone (Dorr and Eschman, 1970). The crystals are brown to golden brown, some strikingly iridescent, with associated pyrite.

Iron County: **1.** Buck iron mine: Poikiloblastic crystals as large as several centimeters across are found in soft hematite ores (James et al., 1968). **2.** Cannon iron mine, Stambaugh: A probable manganoan calcite is reported by Kustra (1961) as an associate of manganese ores in Young's ore body in the Riverton Iron Formation. Also with pyrrhotite in a vug in oxidized iron ore in the Cannon mine ("dogtooth spar") (Hawke, 1976). **3.** *Hiawatha iron mine*, Stambaugh: Acute scalenohedra, and, rarely, rhombohedral crystals, occur as vug fillings in iron ore as a post-ore species at the Number 2 mine (James et al., 1968). Some crystals include red earthy hematite. Also as sharp, gray-white shallow rhombohedral crystals with goethite. **4.** In shell marl on the bottom of proglacial Blue Lake near Alpha.

Jackson County: **1.** Jeffrey quarry, Parma, NE ¼ section 30, T2S, R2W: Rhombohedral calcite crystals in solution vugs in Bayport Limestone with aragonite, dolomite, and pyrite (Squire, 1972). **2.** Blue Ridge esker: A cream white, travertine-like calcite cements gravel and cobbles in a gravel pit in the Blue Ridge esker, approximately 8 km south of Jackson, along U.S. Route 127 and Blue Ridge Road, in section 6, T4S, R1E (A. Blaske, personal communication, 2001). Where space permits, small rhombohedral crystals may be developed on some surfaces. This calcite is highly fluorescent and phosphorescent (cream white) in both long- and short-wave ultraviolet light.

Kent County: Grand Rapids: Lustrous dark brown crystals lining vugs in limestone. One specimen in the Harvard University collection has dark brown crystals of rhombohedral habit with white crystals of scalenohedral habit in the same vug.

Keweenaw County: **1.** *Allouez mine*: Fine crystals with native copper inclusions (Spiroff, 1938), some so filled with copper as to be blood-red in color. Some of these may be set in gray carbonate matrix. Also found are cleavable masses of black calcite (Spiroff, 1964). **2.** *Copper Falls mine*: Beautiful crystals of museum quality. On the 4th level of the Gribble vein as opaque white (sometimes twinned) pseudocubic crystals. **3.** Mohawk mine: In fissure veins. **4.** Seneca mine: Similar to Mohawk mine occurrence (Stoiber and Davidson, 1959). Also, Seneca Number 2 mine has cave pearls which appear as white pebbles in mine water puddles and are post-mining in age and origin (Spiroff, 1950). Forms noted are {00\s\up6(–2} and {10\s\up6(–0}. **5.** *Phoenix mine*: Fine crystals with vicinal forms. The west vein of the Phoenix mine has yielded crystals of pseudocubic habit. **6.** Central mine: Twinned parallel to base with epidote flecks in outer parts. **7.** *Five Mile Point*: 1.5 meter-wide fissure vein with cleavage pieces up to 25 cm on edge. In the 1970s some remarkable, tabular, "butterfly" twinned crystals to 6 cm were collected from a calcite vein cutting sandstone on the shore of Lake Superior midway between Sand Hills lighthouse and Seven Mile Point. **8.** Ahmeek mine: Crystals with copper phantoms. **9.** Additional mine localities: Cliff, Delaware, Iroquois, Medora, New York, Northwestern, and Ojibway. Also in Isle Royale National Park, at Hays Point at Copper Harbor, and Silver Creek near Eagle River. **10.** North side beaches, Keweenaw peninsula: Stromatolites (Collenia undosa) occur abundantly in some thin limestone layers in the Copper Harbor Conglomerate. These fossil algal colonies, which are known along the strike for at least 15 km, take the form of laterally linked bulbous hemispheroids, 1-30 cm in diameter. They consist of calcite in couplets of light-dark laminations, 20 mm to a few millimeters thick. The darker members contain more ultrafine hematite pigment. Also seen microscopically are radial, fibrous calcite fans and some calcite blades pseudomorphous after gypsum (Elmore and Daniels, 1980; Elmore, 1981). Microscopic native copper (q.v.), cuprite, copper sulfides, and domeykite have been found in some of the stromatolites (Nishioka et al., 1984). **11.** Clark mine: Crystals and twinned microcrystals on pumpellyite, some coated by tenorite or cuprite crystals (Bee and Dagenhart, 1984).

Figure 48: Calcite crystals on drusy quartz from the Jackson mine, Negaunee, Marquette County. Field of view 2.5 x 3.5 cm. A. E. Seaman Mineral Museum specimen No. DCG 544, Jeffrey Scovil photograph.

Marquette County: **1.** Beacon iron mine: With magnetite, garnet, rhodonite, and tourmaline (Rexin, 1958). **2.** *Negaunee iron mine*: Colorless to white prismatic and scalenohedral crystals to 2 cm lining cavities in hematite ore. **3.** *Columbia iron mine*: In large groups of hematite-stained prismatic crystals with rhombohedral terminations to 2.5 cm. **4.** Dead River: In quartz-carbonate veins with copper sulfides (Puffet, 1966). **5.** Bluffs at SW corner of section 29, T48N, R27W: "Seams of white calcspar with cleavage planes large enough to split off rhombohedric blocks 8 inches in

diameter" (Rominger, 1881). These are in veins with talc in steatite. **6.** Crockley pegmatite, section 22, T47N, R29W: Pseudomorphous after titanite (Heinrich, 1962a). **7.** *Princeton mine*, near Gwinn: As prismatic yellow-white crystals to 1 cm in cavities in iron ore. **8.** Bessie mine, near Humboldt: In small, gray scalenohedral crystals. **9.** Wheat mine near Palmer: As iron-stained, etched prismatic and scalenohedral crystals to 2.5 cm in cavities in brecciated iron formation. **10.** *Jackson mine*, Negaunee: In delicate, thin prismatic crystals to 1 cm on dolomite-hematite breccia. **11.** Dalliba mine, near Champion: As small, etched prismatic crystals with dolomite and goethite in cavities in iron formation. **12.** Champion mine: Babcock (1966a, b) reports a coarsely crystalline manganoan calcite ("manganocalcite") rimmed by manganoan siderite in a quartz vein with ferroan talc cutting coarsely crystalline iron formation. **13.** Republic mine: As small crystals perched on dolomite crystals in cavities in brecciated iron formation. **14.** *McComber (Lucy) mine*, Negaunee: Pale pink, finger-like growths of manganoan calcite up to 3 cm line cavities in brecciated iron formation. Much of this material has been called "rhodochrosite," but energy dispersion X-ray spectrometry has shown it is manganoan calcite. **15.** Presque Isle, Marquette: Pinkish, hematite-stained scalenohedral crystals to 1.5 cm in veins.

Monroe County: 1. South of Monroe near Lake Erie shore: Calcite as tufa (travertine) in porous, yellow-brown layered rock with imprints and molds of organisms (Sherzer, 1900). **2.** *Michigan Stone and Supply Company quarry (Woolmith quarry)* 1.6 km west of Scofield, NE ¼ section 29, T5S, R8E: Cavities and fissures in Lower Devonian siliceous dolomite contain scalenohedral crystals, some doubly terminated and up to 5 cm long, and some having thin coatings of iridescent marcasite, associated with pyrite and dolomite. The crystals fluoresce green in long-wave UV light (Zodac, 1947; Mihelcic, 1954; Dorr and Eschman, 1970). **3.** London Aggregates quarry near Milan: Pearly white crystals associated with celestine. **4.** *Detroit Edison's Enrico Fermi Atomic Energy Plant quarry at Monroe*: With celestine in vugs in the Bass Island Formation. **5.** *France Stone Company quarry at Monroe*: As golden brown scalenohedral crystals to 10 cm in vugs in limestone. **6.** *Thompson - McCully Quarry* near Newport: As pale yellow scalenohedral crystals to 5 cm in vugs in limestone. **7.** *Holloway (Rockwood Stone) Quarry*, near Newport: Pale amber scalenohedral crystals to 8 cm with celestine.

Figure 49: Calcite crystals from the France Stone Company quarry near Monroe, Monroe County. 3 x 5 cm. A. E. Seaman Mineral Museum specimen No. DM 23126, Jeffrey Scovil photograph.

Ontonagon County: 1. *Adventure mine*: Fine crystals, many twinned parallel with base, some with copper inclusions, others stained orange by iron oxide. **2.** *White Pine mine*: In veinlets with quartz, pyrite, and copper sulfides (Carpenter, 1963). In 1974, a large pocket was encountered in the Northeast orebody that produced "dogtooth" crystals up to 10 cm partially coated with chalcopyrite crystals (Rosemeyer, 1999). **3.** *National mine*: Larger clear crystals with vicinal forms found on smaller pink, copper-bearing crystals. Also found are veinlets of granular orange calcite with white calcite in centers. **4.** *Caledonia mine*: Scalenohedral crystals with inclusions of native copper. **5.** *Ridge mine*: As twinned, modified scalenohedral crystals to 6 cm with copper and "adularia." **6.** *Minesota mine*, near Rockland: As large scalenohedral crystals (some with copper inclusions) associated with copper, epidote, and "adularia."

Ottawa County: Quarries near Grandville: Brown crystals with gypsum (Dorr and Eschman, 1970).

Presque Isle County: Port Calcite. World's largest limestone quarry, developed in the Rogers City Formation.

St. Clair County: Kettle Point on Lake Huron near Port Huron: Concretions in shale.

St. Joseph County: In marl on the bottom of Marl Lake.

Shiawassee County: Paul Frank quarry near North Vernon: Fine crystals (Rexin, 1960).

Wayne County: *Rockwood (Ottawa Silica) quarry* near Rockwood: Pale yellow crystals with celestine in vugs in the Sylvania Sandstone (Devonian). Some are of the nailhead variety (Mihelcic, 1954; Dorr and Eschman, 1970).

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UPDATE

Scalenohedral calcite crystals from north of Gladstone, Delta County; 3 x 5 cm area. A. E. Seaman Mineral Museum specimen DM 27581, George Robinson photograph.

Alpena County: A number of quarries in the Alpena area have produced specimens of calcite (Vicary, 2007). These include, among others, quarries in sections 14 and 23, T31N, R8E; sections 6 and 25, T32N, R8E; section 30, T31N, R7E; and section 11, T31N, R8E.

Delta County: Approximately 19 km NNE of Gladstone: As lightly etched pale yellow scalenohedral crystals to 5 cm in large, asphaltum-filled vugs in limestone. Associated minerals include minor sphalerite, marcasite, and barite. The crystals were encountered while excavating for a pond (M. J. Elder, personal communication, 2005).

Livingston County: Unadilla Township, SE 1/4 section 21, T1N, R3E: During a recent water testing project, a borehole into a limestone unit (probably Michigan Formation) encountered a 10 to 15 cm clay-filled void at a depth of about 27 meters. Lining the sides of the void were calcite crystals, white on the upper surface of the void and pink/orange on the bottom. Under the microscope, two generations are evident – an earlier growth of clear rhombohedra to 0.5 mm across, and a later one consisting of barrel-shaped, clear to iron-stained (orange/pink) crystals up to 1 mm long. Both are non-fluorescent in ultraviolet light (A. Blaske, personal commun-ication, 2008).

Presque Isle County: Lafarge Presque Isle Quarry (Stoneport), section 2 and surrounding area, T33N, R8E: Small (~1 mm) calcite crystals occur in vugs with chert in the middle Devonian Rogers City Limestone, and in small vugs with dolomite in the middle Devonian Dundee Limestone (A. Blaske, personal communication, 2007).

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