

GOETHITE

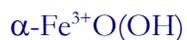


Figure 81: Stalactitic goethite from the Section 16 mine, Ishpeming, Marquette County. Field of view 4 x 6 cm. A. E. Seaman Mineral Museum specimen No. AES 602, Jeffrey Scovil photograph.

One of the commonest iron oxide minerals. Much of the rusty, massive material called “limonite” is probably mostly goethite. “Limonite” is a catch-all term for various iron oxide species that cannot be identified megascopically. Most limonite, when analyzed, is found to be goethite plus adsorbed water. Lepidocrocite, hematite, and amorphous iron oxides or hydroxides also may be present.



Figure 82: Stalactitic goethite from the Cleveland mine, Ishpeming, Marquette County. Stalactites are 4 cm in diameter. A. E. Seaman Mineral Museum specimen No. DM 562, Jeffrey Scovil photograph.

Goethite is a widespread mineral in the iron ranges of the Northern Peninsula, and as an alteration product of iron-bearing minerals in rocks throughout the state.

Goethite typically forms under supergene oxidizing environments by weathering of iron oxides, sulfides, carbonates, and silicates. It is also a primary inorganic or biogenic species in fresh and marine waters. In Michigan iron deposits, it is principally in the “soft” iron ores formed by oxidation of various primary iron ores. Goethite was preferred to hematite during early mining days because steam, from its water content, rendered it porous and easier to smelt.

Goethite crystals are often prismatic [001] in habit, and occur in a variety of aggregates: acicular forms, some radially arranged, others as velvety aggregates; masses with botryoidal or reniform surfaces; and stalactitic, all with radial-fibrous and/or concentrically layered internal structures (figure 82). It is also found as massive or fibrous concretions, as earthy, porous masses, and as thin irregular films. “Ferrite,” “grape ore,” “ocher,” and “xanthosiderite,” and are all obsolete varietal names. Northern and Southern Peninsulas.

Baraga County: 1. Ohio mines, Imperial Heights. 2. Taylor mine, Alberta (1, 2, Morris, 1983).

Calhoun County: 16 km north of Battle Creek on the west side of Battle Creek River: Dogtooth crystals of calcite associated with limonite and pyrite (*Rocks and Minerals*, 28, page 248, 1953).

Dickinson County: 1. *Western part of the Menominee iron range*: As botryoidal masses and in limonitic ore (Brower, 1968). 2. East Vulcan mine: Radial-botryoidal masses. 3. Metronite quarry, 4 km east-northeast of Felch: As attractive microcrystals (DeMark, 2000).

Gogebic County: 1. Penokee mine (as well as the Cary and Montreal mines in nearby Wisconsin): Occurs in all three with calcite, aragonite, and manganite (Rexin, 1959). 2. Newport mine: Radial-botryoidal masses. 3. *Geneva*, Ashland, Norrie, Townsite, and Yale mines, Ironwood (Morris, 1983).

Iron County: 1. *Mines of the Iron River-Crystal Falls district*: Generally common as both an ore and a post-ore species (Carr and Dutton, 1959). It may be a major ore constituent. It is also found as botryoidal masses in cavities and as fine needles coating other vug species (James et al., 1968). Associated minerals are earthy and specular hematite and minor late vein minerals (chalcopyrite, pyrite, marcasite, barite, chlorite, calcite, and apatite) (James and Wier, 1948). Examples: Bengal, Bristol, Buck, Cannon, and Hiawatha mines (Morris, 1983). 2. Section 35, T43N, R35W, south of Iron River: The soft iron ore here had many irregular "druse cavities" lined with bushy clusters of goethite needles. Other cavities were lined with grape ore. 3. SW ¼ SW ¼ section 36, T43N, R35W, south of Stambaugh: Soft iron ores contained grape ore, stalactitic goethite, and rhomboid hematite crystals (Rominger, 1881).

Jackson County: John C. Jeffrey quarry, Parma, with carbonates, iron sulfides, and glauconite (Morris, 1983).

Marquette County: 1. *Jackson mine*: Occurs in drusy vugs as lamellar crystals less than a centimeter long and in limonite and hematite. It is also found as stalactitic masses of limonite covered with radiating blades of goethite over 2.5 cm long

(Brooks, 1873). Velvety, pearly black limonite is also found as earthy masses and botryoidal groups (blackberry ore, grape ore, and kidney ore). 2. *Lake Superior mine*: Occurs in botryoidal, stalactitic, and earthy varieties. 3. Athens mine: In cavities in hematite ore. 4. *Lucy (McComber) mine*, Negaunee: Velvety botryoidal masses. 5. *National mine*: Excellent specimens of the botryoidal type (Markert, 1960). 6. Burt mine: Fine, radiating masses. 7. Mather mine: In 1968 was still producing from soft (goethite) ores. Attractive, compact reniform masses of needle-like crystals (Hawke, 1976). 8. Tracy mine: Also producing (1968) from soft ores. 9. Occurs as nodular concretions, bulky seams (hogbacks), radiating fibrous masses (grape ore), and yellow-brown earthy porous limonite. It is also found in altered Negaunee Iron Formation with hematite, martite, quartz, and pyrolusite (Rominger, 1881). Goethite is also reported in the Negaunee and Bijiki Iron formations as an alteration of grunerite or minnesotaite (Harcourt, 1942; Mann, 1953). 10. Empire mine: Quartz-goethite veinlets cut iron formation. 11. *Cleveland mine near Ishpeming*: Kidney ore. 12. *Section 16 mine near Ishpeming*: Velvety botryoidal masses in vugs in hematite. 13. Pendill mine: Stalactitic. 14. Blueberry (Dexter) mine, Snowville, near Diorite: With manganite and barite. 15. Michigamme mine, Michigamme. 16. Palmer Ridge. 17. Phoenix pit at Champion. 18. Republic mine, Republic. 19. *Salisbury mine*, Ishpeming. 20. Tilden and National mines, near Ishpeming (14-20, Morris, 1983). 21. Sellwood mine, Ishpeming. 22. Pascoe mine, near Champion. 23. Northampton (SE ¼ section 30, T48N, R29W) and Dalliba (SW ¼ section 29, T48N, R29W) mines near east end of Lake Michigamme, north of the Champion mine: In limonitic iron ore, radial grape ore in stalactites "of great beauty" coated by "a smooth, brightly shining, black, varnish-like cuticle" or a velvety or needle-goethite coating. Vugs contain radial clusters of goethite and quartz crystals (Rominger, 1895, page 68). 24. Cheshire (S. C. Smith) mine, SE ¼ SE ¼ section 18, and SE ¼ NW ¼ section 20, T45N, R25W, near Gwinn: Vugs in martite ore contained velvety goethite (Rominger, 1895). 25. Ishpeming: Botryoidal, brown goethite lines fracture surfaces in iron formation excavated during construction for the Jubilee I. G. A. store on the north side of highway 41 in the village of Ishpeming. Minor barite, hematite, manganite, and

neotocite are associated. **26.** Lighthouse Point, Marquette: As bladed, brown microcrystals in seams and veinlets in schist.

Monroe County: In marshy areas near Milan, Petersburg, and Bedford: Bog iron ore occurring as irregular rusty lumps is found just below the surface (Sherzer, 1900).

Ontonagon County: Caledonia mine: As tiny spars of microcrystals on earlier-formed minerals (Rosemeyer, 1990).

Schoolcraft County: Manistique River: Bog iron ore.

Van Buren County: Approximately 7 km south of South Haven, and 3 km south of Lake Michigan shore: Root-shaped, hollow, cylindrically shaped limonitic concretions as much as 7.5 cm long occurring in limonitic sand (Hill, 1948).

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UPDATE

Baraga County: Roland Lake: Unusual stalactitic growths of goethite (and opal, q.v.) occur as speleothems in voids between boulders in a Pleistocene till exposed in an unnamed gravel pit ~3 km southwest of Roland Lake.

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