APATITE GROUP

$Ca_5[(PO_4),(CO_3)]_3(F,OH)$

The apatite group includes some nineteen different mineral species, though only two are known from Michigan: fluorapatite and members of the carbonate-fluorapatite - carbonate-hydroxylapatite series. The former is a common accessory mineral in many igneous rocks including granite, diorite, syenite, gabbro, and their extrusive equivalents (rhyolites, andesites, trachytes, and basalts). It is also found in pegmatites and hydrothermal veins, as well as in many metamorphic rocks (various schists, gneisses, and iron formation) similarly as a microscopic accessory. Carbonate-fluorapatite and carbonate-hydroxylapatite are primarily of sedimentary origin, occurring as the variety "collophane" in phosphorite, which, in Michigan, forms units associated with the Precambrian iron formations. It is found in general as a microscopic constituent of siderite-chert iron formation in the Marquette iron range (Mann, 1953). Apatite also may occur in sedimentary rocks (e.g., sandstones) as a detrital mineral. Mainly Northern Peninsula, also Southern Peninsula.

Figure 36: Apatite crystals to 1 mm from the Old Richmond mine near Palmer, Marquette County. The red-brown coloration is probably due to inclusions of iron oxide. Dan Behnke specimen and photograph.

Baraga County: **1.** Bed of Huron River NW ¼ section 35, T52N, R30W and **2.** West of the Slate River near center of section 28, T51N, R31W: Brownish black, partly colloform bands or laminae of carbonate-rich apatite (± pyrite and uncommon calcite) alternate with white calcite-chert-minnesotaite in bands in cherty iron formation exposures (Mancuso et al., 1975). Verified by X-ray diffraction. **3.** Michigamme, NW ¼ section 24**,** T48N, R31W: Phosphate in well-rounded pebbles and thin (~1 cm) beds. The conglomerate (Ajibik Quartzite) contains pebbles of vein quartz, gneiss, older quartz-pebble conglomerate, and apatite in a quartzose matrix with disseminated grains of pyrite and magnetite. Both pebble and stratiform apatite are extremely fine-grained and difficult to identify even microscopically. It appears to comprise no more than 1% of the host rock (Cannon and Klasner, 1976). Samples of this phosphate rock have been subjected to beneficiation studies (Brown and Rule, 1978; Brown and Daellenbach, 1981), and analyzed by Snider (1977b) and the U.S. Bureau of Mines (Brown and Rule, 1978; Brown and Daellenbach, 1981). **4.** Cloud and Morrison (1979) report chains of pyritic microbiota in basal Michigamme beds in "a black phosphatic layer 1 to 9 mm thick at Big Eric's crossing of the Huron River." **5.** Ohio mines (Imperial and Webster mines) Imperial Heights near Michigamme: With hematite, goethite, sulfides, carbonates, graphite, and palygorskite (Morris, 1983; DeMark, 2000). Also as thin, colorless crystals to 2 mm with quartz and calcite (T. M. Bee, personal communication, 1999). **6.** Taylor mine, approximately 3.2 km north of Alberta, off old U.S. Highway 41: As microscopic tufts of pale pink crystals in cavities in dense "limonite" ore. An energy dispersive X-ray spectrum obtained from one sample (A. E. Seaman Mineral Museum, specimen DM 23018) showed substantial enrichment in Cl, suggesting the species may be chlorapatite.

Dickinson County: **1.** Menominee iron range: Very fine-grained, disseminated through iron ores in small amounts (Brower, 1968). **2.** NW ¼ section 32, T42N, R28W: Found in the Randville Dolomite replaced by iron oxide minerals and then brecciated. The hexagonal to barrel-shaped crystals in limonite appear to be carbonate-hydroxylapatite ("dahllite") (James et al., 1961).

Houghton County: **1.** Many native copper deposits: As a microscopic constituent of felsites and basalts (Lane, 1911; Butler and Burbank, 1929). **2.** Jacobsville Sandstone: As detrital grains of both ordinary apatite and the variety collophane (Denning, 1949), the latter derived from Precambrian phosphorite. **3.** Isle Royale lode: In hangingwall flow.

Iron County: **1.** *Cannon (Bengal) mine*: Clear, well-formed crystals 1 mm in diameter coating hard hematite ore (James et al., 1968). **2.** Buck mine, Gaastra (Morris, 1983). **3.** *Hiawatha mine*, Stambaugh: Color-zoned pinkish brown microcrystals on goethite (DeMark, 2000). **4.** *Ravenna mine*, Crystal Falls: Excellent orange-red microcrystals (resembling vanadinite) on goethite. **5.** Chicagon mine: Small iron oxide-stained crystals on goethite, similar to other occurrences. **6.** Several low-grade Precambrian phosphorite occurrences are reported in the Gogebic range (Cannon, 1983a; Ojakangas, 1983) (phosphorite). **7.** Great Western mine, Crystal Falls: As microscopic colorless tabluar crystals with gypsum in brecciated iron formation.

Kalkaska County: In core of Kalkaska 3 to 28 oil well section 28, T27N, R8W: In voids with fluorite, halite, anhydrite, calcite, and dolomite in the Niagaran A1 Evaporite (Cercone, 1984). Presumably a variety of collophane.

Keweenaw County: Native copper deposits: Microscopic crystals in both felsites and basalts (Lane, 1911, Butler and Burbank, 1929; Cornwall, 1951a, b). At the Washington mine, fluorapatite occurs as colorless, complex crystals to 1mm, lining cavities in brecciated basalt.

Marquette County: **1.** Jacobsville Sandstone: As detrital grains and collophane (Denning, 1949). **2.** Lake Michigamme area: Greenish crystals as large as 2.51 x 7.5 cm in pegmatites and quartzose veins. Associated with the apatite are quartz, muscovite, beryl, and andalusite (Snelgrove et al., 1944). **3.** Republic, section 8, T46N, R29W: In pegmatite with molybdenite and beryl (Snelgrove et al., 1944). **4.** South Jackson iron pit: Minute, thin hexagonal prisms in iron formation (Spiroff, 1940). **5.** *Champion iron mine*: Gray, yellow or reddish, hexagonal prisms from 1 mm to 2.5 cm across on limonite (Michigan College of Mines, 1905), and embedded in quartz (T. M. Bee, personal communication, 1999). **6.** Phoenix iron pit: Small red hexagonal platelets in cavities in hematite (Mandarino, 1950). **7.** Beacon iron mine: Pink or yellow hexagonal prisms 1 to 5 cm long (Mandarino, 1950). **8.** Webster iron mine near Michigamme: As microscopic drusy crystals on fracture surfaces in limonite ore. **9.** *Dalliba iron mine* at Champion: As reddish, blocky, hexagonal crystals to 2 mm in cavities in limonite. **10.** Bessie iron mine, at Humboldt: As colorless to pink microcrystals (occasionally with marcasite) on goethite. **11.** *Mitchell mine* at Ishpeming: As colorless tabular crystals to 5 mm with hematite in cavities in a micaceous matrix. **12.** New Volunteer mine, NE ¼ section 25, T47N, R27W: As pearly gray hexagonal microcrystals to 1mm with minor "adularia" in cavities in brecciated iron formation. **13.** Tracy mine, Negaunee. **14.** Blueberry mine, Snowville, near Diorite. **15.** Republic mine (13-15, Morris, 1983). **16.** *Foster mine*, Negaunee: Good reddish microcrystals on goethite with calcite. **17.** *Old Richmond mine*, near Palmer: Colorless tabular microcrystals stained pink by hematite in cavities in hematite ore (DeMark, 2000). **18.** Humboldt mine: In small crystals (T. M. Bee, personal communication, 1999). **19.** National mine, south of Ishpeming: As iron-stained aggregates of subparallel tablular crystals to 1.5 cm in diameter (A. E. Seaman Mineral Museum collection, Michigan Technological University, specimen DM 22982). **20.** Davis mine, Negaunee: As orange microcrystals in fractured quartz. **21.** Rock phosphorite of the pebble type has been found at two localities: NE ¼ section 15, T49N, R28W and on the north shore of Silver Lake, NW ¼ section 8, T49N, R28W. At the first, phosphatic beds are abundant in a stratigraphic unit 82 to 91 meters thick, underlain by a dolomitic quartzite, the basal unit of the Baraga Group. The phosphate beds contain well rounded flat pebbles of black apatite up to ~ 10 cm long (Cannon and Klasner, 1976). The pebbles are set in a fine-grained quartz sand matrix, which in the richest beds also contain abundant arenaceous apatite and 1 to 2% muscovite and pyrite, and, in some layers, numerous carbonate rhombs. Ilmenite and graphite are reported by Brown and Daellenbach (1981), and stilpnomelane by Johnson et al. (1978). Dark chert, argillite, and arkosic quartzite are interbedded with phosphorite and phosphate-bearing conglomerate. The richest beds contain 40-60% apatite (15% P_2O_5). The lowest 41 meters of the unit contains many phosphatic beds, 0.1 to 1.8 meters thick. The section 15 deposit is believed to be the richest Precambrian sedimentary phosphorite deposit of the United States, as well as one of the oldest (Cannon and Klasner, 1976). At the Silver Lake locality only the lowermost 1 to 2 meters of Baraga Group beds are exposed, resting unconformably on Precambrian gneisses. The beds are mainly poorly sorted conglomerate with

some shale. Pebbles include gneiss, vein quartz, and rare fine-grained apatite, up to about 2 cm long (Cannon and Klasner, 1976).

Monroe County: 1. Brest. **2.** Pointe aux Peaux. **3.** Stony Point. **4.** Monroe (1-4, Dana, 1892).

FROM: Robinson, G.W., 2004 Mineralogy of Michigan by E.W. Heinrich updated and revised: published by A.E. Seaman Mineral Museum, Houghton, MI, 252p.