

LORES, LEGENDS AND LODES FROM LAKE SUPERIOR - MOTHER OF COPPER DEPOSITS

Introduction

Copper rarely occurs in huge quantities in native form. But an exception is the renowned century old Lake Superior mining region in Northern Michigan, USA, of which many interesting lores and legends abound.

The 48 km wide Keweenaw Peninsula (KP; also known as the Copper Country or the Upper Peninsula, UP); situated in the State of Michigan, has an appearance of a narrow, crooked thumb testing the cold, blue waters of the Lake Superior (Fig.1). An ancient legend considered the KP to be of solid copper! The Red Indian tribes Algonquins and especially the Chippewa vaguely hinted at a powerful lost ancient race that had mined copper. The UP was divided when Ohio occupied Toledo city and as compensation 40,000 sq. km of unknown and unexplored wilderness between Lakes Michigan and Superior was exchanged with a reluctant Michigan State.

General Geology

Precambrian rocks and glacial deposits constitute the western and central UP. An Archaean (2.5 to 3.4 billion year old) basement of greenstone belts interspersed with gneissic terraces is faulted, folded and partly covered with 19 M.Y. year old sedimentary basins containing huge deposits of iron ore. The last geological episode (the "Keweenawan") began with the origin of a hot spot beneath the present day Lake Superior and formed a 100 km wide domal structure, ~1.1 to 1.2 billion years ago, the mid-continental rift system developed that formed a linear belt of subsidence with a number of fault-bounded basaltic blocks. Volcanism lasted for 25 M. Y. (1109 to 1084) and covered hundreds of square kilometers. After sedimentation, the Lake Superior region was compressed perpendicular to basinal axis. The five major stratigraphic units, over 14,000 m thick, are: Portage Volcanics, Copper Harbor Conglomerate, Nonesuch Shale, Freda Sandstone and Jacobsville Sandstone.

Native Copper Deposits

Native Cu almost exclusively occurs in the Portage Lake with over 200 basaltic flows and is of hydrothermal origin (200° to 350°C) as also evident from the wide-spread deposition of calcite, quartz, epidotes and a variety of zeolites. After the tectonic uplift, erosion slowly levelled the area to a gently roiling plain. Melting of

glaciers during the Pleistocene produced a number of lakes.

The Cu deposits are closely related with silver with both having similarities in their occurrence, associated minerals and crystal habits. Native Ag is widespread but is relatively less and occurs irregularly and unexpectedly. Since mining was confined largely to Cu, Ag was something like a "finders-keepers". Few early mines showed abundant Ag in the upper levels, that for a time Cu was looked upon as a by-product, as more profits were from Ag! Co-occurring Cu and Ag samples ("half-breeds"), consist of rounded nuggets of Cu and Ag up to few cm in diameter. Although both occur in natural and native forms, many half-breeds are not true minerals *sensu stricto* as they have been mashed by the pounding of the mills and the original forms altered. Genuine Cu nuggets and Ag occurring in the glacial till deposits of the districts ("float copper") sometimes weighing tonnes, can still be found. The major ore production centres were geographically restricted to a 45 km long belt within the Portage Lake Volcanics with the amygdaloidal and brecciated flow tops accounting for 58.5%, interflow conglomerate (39.5%) and fissures and veins (2%).

History of Cu-Mining

Long before Champlain and Columbus came to N. America, some long forgotten race of people extensively mined and worked thousands of pits, extracted a vast amount of Cu and vanished! This is apparent on Isle Royale, which has at least 10,000 ancient pits and several hundreds on the KP mainland. In 1770, J. Carver first described the Lake Superior deposits and formed a mining consortium. After five decades, H. Schoolcraft and L.F. Cass led several expeditions. Dr. D. Houghton, a botanist and surgeon, joined the second expedition in 1830 and was the first to notice the legendary solid Cu ("Big Boulder") lying on Ontonagon River bank. His reports revealed a number of indications of huge Cu deposit but they failed to provoke any mining interest. For five tedious years, he got a nominal salary although the mines eventually doled out millions of dollars in dividends alone! But for a monument near Eagle River and the naming of the principal city in the UP, the Father of Cu-mining is nearly forgotten.

In 1843, Congress obtained from the Chippewa Indians 46,000 sq. km of the UP, including 480 km of the Lake

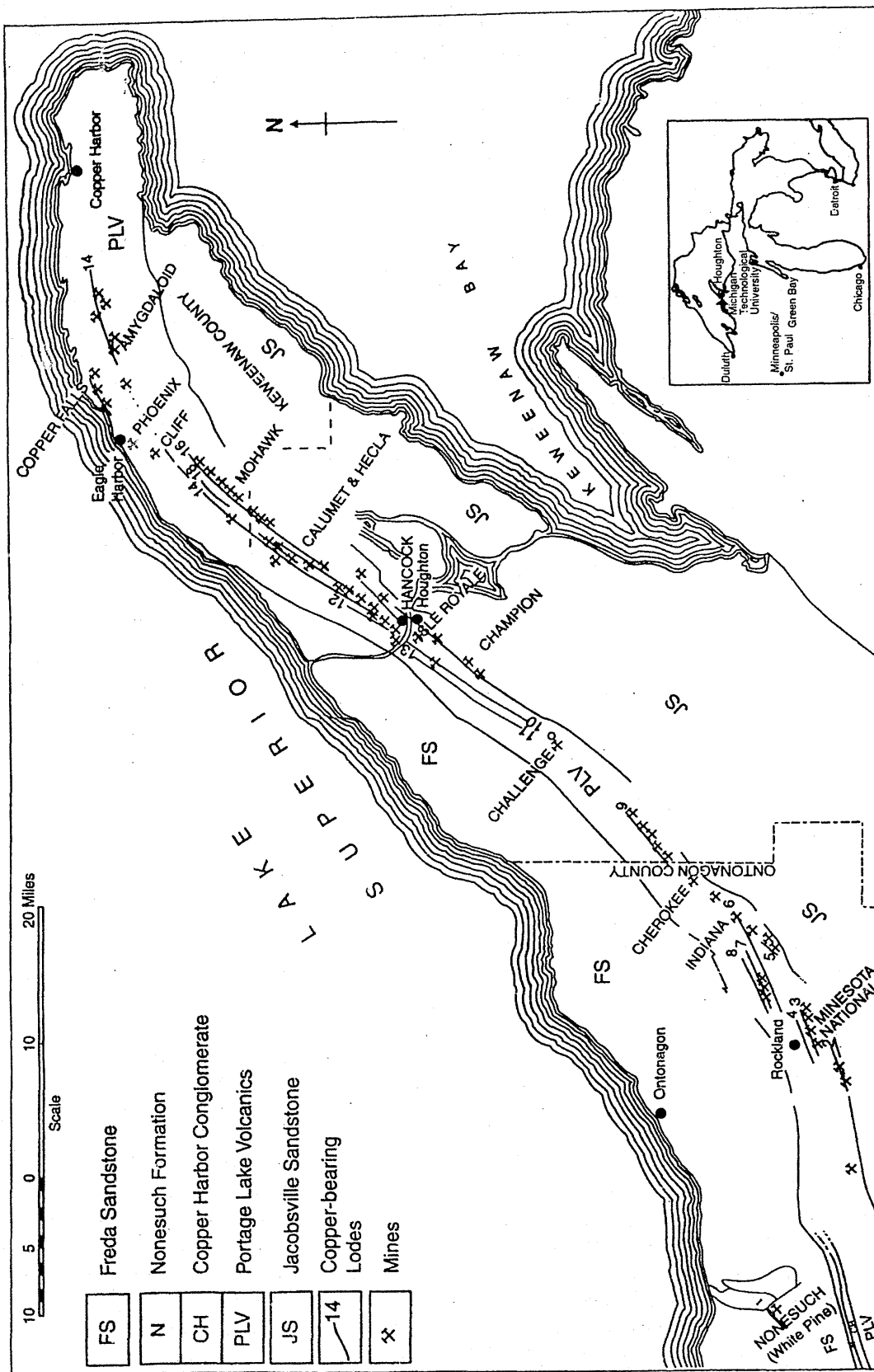


Fig.1. The Keweenaw Peninsula, Michigan, projecting like a finger into the cold waters of the Lake Superior. The simplified map depicts the geological formations and few of the copper mining districts and lodes (Map source: Wilson and Dyl, 1992 and with permission from Dr. W.E. Wilson, Editor-in-Chief of the 'Mineralogical Record').

Superior shore line. This led to an exodus akin to that for gold in California and Australia. The living conditions were tough, with deep woods and undergrowth, swarms of black flies and mosquitoes. Added to these, the area had nine months of heavy snowfall and bitter winter. Congressman Patrick Henry aptly noted that the KP is, "beyond the most distant wilderness and remote as the moon"; while further back in history Baron L'Horton wrote to the King of France, "The Keweenaw is at the fag end of creation."

The prospector carried a permit and once a likely site was found, filed a claim with the War Department and paid up to 10% of the metal mined as rent. To help prospectors, agents ("White Pawnees") cropped up who sometimes owned more than one permit, being either politically connected or agents of politicians. Buying and selling of permits were common as these were blank and transferrable. The White Pawnees would rush to file a number of claims ("benami") surrounding the area and sometimes even that of the prospectors if he had not done so!

Even more than 150 years ago the concept of public issues was prevalent when the mining companies raised their capitals. Cu production began in 1845 with the development of the Cliff Mines in Keweenaw County and the Minesota Mine in Ontonagon County that mined the mass of Cu. The Quincy Mine ("Old Reliable"), operated by the Quincy Mining Company from 1865 to 1945, was the first of the lower-grade, altered amygdaloidal basalt deposits. The Cu-bearing conglomerates, discovered in 1859, led to the opening of mines on the Calumet lode in 1864. The conglomerates were harder to mine but the ore grade (4.5%) was considerably higher than at Quincy (1.2 to 1.5 %).

Largest Solid Mass of Native Cu

The Minesota Mine still holds the record for producing large amounts of Cu per volume of rock from a small area wherefrom huge masses of pure Cu was frequently mined. Practically, all the museums, libraries and science departments of colleges and universities then obtained fragments of Minesota mass Cu. Specimens were sold to visitors thus, generating a good deal of revenue for the company! The mine broke all records in 1856 with the discovery of the largest solid mass approximately 14x5.7x2.5 m of pure native Cu. To dislodge this, 1250 kg of gunpowder was used and 20 men worked for 15 months to cut down this gigantic irregular mass that finally yielded 27 tonnes of Cu. Some of the other large masses of copper recovered were: National 1200 tonnes, Quincy 300 tonnes, Flint Steel 125 tonnes, Aztec 100 tonnes, Mass 80 tonnes and both Rockland and Caledonia 40 tonnes.

In 1864, the Calumet Conglomerate Lode was found by E.D. Hulbert. After some years, the Hecla Mining Company operated this mine (C&H). In 1867, Quincy the president of C&H, appointed his brother-in-law, Alexander Agassiz, son of the famous naturalist, to manage the mines. Agassiz did a commendable job, made large profits and paid rich dividends to the stockholders. In later years, he conducted the affairs of the richest metal mine on the earth as a sideline to zoology! He visited biannually and during other times collected specimens as a curator of the Harvard Museum of Natural History.

In the early days, "man engine", a kind of conveyor belt system to lower and raise men and equipment, was used in the mines. Later, steam-driven hoists were introduced, like the monstrous one in the world at the Quincy mine, Hancock. It was built and installed in 1920 by B.V. Nordberg, a Finnish immigrant. The hoist weighs 8,02,272 kg and is 18x 16 m and 18 m high. A wire rope of 4030 m length was wound on the hoist drum, which is 4.8 m diameter at end and 9 m at centre. The hoisting speed was 970 m/minute (58.24 km/hr) and the skip could bear a load of 9000 kg. The operations were stopped when the mine was closed down in 1931. Presently tourists visit this mine.

On the 22x13 m Silver Islet mine, located on the north shore of the Lake Superior in Canadian waters, Ag was exclusively mined. W.B. Frue, discoverer of the Pewabic amygdaloidal Cu lode, twice built a cofferdam to keep the mine dry from the stormy Lake Superior and on the third try a shaft was sunk and Ag retrieved. Amazing profits resulted in a short time for e.g., \$370,000 worth Ag was found in 5 weeks, rocketing the company's share from \$22 to \$2500! Unfortunately, in late Nov. 1944 the tug carrying the coal supply for the mine got frozen in the Portage Lake. The miners pulled down buildings and broke all wooden structures to feed the boilers to keep the pumps operational. But it was futile and after 13 years of successful Ag mining they returned.

The Growth and Decline

The UP was the location of a multi-billion dollar Cu mining enterprise. From 1845 till 1968 the mines produced over 6 billion kg of refined Cu and 16 million ounces of Ag from 17,600 km of underground tunnels and workings. It was apparent by the end of WW I that mining had reached its peak. Different methods such as consolidation of mines, retrenchment of workers and use of sophisticated technology for mining and extraction could not fully compensate nor stop the decline. During the boom period, Michigan set world prices because of her great production but by 1928 the US ceased to dominate the world market. Foreign

deposits were discovered and the world balance changed resulting in the US to import Cu instead of exporting! In July 1913 the Western Federation of Miners went on a strike that continued for about 6 months. By then enough damage was done which, together with the falling Cu prices, WW I and other factors, saw the closure of many mines. Consequently, a reverse exodus of people to the Arizona and Montana copper mines or to Chicago and to the upcoming car factories at Detroit occurred. This event dealt the Cu industry a severe blow from which it never fully recovered. Despite the presence of at least 500 mining companies, over a period of 100 years and with the kms of levels, drifts and stopes worked, it is believed that only about a tenth of the 240 km Cu range, has been explored. Besides Cu, the KP region also supplied millions of dollars worth of timber and iron.

Presently, most of the mines are closed and a Keweenaw National Historic Park has been created to preserve a few of them. In some, conducted tours are made and souvenirs sold. The more than 100 years Michigan Technological University (MTU), Houghton, acquired the lease to the SW portion of the Quincy mine to create an underground scientific and academic facility. The entrance to the old mines was widened to accommodate modern mining vehicles and equipment. After reaching the old workings, an additional 303 m of crosscuts and drifts were opened to provide areas for diverse research. Besides the mining research, biological, mechanical and geological engineering studies, such as monitoring mine air blast and diesel emission pollutants, the effect of stemming on fragmentation, *in situ* stress measurement in rocks by hydraulic fracturing, bat hibernation etc. are carried out.

A.E. Seaman's Mineral Museum

Arthur Edmund Seaman (1853-1937) born near Grand Rapids, Michigan, came to the UP as a timber man. A self-taught geologist, he joined the Michigan Geological Survey in 1885 and in 1892 the Mining School (as MTU was then known). In 1897, he headed the geology and

mineralogy department and helped build the mineral collection. In 1888, the mineral collection was ~7000 specimens and in due course more than 20,000 specimens were added through purchases (even zeolites from Pune, India) and by donation from many alumni and local residents. This makes the museum 8 times larger than even the famous Smithsonian Museum. After retirement till 1928 he was an emeritus professor and curator of the museum. In 1930, the mineral "seamanite" $[\text{Mn}_3^{+2}(\text{PO})_4\text{B}(\text{OH})_6]$ from Iron County, Michigan, was named in his honour.

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