Porphyry-type Copper Deposits in Japan

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Porphyry copper deposits are considered to be associated dominantly with calc-alkaline magmatisms of the magnetite-series (ISHIHARA, 1977) being generated above the subduction zone at convergent plate margins. Within this tectonic setting, porphyry copper deposits may have formed underneath stratovolcanoes, but Kuroko-type deposits in submarine caldera (SILLITOE, 1980). Kuroko vs. porphyry mineralization is undoubtedly a major issue of the Mesozoic-Cenozoic Circum-Pacific metallogeny. In this lecture, what appears to be most important among "porphyry copper deposits" in Japan will be revisited to compare them with the representative examples in other parts of the world.

Kitakami-Abukuma Belt (Cretaceous)

Akagane mine: Jishakuyama orebody of Akagane mine, Iwate Prefecture, which was found through underground exploration for skarn-type copper deposits, could be of porphyry type, because chalcopyrite and pyrrhotite occur in disseminated, stringer and vein forms in a mass of quartz porphyry (SiO₂ 71-72%, ISHIHARA, 1973), which could have been the feeder for then-existed effusive equivalent. Most common altered products are sericite and calcite. The intrusive is elongated in a northeast direction (AISAWA, 1966); the mineralization is also controlled by the northeast-trending fractures, giving the total dimensions of 200 m (strike, N50°E), 300 m (dip, 40-70°SE) and 12 m (maximum width) (Akagane mine, 1969). The quartz porphyry seems to be originally an ilmenite-series, but the later granodiorite intrusion which is likely to be the source for chalcopyrite and pyrrhotite mineralization in skarn deposits belongs to a weakly magnetic magnetite-series.

Cape Nichube: A porphyry-type copper showing at the Cape Nichube, southwestern Hokkaido was found rather recently by seeking analogy to the porphyry-type prospect of Okushiri island (SAWA and YAMADA, 1968) along the facing coast in Hokkaido. The host rock is a differentiated phase (SiO₂ 67%) of granodiorite (SiO₂ 62%) of Setana pluton which belongs to the ilmenite-series. Chalcopyrite, pyrite and rarely molybdenite occur, filling the cooling joints arranged in parallel (Fig. 1) with a northwest strike and near vertical dip. The jointing is well developed for about 500 meters along the coast from the cape northwards. However, intense mineralization is only seen in limited places where hydrothermal alteration (sericite, chlorite and calcite) is conspicuous and the joints are filled with chalcopyrite-pyrite quartz vein. Homogenization temperature of vein quartz is too low (around 240°C, MMAJ, 1978) for the formation temperature of typical porphyry copper deposits.

Fig. 1 Parallel joints at the Cape Nichube, southwestern Hokkaido. Each fracture is weakly mineralized without altered selvage in general. Note rather sparse distribution of the joints.
Inner Zone of Southwest Japan (Late Cretaceous)

Obari mine: Many disseminated and vein-type deposits occur in hornblende-biotite granodiorite of Wasada pluton, Yamagata Prefecture, which belongs to the magnetite-series. These ore deposits follow northwest or northeast fractures which are the same in direction as cooling joints of the host granodiorite (SHIMAZU and KAWACHI, 1961). A representative is the Obari deposit. Zone of 1 to 4 meters wide along the fractures is strongly sericitized (Y. HORIKOSHI et al., 1956). Chalcopyrite, bismuthinite, sphalerite, pyrite, arsenopyrite, tetrahedrite and molybdenite disseminate in the altered granitoids; some parts have very high grades (Cu 10%, Bi 7%, Au 200 g/t, Ag 270 g/t, SHIMAZU and KAWACHI, 1961). These ores, however, occur in a limited extent.

Ariga mine: Ariga deposit of Hyogo Prefecture is often cited as a porphyry copper deposit (e.g., NARITA et al., 1979). This occurs in one of the magnetite-series granodiorites aligned in a west-northwest direction. The ore deposit is located toward the northern margin of Chigusa pluton and is controlled by N80°E and N10°W fractures. Chalcopyrite, pyrrhotite, pyrite and molybdenite occur in disseminated and fracture-filling manner in the altered granodiorite (MMAJ, 1973). Quartz, sericite and carbonates are common altered minerals. The largest orebody is reported to have horizontal dimensions of 18–23 m and 12–15 m, and extends 30–40 m vertically (MMAJ, 1973).

Yoshioka mine: The examples mentioned above possess some characteristic aspects of porphyry copper deposits. However, they seem to show a deep level of the volcano-plutonic profile, except for the Akagane mine. At Yo-

![Diagram](image_url)

**Fig. 2** Intrusives and vein system of Yoshioka mine area, Okayama Prefecture. Compiled from MMAJ (1973) and unpublished map of the mine. Intrusives are shaded. QP, quartz porphyry; Qd quartz diorite. Chemical analysis of altered quartz porphyry is courtsey of S. TERASHIMA, Geological Survey of Japan.
shioka mine of Okayama Prefecture, chalcopyrite-pyrrhotite veins and skarns are known to be associated with a fine-grained intrusive mass. Indeed, a plug of quartz porphyry intrudes into the center of the mineralized area (Fig. 2). Unfortunately, the altered (calcite-chlorite) quartz porphyry is found to have poor stockworking and dissemination of quartz and sulfides. The pervasively altered rock gives copper contents only up to 100 ppm. The mine area belongs to a weakly magnetic magnetite-series terrain but the presence of abundant pyrrhotite in the ore deposits may indicate that the genetically related porphyry to the vein and skarn deposits belongs to the ilmenite-series.

**Green Tuff Belt (Miocene)**

Magmatism of the Green Tuff belt belongs to a magnetite-series and is similar in many respects to that of the Philippines where many porphyry copper deposits have been known. Gold and silver are common in Kuroko and vein-type deposits. One may expect a porphyry-type Au–Cu deposit in the Green Tuff belt. **Chichibu mine**: At Chichibu mine of Saitama Prefecture, a main quartz diorite-granodiorite stock (Fig. 3) and many satellitic granitic cusps, including various porphyries, are exposed in the basement sedimentary rocks (late Paleozoictoearly Mesozoic). The magmatism appears to have taken place in subareal environment. Another center of plutonism associated with ring dikes are known about 25 km to the west of the mine (MMAJ, 1975). The Chichibu mine is composed of several skarn deposits of dominantly galena, sphalerite, pyrrhotite and magnetite. A very small stock occurring near Daikoku orebody (Fig. 3) has been pervasively altered. Potassic alteration is present in addition to more commonly distributed phyllic and propylitic alteration. These rocks are disseminated with pyrite but contain up to 200 ppm copper as chalcopyrite.

**Conclusions**

Among many ore deposits and prospects in Japan, which have disseminated chalcopyrite and are possibly of “porphyry-type”, several important ones are described. Most of the known deposits appear to be plutonic rather than subvolcanic, within the volcano-plutonic system. Potassic alteration is rare and none of
these deposits shows concentric zoning of the altered and ore minerals, the features characteristic to the porphyry-type mineralization (LOWELL and GUILBERT, 1970). More significantly, stockworking is very rare in these deposits. Stockwork texture and breccia pipes are, indeed, uncommon in any type of ore deposit and granitic mass in Japanese islands, as compared with ore deposits and granitoids in west coasts of North and South America. Since these phenomena are resulted mainly from the second-boiling reaction of hydrous felsic magmas (BURNHAM and OHMOTO, 1980), there must have been a geological condition that inhibits the second-boiling during the then-current granitic magmatism in Japanese islands.

References


