

# METALLOGENIE DU CUIVRE ASSOCIE AUX ROCHES VOLCANIQUES D'AGE PRECAMBRIEN III SUPERIEUR DANS L'ANTI-ATLAS MAROCAIN

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In the Anti-Atlas ( Morocco), copper-bearing mineralizations of the uppermost Upper Precambrian ( PIII ) are hosted mostly in basic and intermediary volcanic rocks. They occur as veins, fracture - fillings or disseminated. The main sulfides encountered are bornite, chalcopyrite, chalcocite, digenite, wittichenite, tennantite, molybdenite, pyrite and galena.

At Wawfengha, in the western Anti-Atlas, subvertical mineralizations are tightly bound to a brecciated and crushed tectonic zone along a shear corridor. The copper sulfides are associated to a quartz and calcite gangue whereas the host rock suffered propylitic alteration demonstrated by abundant chlorite and epidote. In the Assif Imider deposit, metallogenic studies indicate that interaction between tectonic and hydrothermal events is the main concentration factor for copper which reaches there average grades of 4%. Physico-chemical conditions are estimated at (T) 300°C, (P) 1.6 Kb and a salinity between 13.7 and 18% NaCl.

South of Ouarzazate, in the central Anti-Atlas, copper showings are numerous around Issougri but none was found economic so far. The most obvious ones are lying within a N45 to N70 mostly andesitic dike swarm. Mineralizations are tightly controlled by NE-SW striking magmatic and tectonic structures along which rocks are albitized and chloritized. Copper precipitations is late- to post-volcanic, yet remains connected to the magmatic and hydrothermal activity of the upper PIII. Sulfides are associated in high temperature parageneses and are sometimes surrounded by a gangue of chlorite, barite and orthoclase. Geothermometry on chlorite indicates temperatures in the order of 283 to 328°C.

PIII volcanism is mainly tholeiitic at Wawfengha and tholeiitic, calc-alkaline and alkaline south of Ouarzazate. The end of the upper PIII is ascertained by a NE-SW distension that generated a monzodiorite plutonism as well as an essentially andesitic dike swarm. These magmatic rocks have been dated  $561 \pm 3$  Ma and their late hydrothermal low temperature alteration at  $400 \pm 7$  Ma.