# *The tailings impoundment of Talabre (Chuquicamata, Chile): from the primary mineralogy of a porphyry copper to the geochemical evolution of pore-water in a hyper-arid climate

**VOGT Marie-Louise**; Mars 2006

*Supervisor: Prof H.-R. Pfeifer, Centre d'Analyse Minérale, Institut de Minéralogie et Géochimie*

In the present work, mineralogical and geochemical characteristics of a sulphide-poor (1-2 wt% pyrite equivalent), carbonate depleted, tailings impoundment from Chile are presented (Talabre, Chuquicamata). Talabre is the unique tailings impoundment of the Chuquicamata giant porphyry copper deposit, and is located in the hyper-arid climate of the Atacama Desert. The impoundment was constructed in 1951, and presently it covers an area of 52 km2 and there are over 600 Mm3 of tailings stored. Chuquicamata has an approximate milling rate of 182'000 tonnes per day (tpd). Tailings, processed by an alkaline flotation circuit (pH 10.85), contain 1-2 wt% combined pyrite, chalcopyrite, sphalerite, bornite, covellite and chalcocite/digenite. The principal aim of this study is to characterize the initial steps of sulphide oxidation in an active, sulphide-poor and carbonate depleted tailings impoundment. The Talabre tailings impoundment, due to the particular deposition technique used at the Chuquicamata metallurgical operation, can be considered as a giant « natural laboratory ». Because of the periodically moved spigot, some areas of the tailings impoundment are left exposed to oxidation for a known period of time, before the deposition point comes back and covers again the surfaces with fresh material. This enables us to study different areas of the tailings impoundment, corresponding to different ages of oxidation and therefore to examine the kinetics and the geochemical evolution of the tailings and its pore-water.

To achieve the fixed goals we sampled four different areas of the Talabre tailings impoundment, corresponding respectively to a young sediment and to sediments exposed to oxidation for a period of 3 months, 1 year and 3 years. To perform this work a total of 47 samples were studied mineralogically, 33 water samples were analyzed and 4 pore-gas profiles were performed.

The characterization of the tailings impoundment of Talabre is based on three principal aspects : the physical parameters (granulometrical distribution, moisture content, gas content, porosity), the mineralogy and chemistry of the solids (optical microscopy, SEM, XRD, electronic microprobe, XRF) and the chemistry of the pore-water (major and trace elements, 18-oxygen and deuterium stable isotopes).

The principal alteration mechanisms of Talabre’s oxidized zone are described in this report. The main reactions involved are iron sulphide minerals oxidation, oxidation of liberated reduced aqueous species of sulphur and iron, and subsequent precipitation of iron hydroxides (Ferrhydrite). The acidity produced by iron hydrolysis is buffered in the first place by calcite, followed by albite and K-feldspars. Liberated elements react with the environment and, when displaying a mobile behavior, they might cause the formation of an erichment zone. In primary alkaline tailings, seepage of water is predominant and oxyanions (e.g. As, Mo, V) exhibit a mobile behaviour. As oxydation and acidification of the environment proceeds, divalent cations (e.g. Cu, Zn) acquire a mobile character. With increasing evaporation, upward migration of the mobilized elements via capillarity enriches the surface, where supersaturation controls the precipitation of secondary water-soluble efflorescent salts.

This work proves the utility of performing a study on an active (i.e. in operation) tailings impoundment : such a study provides a better understanding of the system’s geochemical behaviour and can bring significant contribution to the long-term planning of a mining operation, if important environmental damage should be avoided.