

Present copper-rich “gel” formation in the giant porphyry copper deposit of Chuquicamata (northern Chile)

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In the frame of a project focused on supergene processes in the Chuquicamata deposit (Pinget et al., 2011 and 2012), copper-rich "gel" crusts that are presently precipitated in the exotic deposit of Mina Sur, south of the Chuquicamata porphyry deposit (Fig. 1A, 1B), are studied.

The "gels" are precipitated from moderately saline waters containing up to several 100 mg Cu/l. Three groups of copper-rich “gels” (up to 61% Cu in weight, Table 1) have been distinguished according to the pH of the waters from which they precipitate. In "gels" formed from waters with pH between 5.8 and 6.0, posnjakite ($\text{Cu}_4(\text{SO}_4)(\text{OH})_6$), brochantite ($\text{Cu}_4(\text{SO}_4)(\text{OH})_6$), malachite ($\text{Cu}_2(\text{CO}_3)(\text{OH})_2$) and possibly diopside $\text{CuSiO}_2(\text{OH})_2$ were identified using XRF, XRD, SEM and ESEM analyses. In "gels" precipitating from waters with pH between 7.2 and 7.7, devilline ($\text{CaCu}_4(\text{SO}_4)_2(\text{OH})_6 \cdot 3(\text{H}_2\text{O})$) is mainly present. A third group of "gels" consists mainly of atacamite ($\text{Cu}_2\text{Cl}(\text{OH})_3$) and were precipitated of water with a pH of 5.7. In addition to the above copper minerals, the "gels" contain also gypsum, a not yet identified sodium sulphate, and halite (Fig. 2A). The sodium sulphate occurs as lenticular crystals (Fig. 2A) and as efflorescent aggregates (Fig. 2B).

Table 1 : Semi quantitative analyses of "gel" sampled at Mina Sur (XRF, using UniQuant, in wt-%). Part of the aluminium content may be due to clay particles transported in suspension and incorporated in the gel crusts.

Gels sample	pH	Na2O	MgO	Al2O3	SiO2	MnO	Fe2O3	P2O5	K2O	CaO	SO3	Cl	Cu	Zn
2Nord	7.2 to 7.7	b.d.	0.3	5.3	1.7	0.1	0.5	b.d.	0.3	2.4	15.7	1.3	57.5	0.1
2Sud	7.2 to 7.7	b.d.	0.8	1.4	6.2	0.1	1.1	b.d.	0.8	5.4	19.8	1.6	49.4	0.5
7C1	5.8 to 6.0	5.2	2.3	3.1	3.5	0.1	0.8	b.d.	0.9	7.4	23.4	3.3	39.1	0.4
7C2	5.8 to 6.0	b.d.	1.0	3.0	2.3	0.1	0.7	b.d.	0.8	6.9	21.7	3.4	47.1	0.4
EX2	5.7	b.d.	b.d.	2.7	2.8	0.1	0.4	0.3	0.1	0.5	2.5	13.4	61.6	0.1

(b.d. = below detection limit)

The possibility of using the precipitation mechanisms of the present copper gels as analogue for the formation of copper minerals in the exotic Mina Sur is examined.

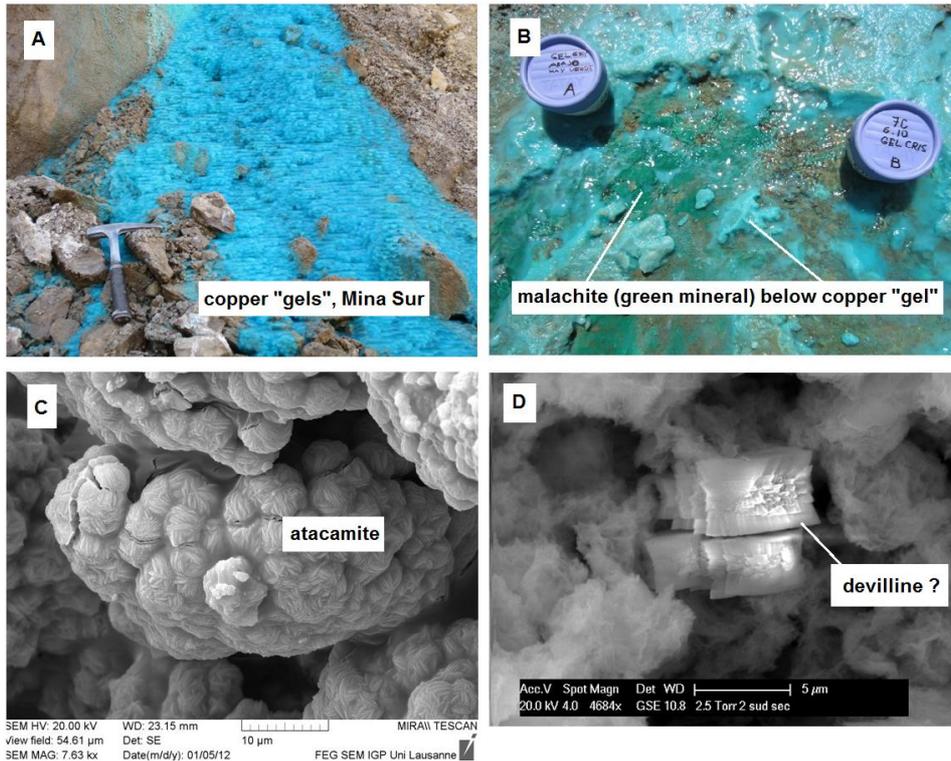


Figure 1 : A) Outcrop of copper rich "gel" being precipitated from water with pH between 7.2 and 7.7 (Mina Sur). B) Malachite overgrown by copper "gel" precipitated from water with pH between 5.8 and 6.0 .C) SEM photograph of atacamite precipitated from a water with pH of 5.7. D) ESEM photograph of "gel" with a probable devilline aggregate

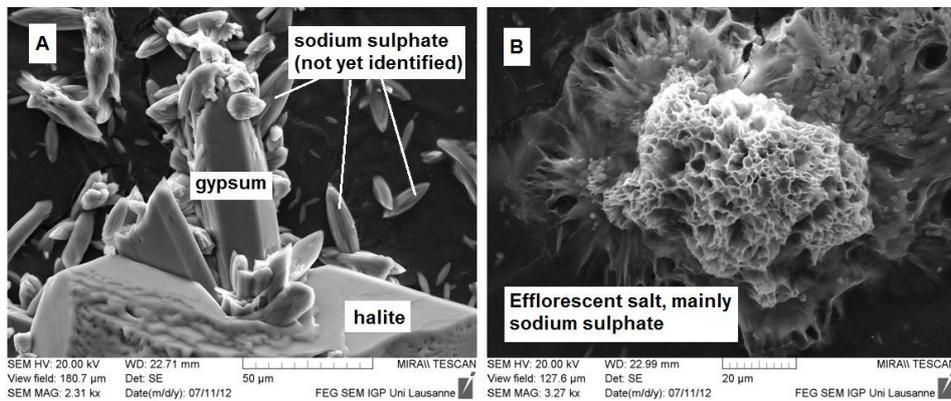


Figure 2: Phases formed by drying gels formed from water with pH between 7.2 and 7.7. Microscope observation shows that the phases precipitate in the following order: gypsum, sodium sulphate and halite.

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