Crossroads in analytical chemistry and non-classical crystal nucleation: deciphering the role of inorganic polymers in poorly crystalline nanominerals nucleation

MANUEL A. CARABALLO[1,2*], MERCEDES BECERRA-HERRERA[3], PABLO RICHTER[3], SERGIO D. MORAGA[4], RODRIGO MOLINAS[4], PABLO CRUZ-HERNÁNDEZ[1], MICHAEL HOCHELLA JR.[5]

[1]Dept. of Mining Eng., Univ. de Chile, Ave. Tupper 2069, 8370451, Santiago, Chile (correspondence: mcaraballo@ing.uchile.cl)

[2] AMTC, Univ. de Chile, Ave. Tupper 2007, 8370451, Santiago, Chile.

[3] Dpt. Inorg. and Anal. Chem., Univ. de Chile, Sergio Livingstone 1007, 8380492, Santiago, Chile.

[4] Dept. of Geology, Univ. de Chile, Plaza Ercilla 803, 8370451, Santiago, Chile.

[5] Dept. of Geosciences, Virginia Tech, Blacksburg, Virginia 24061, U.S.A.

Electrospray ionization source mass spectrometry (ESI-MS) is one of the most powerful and robust analytical techniques for the characterization and quantification of organic molecules. Additionally, it hosts a (yet to be discovered) tremendous potential for the study of the role played by inorganic polymeric precursors in nanomineral nucleation and growth.

Some recent and pioneering studies related to coagulation processes in wastewaters [1] and tubular nanomineral synthesis (i.e., imogolite [2]) have proven the feasibility and robustness of this analytical technique to characterize aluminium-based inorganic polymers in aqueous solutions.

Our research group has measured and precisely identified, for the first time using ESI-TOF MS, a set of Fe- and Al-based polymers involved in the early stages of schwertmannite and hydrobasaluminite growth in aqueous solution. An analytical method was optimized to assign polymers using their mass/charge ratios with up to 4 decimal significant figures, allowing a precise and unequivocal identification of these polymers.

A long way is still ahead but our research group is setting the ground to generate a unified theory connecting the possible new non-classic nucleation mechanisms (leading to poorly crystalline iron and aluminium nanominerals) with the complex hydrochemistry of these Fe-S or Al-S rich solutions.

[1] Feng et al. (2012) Int. Jour. of Mass Spect., 309, 22-29. [2] Yucelen et al. (2011)