

Research programme on Zn deposits in Northern Peru

Tutor: Dr. Nicola Mondillo, co-Tutor: Prof. Giuseppina Balassone.

In the last three years, the Mineral Deposits research group (MDRG) of the DiSTAR (M. Boni, G. Balassone, N. Mondillo) has conducted several researches on the genesis and main features of sulphide and nonsulphide Zn(Pb) deposits of northern Peru (Mina Grande and Cristal, Bongará area), producing several papers (see list below), and a PhD Thesis (Dr. G. Arfé). This research has shown that the Bongará area was affected by district scale MVT ores-producing hydrothermal processes, also characterized by anomalous concentrations of critical elements (CE), like Ge. In addition, it was also demonstrated that during the tropical weathering of sulphides, the Zn and Pb grades were preserved in the oxidized ores (nonsulphides), together with anomalous amounts of CE. Considering that other Zn-Pb occurrences are known in the Bongará district, and that the area is characterized by important weathering and soil production, it would be of great interest: a) to investigate the mineralogy and geochemistry of the other occurrences; b) to test on the other deposits of the area the model of the Ge-bearing MVT fluid flow, and to verify the conditions allowing the preservation of Ge and other CE in the weathering products.

To follow this research aim, the MDRG has established a scientific collaboration with Nexa Resources Perú S.A.A, which is a Peruvian mining company dedicated to the exploration, extraction, processing and commercialization of zinc, copper and lead concentrates with contents of silver and gold, and is currently one of the main polymetallic producers in Peru. The Company belongs to Nexa Resources S.A., the metals and mining division of Votorantim S.A and is one of the biggest mining companies in the world, and a leader in Latin America. Nexa Resources Perú (hereafter Nexa) is now conducting a big drilling campaign in the Bongará area aimed to: 1) expand, the current resources of the Florida Canyon deposit (3.26 Mt @ 12.2% Zn, 18.5 g/t Ag and 1.53% Pb), and 2) evaluate other Zn-Pb prospects located in the district. Therefore, Nexa has big interests in the same area recently investigated by the MDRG of the DiSTAR.

The sulphide mineralization is the primary ore concentration at Florida Canyon and is preferentially hosted in dolomitized volumes of the Upper Triassic Chambará Formation. The form of the orebodies is stratabound in *mantos* and/or controlled by faults. The sulphides have been already studied by Basuki et al. (2008), Basuki and Spooner (2009), and Reid (2001). Recent papers on nonsulphides were published by de Olivera et al. (2019), and de Olivera & Saldanha (2019). In the Florida Canyon the Zn-sulphide (sphalerite) mineralization is the primary ore mineral. Sphalerite has been oxidized to smithsonite and hemimorphite, which are the main nonsulphide minerals. Lead occurs as galena (locally Ag-bearing), cerussite and anglesite.

In July 2019, after having hosted a MDRG's M.Sc. student for 2 months in the Florida Canyon camp, and after the visit of the MDRG researchers at the Nexa offices in Lima and in Pedro Ruiz (June 2019), Nexa agreed to sign a Memorandum

of Understanding (MoU, with a length of 3 years) with the DiSTAR, to formally establish a cooperation (responsible of the project Dr. N. Mondillo) to study the mineralizations of the Bongará area. This cooperation is aimed to conduct mineralogical, petrographic and geochemical analyses on the samples from Florida Canyon and other prospects owned by Nexa, for evaluating the key characteristics of the ores. The results will be useful to better understand the metallogenesis of the area, and for metallurgical and exploration purposes.

Proposal for a PhD position on the study of Zn deposits in Northern Peru

The proposed PhD project is aimed to study the Zn metallogenesis in the Bongará area. The study is supported by Nexa (in the limits established by the MoU), and will be carried out through fieldwork, and mineralogical and geochemical investigations on Zn-Pb sulphide and nonsulphide samples of Florida Canyon and other prospects owned by Nexa in northern Peru. The company agreed to support for accommodation, transportation and fieldwork of the PhD student.

The proposed PhD project is based on basic mineralogical and geochemical ore characterization (bulk-rock chemical analysis, X-ray powder diffraction, petrographic studies on thin sections, SEM-EDS-WDS microanalysis), followed by specific analyses for:

- Determining the deportment of major and critical elements in the mineralization, and make comparisons with existing studies at the district scale,
- Investigating the fractionation of stable isotopes (C, O, Zn) and the composition of radiogenic isotopes (Pb) in Zn-Pb minerals at the deposit and the district scale.

The main deliverable of the study will be a mineralogical and geochemical model explaining the genesis of the sulphide and nonsulphide ores in the Bongará area, and the pathways of CE from sulphides to nonsulphides.

The PhD candidate should have a good knowledge in Economic Geology, as well as of the techniques of mineralogical and geochemical analysis. He/she must be fluent in English and, if possible, also in Spanish.

The PhD study will be carried out as follows:

months	0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	24-27	27-30	30-33	33-36
Bibliographic research	X											
Field work		X			X							
Sample preparation		X	X			X						
Basic mineralogical analysis			X	X		X						
Basic chemical analysis			X	X		X						

Stable isotopic analyses					X	X						
Radiogenic isotopic analysis							X	X				
Geochemical modelling								X	X	X		
Metallogenetic modelling								X	X	X		
Courses	X			X			X					
Participation at conferences				X				X		X		X
Paper preparation					X		X		X	X	X	X
Thesis work										X	X	X

Projects

Memorandum of understanding between the Department of Earth, Environment and Resources Sciences, University of Naples "Federico II", and the Company Nexa Resources Perú, Lima. The MoU formally establishes a scientific collaboration between the two parties aimed to study the nonsulfide mineralization of the Florida Canyon and Bongará area, from 2019 to 2022.