Ph.D. position at the University of Lorraine (France)

GeoRessources Laboratory

Title: Main factors of nickel enrichment in saprolitic ores of New Caledonia: Dynamics of metal transfer and modeling of coupled geochemical and hydrodynamical processes

Context: Laterite nickel-ore formation in New Caledonia is classically assumed to be governed by supergene processes, and downward migration of waters with Ni-enrichment at the basis of the laterite profile. However, the heterogeneity of Ni-ore distribution seems to have favored by secondary processes controlled by the combined effects of inherited tectonics, geomorphological evolution and hydrologic systems since the main laterite formation. Fluid flow and mass transfer processes are not purely downward at low temperature conditions, but can be also related to lateral fluid circulations, and local drainage along damaged zones in the vicinity of faults (Cathelineau et al., 2016a; 2016b; Gautier et al., 2016). The objective is to investigate in-depth the high variability of exploitable Ni, Co and Sc distributions related to the overlay in time and space of several processes.

If 1D reactive transport models (Domènech et al., 2017 ; Myagkiy et al ; 2017) highlighted the main chemical retardation processes for Ni and reproducing in situ observations of Ni enrichment in vertical lateritic profiles, a recent advance coupling 2D fluid flow and geochemical transport modeling highlighted the contribution of preferential pathways, lateral movement, and topography during the supergene alteration processes (Myagkyi et al., 2019). But these preliminary results need to be extended to realistic geological structures at the deposit scale.

This PhD will improve the understanding of the mechanisms of enrichment/co-enrichment and spatial and temporal distribution of Ni and other accompanying metals in New-Caledonian deposits, combining the study of discontinuity network geometry and geomorphological evolution. Reactive transport modelling constitutes the last objective.

From the mineralogical/geochemical point of view, the work will partially rely on the existing analytical data and multi-scale observations (TEM, SEM...) on the time relationships between newly formed phases (e.g., Ni rich talc-like phases) and inherited silicates (olivine, serpentine). At the scale of open pits, the objective is to understand the factors controlling the geometric distribution of Ni enrichment, within the discontinuity network thanks to statistical approach of the fractures and faults, and related Ni anomalies.

On the basis of these data, a numerical approach will be conducted: A geochemical modeling of fluid-rock interactions and mass transfer and fluid flow within the rock formation will be carried out using commercial softwares. Time and space changes of the fracture network geometry due to stress-state variations and the related impact on local fissure permeability and porosity will be particularly investigated. Different scenarii will be considered and numerical predictions will be compared to in situ observations.

Student profile: The candidate must be a highly-motivated and self-directed person with a solid knowledge of geosciences. Ideally, the candidate should have a recent university master degree (or equivalent) in geology, mineral resources, geochemistry, reservoir engineering or other relevant fields. A solid background in geochemistry and a strong interest for modelling water-rock interaction processes are required. He or she may demonstrate basic knowledge of solid and fluid mechanics principles governing the behaviour of porous and fractured media and motivation for work at the interface between disciplines. An experience in using geochemical codes would be an asset. The candidate will need to be fluency in English. French is not mandatory but the willingness to learn French would be appreciated.

Funding: This PhD will be funded by Ministry of Research of Research and Education and conducted within the framework of the CNRT projet and "Laboratoire d'Excellence" RESSOURCES21. The candidate will perform her/his research at the GeoRessources laboratory (University of Lorraine) in collaboration with Mines ParisTech's Center of Geosciences. This PhD project is funded for 3 years, starting on October 1st 2019 (Net salary, including social security: ~1 500 €/month).

Applicants should send via email a Curriculum Vitae and the names and email addresses of two references to:

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References:

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