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# Sulfide trace element geochemistry and its implications for metamorphism and ore formation: an example from a sediment-hosted Cu-Co mineralization in northwestern Namibia

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The Dolostone Ore Formation (DOF) is a sediment-hosted Cu-Co mineralization in Neoproterozoic carbonates and siltstones of the Ombombo Subgroup, Kunene Region, northwestern Namibia. The DOF has potential of becoming Namibia's first cobalt mine, which is currently a sought-after commodity as Co is classified as a critical raw material essential for energy storage in electric vehicles. The DOF sulfide mineralization is dominantly comprised of pyrite, pyrrhotite, chalcopyrite, sphalerite and linnaeite. Such base metal sulfides have the potential of being a significant source of other critical elements (e.g., Ga, Ge, In). Furthermore, trace element composition of sulfides has proved useful in constraining formational aspects of the sulfides and the mineralization.

Trace element analyses of DOF sulfides, by LA-ICP-MS, indicate that regional metamorphism has affected the mineralization. Gallium-Ge-In-Mn-Fe in sphalerite geothermometer [1] reveals sphalerite formation temperatures above the closing temperature of the geothermometer (310 ± 50 °C). Raman analyses of carbonaceous matter (STA geothermometer) [2] show that temperatures of 340 ± 32 °C have affected the Neoproterozoic sedimentary package, but also indicate slight differences in Raman spectra of carbonaceous material in the ore horizon(s) compared to the unmineralized host rock.

Comparing the trace element compositions of coexisting euhedral pyrite and anhedral pyrrhotite associated and intergrown with sphalerite and chalcopyrite, indicates the possibility of Zn and Cu of the sphalerite and chalcopyrite being sourced from earlier pre-ore pyrites. Pre-ore framboidal pyrite can be found in the surrounding clastic metasediments. Trace element trends and temperature indicators suggest that regional greenschist facies metamorphism attributed to the Pan-African Damara orogeny had a pervasive effect on the DOF mineralization. It is hypothesized that DOF mineralization is an analogue to the Central African Copperbelt deposits and that basinal brines are the source of the metals. Ongoing investigations of early mineralizing fluids will test this model.

[1] Frenzel, M., Hirsch, T. & Gutzmer, J. (2016), *Ore Geology Reviews* 76, 52–78.

[2] Lünsdorf, N. K., Dunkl, I., Schmidt, B. C., Rantitsch, G. & von Eynatten, H. (2017), *Geostandards and Geoanalytical Research* 41(4), 593-612.