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Mineral characterization of the metallurgically detrimental talc-carbonate-pyrite schist in ultramafic rocks of the Nkomati Ni-Cu-PGE(-Co-Cr) Mine, Mpumalanga Province, South Africa

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The Nkomati Ni-Mine, which is situated in the Uitkomst Complex, is currently the only primary nickel producer in South Africa (ARM-NorilskNickel-Joint Venture). The 2044 $\pm$8 Ma old (De Waal et al., 2001) Uitkomst Complex is a layered, mineralized, mafic to ultramafic intrusion with significant amounts of Ni-Cu(-PGE) ore. Cobalt, chrome and minor gold are economically important by-products. The complex is situated in the Mpumalanga Province, South Africa, 20 km north of Badplaas. It has an elongated, trough- to tube-like shape, is approximately 750 m thick, and can be followed for about 12 km down-dip extension. The magmatic body intruded into the sediments of the Lower Transvaal Supergroup at a dip-angle of 4-5° to the NW. The different rock units are from bottom to top: Basal Gabbro, Lower Pyroxenite, Chromitiferous Peridotite with a massive chromitite layer on the top, Main Harzburgite, Upper Pyroxenite and the Gabbronorite Unit.

A talc-carbonate-schist with pyrite-rich portions occurs frequently in the Chromitiferous Peridotite, and amphibolitised parts of the Lower Pyroxenite Unit can also be pyrite-rich. During the exploitation of the ore body in a large open-pit operation, these pyrite-rich portions cause dilution of the ore due to their favourable flotation behaviour. This decreases the nickel and copper content of the ore concentrate.

Therefore lithological open-pit mapping of the geology and the structural features was carried out in pit 3 on six benches. This appears to be essential for grade control of the operation.

First interpretations of the mapped data revealed a link between the main NE-SW-striking structural zones and the trend of the alteration as well as the occurrence of pyrite. Syn- to post-intrusive fluids evidently migrated along the faults and shear zones into the ultramafic body and caused varied alteration of the geological units.

Fluid compositions of similar rocks in the Agnew Mine (Australia) have been shown to be a binary mixture of water, CO_2 and minor H2S with a maximum partial pressure less than 1% (Gole et al., 1987). It is evident that the hot ultramafic magma caused contact metamorphism of the Malmani Dolomite in wall rocks and xenoliths leading to a high CO_2 content of the fluids partially derived from formation waters. The serpentinisation and the abundant occurrence of sulphide minerals such as pyrrhotite, pentlandite, chalcopyrite and a pyrite-millerite-heazlewoodite-awaruite assemblage (Woolfe and Davidson, 2004) indicate that the fluids were of a reducing nature.

The encountered mineral paragenesis comprises an calcite-dolomite-antigorite-chlorite-tremolite-pyrite assemblage according to XRD investigation, indicative of a low grade metamorphism. It is thought that a decarbonation reaction similar to dolomite [U+F0E8] periclase + calcite + CO_2 at temperatures above 750 °C during magma-host rock interaction provides the CO_2 necessary for a later carbonation reaction such as 2 serpentine + 3 CO_2 [U+F0E8] talc + 3 magnesite + 3 H_2O to form magnesite from the serpentine-talc assemblage. Further fluid studies and EMPA measurements will define the fluid properties and the exact mineral chemistry of the talc-carbonate-schist.

References

De Waal, S.A., Maier, W.D., Armstrong, R.A., Gauert, C.D.K. (2001). Parental magma and emplacement of the stratiform Uitkomst Complex, South Africa. The Canadian Mineralogist, 39, 557-571.

Gole, M.J., Barnes, S.J. and Hill, R.E.T. (1987). The role of fluids in the metamorphism of komatiites, Agnew nickel deposit, Western Australia. Contrib. Mineral. Petrol., 96, J51-162.

Woolfe, J., Davidson, M. (2004). Nkomati Mine Report. Feasibility study for the MMZ Mine, unpublished company report, 60p.