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Mineralogical Characterizations of Low-grade Nickel–Iron Laterites from North Oman: MLA-SEM based automated quantitative mineralogy approach

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This paper conveys the results of a detailed mineralogical study of low-grade nickel-iron laterite in North Oman**.** Twenty samples collected from silicate-type (Saqah-1, 2, 3, and 4) and oxide-type (Al Russayl) laterite profiles were studied for modal mineralogy; thirteen of these were selected for grain size distributions, mineral associations and mineral liberation analyses.

Modal analyses determined by Mineral Liberation Analyses (MLA) showed that the main constituents of the samples are Fe-hydroxides, magnetite, chromite, chlorites, and other silicates. False color images show how the different ore minerals (chlorite, Fe-hydroxides magnetite and chromite) are interlocked. The weight % ranges of these minerals are: 34 to 84 for Fe-hydroxides (mostly goethite), 4 to 11 for chromite, 0 to 19 for magnetite, 2 to 20 for chlorites and 3 to 24 for silicates (mainly in the form of serpentines). Grain sizes and the liberation values for the investigated ore minerals vary across the investigated laterite profiles. In this study, the values used for the categorization of the ore minerals are as follows: liberated (>95% is free), high grade (80-95%), medium grade (50-80%), low grade (20-50%) and locked (<20%).

Ni-bearing chlorite is present as wide range grain size in Saqah-3 and Al Russayl profiles (38-212 & 53-150 µm, respectively) but finer in the other Saqah localities (19-38 mm). About 60-80 % of chlorite (Ni-rich) is present as liberated in most of the studied samples. Chromite grains in Saqah profiles occur in grain size range of 10 to 75 µm whereas in Al Russayl profile, they occur in a wider range of 19 to 106 µm. Only about half of the chromite grains are present as liberated phase in Saqah-1, 2, 3 and Al Russayl profiles and 70% in Saqah-4 profile and is distributed over a 19-53 µm sizes with a little bit coarser in Al Russayl profile (27-75 µm). Magnetite grains are present in a wide range grain size and, like the chromite grains, about 40-50% of them are present as liberated phase in all profiles except in Saqah-2 (~70% is liberated phase). Magnetite grains in Saqah-1, 2, and 3 range between 75 and 212 µm, and between 27 and 53 µm in Saqah-4 and Al Russayl. About 56-80 wt % of the Fe-hydroxide is present as liberated phase in Saqah-1, 2, 4, and Al Russayl while about 50% of it is locked with other minerals in Saqah-3 samples. Goethite grains in Saqah-1 are finer (38-53 µm) than those present in the other profiles (38-150 µm).Grain-size-liberation class relationship showed that Ni-bearing mineral phases (chlorite & goethite) are present as liberated phase followed by chromite and magnetite that are interlocked with other phases to lower grade material.

Mineral associations, grain size, and liberation data generated by MLA can aid the characterization of the ores, as well as the beneficiation and processing methods of the ores; this reduces the operational costs and improves recovery of metals.