European Mineralogical Conference
Vol. 1, EMC2012-159, 2012
European Mineralogical Conference 2012

Phase Quantification and Determination of the Location of Al and P in Low Grade Iron Ores

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High-grade iron ores are being exploited at high production rates and will increasingly be depleted. As a result, large resources of lower grade ores and tailings are becoming the focus of the iron ore industry and these will have to be beneficiated to remove unwanted impurities. Impurity removal methods must be tailored to the characteristics of the ores so as to produce the desired effect with the minimum of cost and effort. To do this, the ores must be characterized as far as the deleterious elements are concerned. This applies to the mineralogy of the impurity elements, the distribution of the minerals containing these elements, as well as their physical characteristics such as friability, alteration and grindability.

Five analysed ores were examined mineralogically using Rietveld analysis to determine mineral abundances of predominant hematite and goethite, and minor magnetite, kaolinite, gibbsite, annite and quartz. The principal mineral compositions were determined using energy-dispersive SEM analysis, and these results were then used to calculate the bulk chemical compositions of the samples. The calculated compositions were compared with the compositions supplied with the samples. Good correspondence was obtained for all samples.

A foremost question to be addressed is the location of P and Al in these samples, and to suggest ways to remove them. The Al content is mainly due to the presence of goethite and kaolinite in variable proportions. In one sample, the Al is predominantly located and substituted in goethite whereas in others, Al is located in kaolinite and in gibbsite. No phosphate minerals could be found in the samples, but small amounts of P (0.3% to 1%) could be found in many goethite grains. Doing a mass balance using selected analysed grains, the P content could be accounted for in most samples. An important conclusion of this study is that only a portion of the Al and the P can be removed without a major iron loss. This is due to the presence of a major portion of these elements in the principal iron-containing mineral, goethite.

Because of the presence of numerous coatings of fine-grained kaolinite, it is recommended that the ores be milled to a coarse grain size ($\sim$3mm) corresponding to the natural grain size of the composite hematite-goethite grains and then attritioned to remove the Al-rich coatings. This could be done wet or dry.