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The potential use of the alkaline waste from the aluminum industry as aluminum and silicon source in the geopolymerization process

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The objective of this work was to evaluate the alkaline waste of the aluminum industry (red mud) as a source of aluminum and silicon in the production of geopolymers. These elements are essential to form the tetrahedrally coordinated structures of the geopolymers. The characteristics of the studied material were compared with those of metakaolinite, since the latter is considered an excellent geopolymer precursor material. Samples of the dehydrated red mud were supplied by a Brazilian primary aluminum industry. This material was chemically (X-ray fluorescence) and mineralogically (X-ray diffraction) characterized. Samples of metakaolinite and red mud (original and pretreated by heating at 700 oC/2 h) were subjected to a leaching test with a 12 mol L-1 NaOH solution to determine the contents of reactive silica and alumina fractions. The Si4+ and Al3+ contents of the filtered solutions were determined by plasma optical emission spectrometry. The red mud has a total of 21.7% Al2O3 and 16.6% SiO2, and it is composed by the mineral phases: quartz, hematite, kaolinite, goethite, gibbsite, anatase, sodalite, gypsum. The contents of the leached fractions of Al3+ and Si4+ of the original red mud were respectively 3.9% and 0.7%. The red mud heated sample presented higher contents of Al3+ (8.5%) and Si4+ (6.6%). It was verified that the heating process increased the concentrations of Al and Si fractions available for the geopolymerization reactions. These values are closer to those obtained for metakaolinite (9.2% Al3+ and 4.4 Si4+). The X-ray diffraction data of the heated red mud revealed that the hydroxylated phases became amorphous and promoted the formation of metakaolinite. Thus, the red mud has important components, which when heated, increase the Al and Si availability for the geopolymerization reactions. The other components of the red mud, being less reactive, serve as aggregates for the geopolymer composition.