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Laboratory-scale study of possible use of residual sludge from glass sand beneficiation

Richard Prikryl (1), Zuzana Weishauptova (2), Jaroslav Zach (1), and Petr Kozlovcev (1)

(1) Charles University in Prague, Faculty of Science, Institute of Geochemistry, Mineralogy and Mineral Resources, Praha 2, Czech Republic (prikryl@natur.cuni.cz), (2) Institute of Rock Structure and Mechanics, Academy of Sciences of the Czech Republic, Prague, Czech Republic

Beneficiation of quartz sand from sedimentary deposits for glass sands results in significant amounts of under-size fraction, a sludge rich in clay minerals. This sludge is considered as a waste and is returned in mined-out spaces for a simple rehabilitation, which is also the case of one of the largest glass sand production areas in the Czech Republic. The amount of produced waste sludge in the studied area (glass sand works in Provodín area, Bohemian Cretaceous Basin) is about 20 kt per year.

In the recent study, we have focused on possible employment of this waste material for three applications: (1) a clay component in a raw material mixture for making of hydraulic lime, (2) a kaolinite absorbent, and (3) a geotechnical material. The sampled sludge was primarily analysed for mineralogical and chemical composition, mechanical and physical properties, the specific surface area, and parameters of pore space. X-ray analysis proved the presence of kaolinite, illite (both WCI and PCI), quartz, and accessory microcline. According to silicate analysis, the material is composed of SiO_2 (80.52 wt. %), $Al2O_3$ (11.36 wt. %), and K2O (2.14 wt. %).

For its potential use as an artificial admixture for hydraulic lime production, the studied material was mixed with pure limestone in ratio of 10, 15, 20, and/or 25 wt. %. The experimental mixtures were burnt in the temperature range from 850 to 1,200°C. XRD was employed for the detection of newly formed phases showing formation of hydraulic phase such as C2S, C3A, C4AF starting from the 1050°C burning temperature. Peak burning temperature significantly influenced amount of individual phases in the burnt product.

Second possible mode of use of the investigated waste material focused on its application as a sorbent. Pore space and specific surface area characteristics (SBET 7.4 sq. m/g) range this material to the group of low grade kaolinite-dominated adsorbents. Thermal treatment (burning of raw waste material at temperatures of 500°C and/or 900°C) lead to rapid deterioration of specific surface area, probably due to the structural and phase changes of dominant clay minerals. The latest considered use in the field of geotechnical applications proved possible employment of the studied material as a sealing clay for smaller dams, ponds and/or as a geotechnical barrier for waste dumps.