Characterization of Raw Materials for Salt Extraction from Lake Katwe, Uganda

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Abstract

Uganda is well endowed with economic quantities of salt evident in the interstitial brines and evaporite deposits of Lake Katwe, a closed saline lake located in the western branch of the great East African rift valley. Currently, rudimentally methods of salt mining based on solar evaporation of brine continue to be used for salt extraction at the lake. These have proved to be hazardous and unsustainable to the salt miners and the environment. In this work, literature concerning the occurrence of salt and the most common available technologies for salt extraction is documented. Field studies were undertaken to characterize the salt lake deposit and to devise strategies of improving salt mining and extraction from the salt lake raw materials. The mineral salt raw materials (brines and evaporites) were characterized to determine their physical, chemical, mineralogical, and morphological composition through field and laboratory analyses. In addition, laboratory extraction techniques were undertaken to evaluate possibilities of future sustainable salt extraction from the lake deposit. Also, PHREEQC simulations using Pitzer models were carried out to determine the present saturation state of the lake brine and to estimate which salts and the order in which they precipitate from the brine upon concentration by evaporation.

Results reveal that the raw materials from the salt lake contain substantial amounts of salt which can be commercialized for optimum production. The brines are highly alkaline and rich in Na⁺, K⁺, Cl⁻, SO₄²⁻, CO₃²⁻, and HCO₃⁻. Moreover, they contain trace amounts of Mg²⁺, Ca²⁺, Br⁻, and F⁻. The lake is hydro-chemically of a carbonate type with the brines showing an intermediate transition between Na-Cl and Na-HCO₃ water types. The evaporites are composed of halite mixed with other salts such as hanksite, Burkeite, trona etc, with their composition varying considerably within the same grades. The laboratory extraction experiments indicate that various types of economic salts such as thenardite, anhydrite, mirabilite, Burkeite, hanksite, gypsum, trona, halite, nahcolite, soda ash, and thermonatrite precipitate from the brine of Lake Katwe. The salts crystallize in the order following the sequence starting with sulfates, followed by chlorides and carbonates, respectively. Moreover, thermodynamic modeling in PHREEQC accurately predicted the solubility and sequence of the salt precipitation from the lake brine. Understanding the sequence of salt precipitation from the brine helps to control its evolution during concentration and hence, will lead to an improved operating design scheme of the current extraction processes. The work provides information towards future mineral salt exploitation from the salt lake.

Keywords
Lake Katwe, salt extraction, brine, evaporites, characterization, PHREEQC