ANCIENT TO MODERN IRONMAKING: EXAMINING THE EFFECT ON THE BEHAVIOUR OF PHOSPHOROUS AND OTHER IMPURITIES IN IRON ORE BY DOPING WITH CALCIUM OXALATE (CaC_2O_4)

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ABSTRACT

Charcoal produced from *Syzygium_Zeylanicum* trees was widely used in ancient Sri Lankan iron smelting practices. In this study, relict charcoal from *Syzygium_Zeylanicum* tree trunks, branches and leaves was analysed for the first time. Unusually high concentrations of calcium oxalate (CaC_2O_4 - CaOX) crystals were identified preserved in plant cell structures by optical mineralogy and SEM analysis. Thermogravimetric Analysis (TGA) of CaOX showed that it displayed three decomposition stages, releasing H_2O at 177°C, CO at 493°C and CO_2 at 750°C. Following the identification of CaOX in Sri Lankan charcoal, a series of reduction tests on low grade iron ore fines (high SiO_2: 5wt%; Al_2O_3 4wt%; P: 1.35wt%) doped with CaOX were carried out at various temperatures. Samples were analysed by XRF, SEM and EPMA to determine the degree of reduction and the effect of reduction on the deportment of impurities, in particular P (but also Al and Si).

Reduction tests at 800°C and 900°C with 5 wt% CaOX showed that the reducibility increased to over 65%. At temperatures above 900°C, P was located mainly within a fine, interstitial glass matrix suggesting that the CaOX flux enhanced removal of P from iron-rich pre-cursor phases to form glass. Preliminary magnetic separation tests to remove the P-rich interstitial glass were unsuccessful due to the fine grainsize. Further reduction tests at temperatures above 1200°C with addition of coke to convert the iron oxides into Fe_m were conducted with samples doped with 5 wt% CaOX, 5wt% $CaCO_3$ and equivalent undoped samples. Results confirmed the preferential P-incorporation into a glassy matrix in the CaOX samples although some P incorporation into the metallic phase was noted. Experimental results, including comparisons with the $CaCO_3$ fluxed and undoped samples, are discussed in view of the potential for CaOX flux for removing P (and other impurities) from P-rich iron ores.

Keywords: charcoal, phosphorous in iron ore, calcium oxalate, flux, reduction