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In-situ Neutron Diffraction Studies on Thermally Treated Carbonacious Iron Ore Materials

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Due to the huge demand in iron ores from China the sustainable utilization of the comparatively low grade iron ore deposit of the Austrian Erzberg as well as its permanent availability becomes of increasing importance for steel industry. The carbonaceous iron ore is mainly constituted of the valuable mineral sideroplesite (maximum iron content 42 %) and the iron bearing gangue mineral ankerite with a varying Fe content between 12 and 20 %. The intergrowth between these two minerals causes severe restrictions in the processing of iron ore concentrates especially in the small size range. The natural differences in the physical properties between these two minerals are too small to utilize in a technical process. The introduction of a thermal process introduced by H.J. Steiner [1] for this type of materials turns the sideroplesite into a strong magnetic oxide phase while the properties of ankerite remain unaffected. Dry, low intensity magnetic separation provides the mean to produce a valuable iron-ore concentrate in this size range.

In this context, we investigated the crystallographic and magnetic phase transitions in natural probes of Sideroplesite/Ankerite of the Austrian Erzberg by in-situ neutron diffraction experiments at the high resolution powder diffractometer HRPT at the PSI (Switzerland). The utilization of neutrons has several advantages for the investigation of the phase transitions in these ores. Firstly, due to the weak interaction potential of

neutrons, compared to other diffraction methods as x-rays or electrons, it is possible to address huge sample sizes. This is particular important for mineral processing methods destined for industrial applications, where the random distribution of not completely distributed minerals can falsify the analysis. Secondly, as neutrons penetrate easily matter, it is possible to use complex sample environments as a furnace in our case. In that way, it was possible to reproduce conditions of large-scale facilities at the sample position and to investigate in-situ different steps of the thermal process. The comparison of industrial samples with our laboratory obtained ones turned out to be identical and proofs the potential of this kind of examination.

For the particular case of the thermal process presented here, we profited of two additional properties of neutrons: the magnetic moment and the variation of the scattering lengths. It is long known that sideroplesite undergoes a phase transformation into different magnetic oxide phases depending on the oxygen content by reduction and emission of CO_2 [2,3,4]. The chemical analysis and the x-ray analysis turned out to be ambiguous about the nature of these phases. As natural probes of sideroplesite as well as ankerites of the Erzberg contain beside Fe different proportions of Mg, Ca and Mn, potential candidates beside the iron-oxygen compounds such as wuestite (FeO), hematite (Fe_2O_3) and magnetite (Fe_3O_4), also include ferrites (Fe,Mg,Ca,Mn)O.Fe_2O_3 with varying cation ratios. The detailed knowledge of the end products is crucial for the correct evaluation of the process. Due to the obtained nuclear and magnetic diffraction spectra we were able to identify the reaction constituents from different furnaces and processes. We will show the time evolution of our laboratory samples and compare them with the results from industrial samples.

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