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NATURAL MINERALS – THE MAJOR AND MINOR ELEMENTS CHEMICAL BONDING

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Natural minerals are commonly used in many industrial processes. The content of elements in an ore, and their chemical state depends strongly on the worldwide location of the place where they are collected and can differ even in the same deposit. To properly adjust the chemical reaction used in industry, the knowledge about content of elements and their chemical bonding is very important. The phase content is usually given in form of common oxides. This can significantly differ from real phase content and ionic state of elements. In the presented paper, we demonstrate the usefulness of X-ray absorption (XAS) technique for estimation of chemical states of the majority and minority elements, taking natural ilmenites as the example.

Natural minerals – ilmenites are used in production of white pigment (TiO_2), which reaches several million tons per year. Reaction of titanium raw material with sulphuric acid is the first step of industrial process [1, 2]. Ilmenites, like many natural minerals, have a complicated morphology (Fig. 1) and the standard procedures used in industrial chemical analysis do not provide sufficient information.

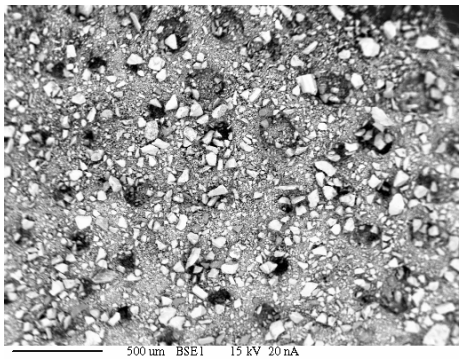

Figure 1. SEM picture of Norwegian ilmenite.

Ilmenites are originated in several places on earth. Our studies were focused on minerals from Norway, Australia, China and India.

The main phases which involve Fe and Ti are usually relatively easy to estimate but estimation of content and chemical state of minority elements is much more complicated. The X-ray powder diffraction (XRD) pattern is very complicated due to many diffraction peaks as well as similarity of phases, which are formed by substitution of minority elements into the majority phase lattice.

In the presented work phases based on major and minor elements in minerals listed above were studied using XRD and XAS. XAS analysis allowed identifying phases based on major elements like Fe, Ti [3-5] as well as minor elements like Mg, Mn [6,7] and Cr. In some of the minerals minor elements were found in more than one phase.

Chemical states of major and several minor elements were evaluated by applying the principal components analysis of X-ray absorption spectra using XANDA code. Knowing that the shape of XANES spectra is a fingerprint of chemical state of elements we consider that the XAS is a good tool for estimation of the phase content in ilmenites.

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