An XPS study on the biotic and abiotic weathering of chromite ore from the "Ring of Fire", Northern Ontario, Canada

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The majority of chromium mined worldwide is in the form of the ore mineral chromite (FeCr2O4). Major deposits of chromite include the Bushveld Igneous Complex, the Stillwater Igneous Complex and (potentially) the Black Thor Intrusive Complex (BTIC) in Ontario, Canada. The discovery of chromium deposits in the BTIC in the James Bay Lowlands, Northern Ontario (commonly referred to as the "Ring of Fire") has led to an increase in exploration and research in this area. This in turn has prompted an interest in the environmental impacts mining these deposits might have. To gain an understanding of these impacts however, one must first have an understanding of the mobility of Cr during weathering of Cr minerals under the conditions which exist at the BTIC. Experiments were conducted on chromite ore from the BTIC in order to gain an improved understanding of the weathering, oxidation, mobilization and inter-element interaction of Cr on the surface of the chromite ore. Samples of chromite-ore were exposed to a variety of oxidizing and reducing conditions, both biotic and abiotic for 4 weeks. After the biogeochemical experiments were conducted, the samples were analysed using x-ray photoelectron spectroscopy (XPS). The XPS analysis of the samples illustrated that under normal circumstances, the Cr on the chromite surface remains in its stable trivalent (reduced) state. However, when exposed to strong biotic or abiotic oxidants, in some instances, a portion of the Cr from the ore material was oxidized from a trivalent (reduced) state to a hexavalent (oxidised) state on the surface of the material. The occurrence of this oxidation reaction on the ore surface may have major environmental implications for mining in this area as hexavalent Cr is a known carcinogen.