Burning before painting: Synchrotron Radiation X-ray and Micro-XRF based Characterisation of rock art pigments from Karim Cave, Sangkulirang-Mangkalihat site, East Borneo, Indonesia

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Borneo island, Indonesia is a home for thousands of rock art depicted on the cave wall with various of motifs and hues. Leang Karim cave, located in Sangkulirang-Mangkalihat karst, East borneo displayed interesting rock art images with pigment varies from light red to purple. This different colour of pigment may due to different properties of pigment. This work try to introduce a scientific technique using combined synchrotron radiation X-ray including powder diffraction (SR-XRD) and X-ray absorption near edge spectroscopy (XANES) and micro-XRF to determine the components, composition, and electronic properties of the rock art pigment material. Chemical component characterization by using SR-XRD assigned that hematite is main component of pigment material with the presence of calcite and gypsum as cave wall minerals. The diffractogram of purple sample show sharper hematite peak due to higher crystallite size and lower crystallite strain. From chemical composition analysis by using micro-XRF, purple sample showed higher iron oxide content compared to another samples. The identification of electronic properties of pigment material was carried out using XANES which showed that the deconvolution of pre-edge peak of purple reveals that the $4T_{1g}$ peaks are relatively becomes lower than $4T_{2g}$ due to shift of favourable transition condition. This phenomena was found when the hematite compound was heated above temperature of 900ºC. It was responsible to the distortion of octahedral symmetry of the crystal system and change favourable transition condition. Analysis of Linear Combination Fitting on Pre-edge region of Fe K-edge XANES spectra of each sample showed the pure composition of the hematite phase (~100%). As result, we conclude that each pigment consist of hematite phase with different crystallite properties. According to XRD and Fe K-edge XANES analysis of KBL sample showed higher crystallite size and distorted crystallite structure due to temperature treatment (by burning) of pigment material.

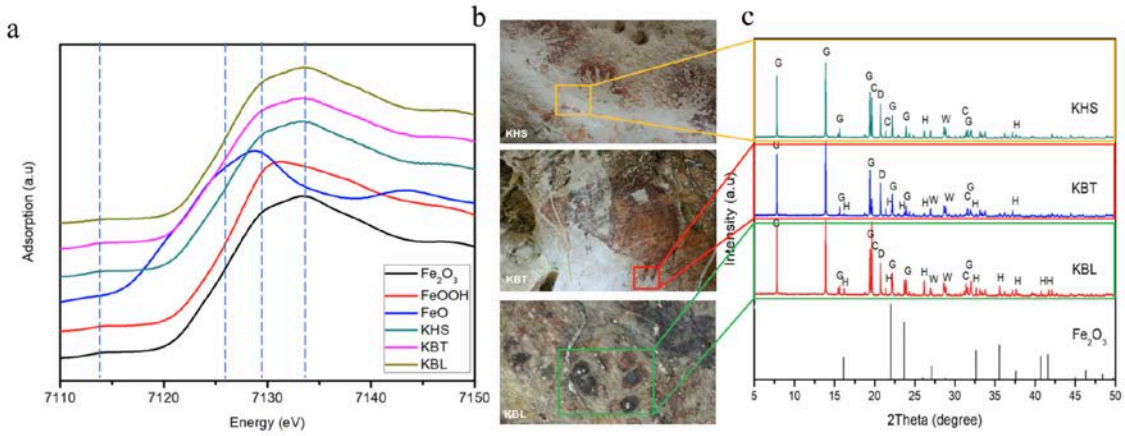

Figure 1. Pre-edge region of Fe K-edge XANES spectra (a), sampling spot of each pigment (b), X-ray diffraction pattern of each pigments (c).