XRF experiments at microscopic rough surface simulating planetary surfaces and its implication to planetary exploration

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X-ray fluorescence experiments are among most basic observation in planetary mission but the planetary surface is usually covered with regolith and not prepared for ideal quantitative analysis. Our previous study reported the influence of microscopic roughness of the surface of sandy sample on the intensities and energy spectral profile of X-ray fluorescence (Kuwada et al., 1977). In that case, we use the simple composition sample such as SiC or alumina powders to investigate the physical processes. In this study, we use the crashed rock samples such as basalt, dacite, and dunite to examine applicability of physical processes quantitatively. Thus we conducted laboratory experiments to evaluate the relation of particle size and X-ray fluorescence intensities, performed numerical simulations to compare them with the experimental results quantitatively, and made speculative calculations to estimate corrections required in planetary missions.

With those experimental and numerical studies, we conclude that 1) X-ray fluorescence intensities are also influenced by the particle size effects even for the crashed rock samples for 25 to 500 microns in size, 2) they are more effective for the larger phase angle and for the larger particle size, 3) they are less effective for heavier elements, 4) they are not different between rock types, 5) the effects can be simulated using rectangular surface with 10% error, 6) supposed that the numerical simulation of remote X-ray fluorescence experiment is realistic, a large difference could be occurred for elemental analysis. This implies that reevaluation should be required for some results of X-ray fluorescence experiments in the past missions and method of proper corrections should be prepared in the future missions. This study will become a important database for that purpose.