DEVELOPMENT ON NON-DESTRUCTIVE ELEMENTAL ANALYSIS OF PLANETARY MATERIALS BY USING NEGATIVE MUON CAPTURE.

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Introduction: The muon is one of leptons having the mass of 105.7 MeV/c^2, about 200 times heavier than the electron. Therefore, the characteristic X-ray energy by muon capture is about 200 times higher than the corresponding characteristic X-ray produced by electron transitions. The penetrability of both negative muon beam and induced muonic X-rays (more than several tens keV) are larger than those of an electron beam and a soft X-ray, so this method can potentially generate a tomographic image from a surface to a deep interior. Since Rosen pointed out the great availability of muonic X-ray analysis about forty years ago [1], muonic atom spectroscopy has been developed over the past four decades. Recently, the intense pulsed muon source, J-PARC MUSE (Japan Proton Accelerator Research Complex, the Muon Science Facility) has been constructed, and in November 2009, succeeded to provide the muon rate of 10^6 cps for 60 MeV/c that is most intense pulsed muon beams in the world [2]. Here, we report the feasibility study of the muon radiography for planetary materials using the negative muon beam at J-PARC MUSE.

Experiment and Result: We carried out the depth profile analysis of the four-layered sample that consists of SiO_2, C (graphite), BN (boron nitride) and SiO_2 using the D2 beam line at J-PARC MUSE. The negative muon beam was collimated to approximately 2.7 cm diameter and focus on the 50 mm × 75 mm × 4 mm sample that was oriented at 45 degree to the beam. Changing the Muon's momentum from 32.5 to 57.5 MeV/c, the generated high energy X-rays were measured by two Ge detectors. We also measured the Muonic X-rays from the Allende and Muchison meteorites. We will talk our recent results [3] in detail at the symposium.

References: [1] L. Rosen, Science 173 (1971) 490. [2] Y. Miyake et al., Physica B 404 (2009) 957. [3] K. Terada et al. KEK-MSL Progress Report 2011 (2012) 32.