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Advanced Lunar Elemental Mapping by XRS onboard SELENE

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1. INTRODUCTION

An X-ray fluorescence spectrometer XRS will globally map major elemental composition of lunar surface in the Japanese SELENE mission, which will be launched in 2007 to orbit the Moon. There have been some previous remote elemental mappings such as the Apollo 15 and 16 missions that covered only 9% in the lunar equatorial region and determine Mg/Si and Al/Si; the Clementine mission in 1994 that, using UVVIS, basically informed on FeO and TiO2 but managed to derive Mg and Al; the Lunar Prospector mission in 1999 that mapped whole elements with low accuracy and spatial resolution through gamma-ray spectrometry; and the SMART-1 mission in 2005 that the D-CIXS happened to observe major elements during the solar flares. In the SELENE mission, XRS and Gamma-ray spectrometer GRS will map major elements in detail. That will highly contribute to geochemical study in lunar science. The XRS is based on charge-coupled device (CCD) with higher energy resolution and with better spatial resolution than other missions.

2. SCIENTIFIC OBJECTIVES

The objectives of the XRS are to perform major elemental analysis of lunar surface and investigate it with spatial resolution within 20km. Even most fundamental chemical data such as Mg/Si and Al/Si has not been available at sufficiently high accuracy, spatial resolution, or surface coverage. The XRS will allow the following sciences: (1) better understandings of crustal formation and evolution by a small scale survey of lunar maria and highlands, (2) information on materials from surface to deep interior by investigating the crater structure that includes a central peak, floor, rim and ejecta field, and further study of lunar interior by studying numerous craters, (3) investigation of lunar volcanism and magma reservoir by observation of volcanic features and various lava flows. The XRS will highly contribute to lunar science such as the origin and evolution of the Moon, along with geochemical data including GRS and LISM and with surface to subsurface structures by LRS.

3. INSTRUMENTAION

The XRS consists of a lunar oriented detector XRF-A, and a solar direct monitor SOL-B, and a solar calibrator SOL-C. XRF-A and SOL-C are based on CCD and SOL-B is on Si-PIN diodes. Onboard data analysis provides such telemetry as the pulse heights and corresponding backgrounds of each X-ray event or the pulse height histograms for each detector. The first step of analysis including X-ray event extraction is conducted using a FPGA, followed by the detailed analysis by software on the CPU. Furthermore, an intelligent operation by optimizing the mode has been developed to avoid data overflow during intense solar flares by several orders of magnitudes (Arai T. et al, 2006, this issue).

4. DATABASE AND GOUND ANALYSIS

For elemental analysis, short-term response of solar X-rays is available with SOL-B. A little longer but precise response of XRF phenomena is available with SOL-C that mounts a standard sample for real-time calibration. This method is used by the XRS on Hayabusa. SELENE passes the same place several times by orbiting the Moon. With integration of sufficient counts of photons, spatial resolution can be effectively reduced by image processing, whose optimized method is under construction. XRF-A always points to the surface vertically but incidence angle of solar X-rays varies time to time. Influence on XRF intensity by incidence angle should be corrected using the database originally studied by Kuwada et al (1997) but investigated in more detail using proper rocks (Maruyama et al., 2006, this issue).

5. CURRENT STATUS

The XRS is in preparation for system pre-flight tests by examining functions and performances almost as expected. Construction and improvement of ground analysis tools and methods is still underway. The mission should provide an advanced elemental map, if necessary, by comparing with data such as SMART-1 and the other lunar missions such as ChangE and Chandrayaan-1.