Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PPS023-P01 Room:Convention Hall Time:May 26 16:15-18:45

Planetary explorations and community: a case study

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For an efficient progress of lunar-planetary explorations, roles of a community around an exploration project are very important in addition to an existence of strong team developing a payload instrument. Making a community does not directly relate to a future plan of the explorations but it would be an important factor on realization of them and strengthening scientific gains and repercussions. In this presentation, we introduce two attempts building a community. One is a community developing a broadband seismometer for a future lunar-planetary exploration and the other is a school of data analyses of lunar-planetary missions such as ”HAYABUSA” and ”KAGUYA”.

Lunar-A was the Japanese mission to explore the lunar interior by building an observation network with penetrators having short period seismometers and heat flow probes. It was however cancelled in 2007 due to a large delay in completion of penetrator technology. Although the seismometer technology is applied in commercial seismometers, scientists working in the projects had severely less gains from the project. A lunar-planetary exploration is very expensive and often forced to be ambitious with hard technical hurdles, and does often not go as scheduled. We should have a strategy in development of an instrument that scientists participating the project can get gains in such a situation. We currently develop a broadband seismometer for a future lunar-planetary exploration and manage that the development team is not specialized to a specific project and has intention to apply it to terrestrial seismology from the lesson in the Lunar-A project. The team consists of not only scientists developing the broadband seismometer but also researchers in ocean bottom seismology and terrestrial broadband seismology, seismological analysts and theorists, and those in planetary sciences. We have a monthly meeting in which we report recent progress in the development of the seismometer, current situation of lunar-planetary exploration projetcs, that of the OBS project and topics in seismology and planetary sciences. We hope and enjoy the discussion producing a new science and technology in the development process.

The other attempt is the school of data analyses of lunar-planetary missions. We feel that there is a gap of thinking between a project team and its surrounding community in the previous missions to the moon and the asteroid Itokawa. It is however necessary for us to have a sense of unity between them in progress of a large project, and it will be more and more. The school is managed that we provide young researchers and students with an opportunity to deal with data from the missions and enjoy them. Through the school activity, we hope they will be main players in a future mission and strong supporters leading the surrounding community. In planning a future mission, it must be a common obligation in both the project teams and community to make use of the data from the previous missions as much as possible. We also hope the school is a help in that point. We however feel concern that only the school is not enough powerful to realize future plans discussed in ”the coming 10 years”. In this presentation, we would discuss how we can raise utilization of the data from ”KAGUYA” and ”HAYABUSA” maximum and how we can build a strong community.

Keywords: lunar and planetary explorations, community, Lunar-A, broadband seismometer, data analyses, school

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Future prospect of planetary exploration by penetrator technology

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A hard landing probe ”penetrator” has been thought to be a very useful tool for the constitution of network stations on the planetary surface and subsurface, because it provides light-weight and cost-effective capabilities of deploying scientific instruments. A long-lived network science by penetrators gives unique possibilities for monitoring the global scale phenomena and for studies requiring simultaneous measurements (seismic, geodetic, magnetic, and meteorological observations) from several sites in one mission. In addition, utilization of penetrators for planetary explorations has some advantages over soft landing probes. The penetrator will make it possible to deliver scientific instruments into the planetary subsurface for in situ chemical analysis and/or heat-flow measurements; otherwise those measurements would require drilling holes from the surface. In situ geochemical measurements with higher resolution can also provide ground truth of remotely sensed data. For the reasons cited above, several planetary missions to use penetrator system have been proposed for a long time and developed by several space agencies. However, the actual space flight has not yet to be fulfilled, except for the European Rosetta spacecraft which has a penetrometry experiment and now under cruising.

ISAS/JAXA of Japan had planned to undertake a lunar mission named as LUNAR-A. The main objective of former LUNAR-A mission was to explore the lunar interior using seismometry and heat-flow measurements. The LUNAR-A penetrator mission had aimed to be the first demonstration to implement the geophysical network. To apply the penetrator system for planetary explorations, the most significant technical issue is an achievement of the shock-durability of the onboard instruments. Therefore, we need the understanding of dynamical aspect at the high-speed impact process into geological materials. And also, a sophisticated potting procedure is required under the severe limitation of weight and power supply.

On the other hand, the present design and manufacturing process of lunar penetrator which we developed for the former project have some disadvantages. One is the prolongation of potting procedure and only a few test trials. The second is the difficulty in partial repairs of payload instruments and their refurbishment. In addition, we have found difficulty to simulate the actual flight condition on the ground test facilities. In these years, we have been studying promising measures to improve the redundancy and robustness as well as multiple uses of penetrator system. Some of them were investigated in the laboratory environmental tests and others were fired for the verification of shock-durability in the high-speed impact tests.

In this study, we will report the application of penetrator technology to the future space program, and propose some mission configuration with the associated model payloads for the achievement of essential scientific objectives.

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Elemental analysis of planetary surface materials by laser-induced breakdown spectroscopy

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Lunar and planetary exploratrions start from remote sensing orbiters,then proceed to in-situ measurements by lander and rover, sample return, and human explorations. Japan had great successes in remote sensing observations by Kaguya and Hayabusa missions, however, Mars missions led by NASA and ESA are already finishing the stage of in-situ measurements, are planning future sample return mission. As for the lunar exploration, the stage of remote sensing has ended by US LRO mission. China, India, and US have announced next plans to be landing and sample return missions. This internatinal trend continues, sooner or later, for other objects in our solar system. JAXA is also planning the first landing mission in SELENE-2, yet development of instruments on lander and rover is slow. As one of such instrument developing team, we propose LIBS as a very important instrument to measure elemental abundances of planetary surface materials.

Keywords: planetary exploration, elemental analysis, laser, spectroscopy

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”Small is beautiful” planetary missions

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Micro-Total Analysis System (micro-TAS) describes a miniaturized chip-sized device that automates all necessary steps for chemical analysis of a sample, such as sampling, transport, filtering, dilution, reactions, separation, and detection. Such micro-TAS technology has been originally developed in analytical chemistry and recently has started to be widely applied in many fields, e.g., medical care, marine technology, and police investigation. Because of its very small size, micro-TAS can be placed close to a sampling site, where human cannot reach easily. In this paper, we discuss possible applications of micro-TAS to space and planetary explorations. Together with our small and distributed FS landers, we propose a new type of planetary explorations with the aim of detection of biomarkers and volcanic gases on Mars, Titan and Enceladus.

Keywords: planetary explorations, chemical analysis, Mars, Titan, methane, volcano

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Exploration of collisional history and material evolution in the inner region and the main belt of the solar system

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We propose a series of asteroidal exploration missions to investigate collisional history and material evolution in the inner region and the main belt of the solar system. The aim of this proposal is to answer two important questions of planetary sciences: Why asteroids could not grow up to planets? and What is constituents of the earth and other inner planets?

Keywords: Asteroid exploration, impact history, material science, remote sensing, sample return

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Lunar palnetary exploration by carbon- and choline-bearing materials

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The followings are summary on this project.
1) There are many volatile elements such as carbon and chlorine which are remained in the lunar breccias.
2) Carbon shows micro-and nano-textures with combined with various cations of Ca, Mg, and Fe in the solid states.
3) Chlorine and trace heavy elements are remained in crushed and quenched textures of solid mineral rocks.
4) On the surface of the moon without the atmosphere, carbon shows strongly the influences of the solar winds from the Sun and asteroid collisions, as well as planetary impacts.
5) A magnetism change is considered originally by state-changes of a carbon-bearing magnetic minerals and the magnetic field of the Moon.
6) Carbon is specifically remained in almost all the lunar Apollo impact breccias and also Ca-rich anorthite plagioclases of the lunar highlands and breccias.
7) The next exploration of the carbon- and chlorine-bearing materials with volatiles will be significant for the lunar formation analyses.
8) On the lunar interior without Earth-type activity, carbon-bearing materials are related with formation of depression hole-structure by gas evaporation after shock wave explosion (with lunar volcanic or moonquake origin).
9) The present study technique is used for every global exploration applied for Mars, Asteroids and other planetary probes.

Keywords: lunar exploration, carbon-bearing materials, chlorine-bearing materials, magnetic minerals and magnetism, planetary impacts, solar wind transportation