The Concept and Science objectives of Lunar Penetrator Mission APPROACH

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A hard-landing mission using a penetrator has a great advantage, being lightweight compared to a soft landing system. LUNAR-A was the first approved as a lunar penetrator mission, however, it was cancelled in 2007 due to the delay of the penetrator development. After that, the penetrator technology was refined on the level of ground experiments in 2011. We re-design the mission to optimize small class mission using Epsilon launch vehicle and submitted to the M-class mission of JAXA as APPROACH (Advanced Penetrator Probe Applied for a Challenge of Hard landing) in January 2018. This paper reports concept and science objectives of this mission.

Mission concept of APPROACH is basically a succession of LUNAR-A mission heritage, although the number of the penetrator is reduced to one. On the other hand, we newly proposed to deploy impact monitor camera to determine epicenter of the seismic source precisely with the aid of ground network observations. The science instruments onboard the penetrator are two seismometers and heat-flow measurement respectively to achieve the science objectives.

The science objectives we defined are derived from one of the fundamental questions of science; “how and why life exists on the Earth and whether life is universal in the universe”, which is a prioritized scientific theme defined in RFI issued by Japanese Society of Planetary Sciences.

Our mission goal of “planetary science” is to clarify origin and evolution of the Moon, which preserves evidence of its formation and early evolution of the Earth-Moon system, and enable us to study the universality of habitable solar-system environment. Another goal of “planetary exploration technology” is to develop a new landing technology on the Moon and planets for in-situ observations of the Moon and planets easily and economically.

Today’s remaining questions in lunar science are summarized by Lunar Exploration Roadmap (Exploring the Moon in the 21st century) which was compiled by the Lunar Exploration Analysis Group (LEAG: https://www.lpi.usra.edu/leag/). By referring to this, we define the following three objectives and investigations of this mission;

Objective 1. Understand the physical conditions of the lunar-forming giant impact
Objective 2. Understand thermal evolution of the Moon.
Objective 3. Understand impact phenomena on planetary bodies.

On the other hand, in order to approach the goal of the planetary technology, we define one objective as;
Objective 4. Development of a hard-landing system for the in-situ geophysical observations on the Moon.

In planetary science, our proposed concept aims to contribute to a new era which will give reliable quantitative data on internal structure. We also aim to supply precision seismic and heat flow data to

revise existing data by state-of-the-art instruments after 50 years from Apollo. The qualified data will be valuable for constraining an entire field, ranging from lunar history to the origin and evolution of the Earth-Moon system.

In planetary exploration technology, the concept aims to realize an easy access to the planetary surface. The low mass of the system has a major advantage to enable deployment of multiple landers which will provide an opportunity to conduct network observations simultaneously. Having this infrastructure could enable international collaboration or cooperation as a candidate of payload for the future planetary missions.

Keywords: internal structure, penetrator, origin and evolution of the Moon

