SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 2 (2B)

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COST-EFFECTIVE GEOPHYSICAL EXPLORATION OF THE MOON USING INSTRUMENTED MICRO-LANDERS AND A RELAY ORBITER

Abstract

High priority goals identified by a recent National Research Council report on The Scientific Context for Exploration of the Moon include a determination of the thickness of the lunar crust and its lateral variability, the characterizing of the chemical/physical stratification in the mantle, determine the size, composition, and state of the core of the Moon, and characterizing the workings of the planetary heat engine. Much of our current seismological understanding of the Moon comes from analyses of the past Apollo lunar seismic data, which are limited by the fact that instruments were clustered in the equatorial near side of the Moon and by the narrow bandwidth and low dynamic range of the seismometer package. A future, geographically distributed geophysical network incorporating high sensitivity broadband seismometers would help answer the fundamental questions regarding the inner workings and bulk composition of the Moon. Small spacecraft missions including microlanders could provide a cost-effective approach to address these issues.

The Hawaii Space Flight Laboratory (HSFL) at the University of Hawaii at Manoa is developing a program to become a low-cost gateway to space with both satellite fabrication capabilities and unique, direct access to orbital space with its own launch vehicles. HSFL is developing the capabilities to design, build, launch, and operate microsatellites in the 1-200 kg range that can be configured for a variety of science and education tasks. Using launch vehicles derived from proven technology, the system will be capable of delivering 300 kg to low Earth orbit with first launch to LEO scheduled for mid-2011.

Using the latest in micro-technology for spacecraft, we estimate that it is possible to do a mission to the Moon for under $00 million including launch costs, the deployment of four instrumented 40-kg micro-landers to install four geophysical stations at widely spaced geographic locations, and an orbiter for communication with instruments on the farside. Power is a crucial issue because it constrains station lifetime, but even a limited duration experiment is likely to provide answers to outstanding scientific questions.

The paper examines mission design issues (various trajectories), micro-lander and orbiter design, science payload (advanced seismometers, imagers, etc.), operations, science data analysis, and lifetime issues. A trade is also done on whether it is more cost-effective to do multiple low-cost launches on the HSFL launch vehicles or stacking all four landers and orbiter on a single larger launch vehicle.