LANDING SITES OPTIMIZED FOR GEOPHYSICAL STUDIES OF THE STRUCTURE AND THERMAL STATE OF THE LUNAR INTERIOR. B.Y. Tian[1], W.D. Poole[2], J. M. Garber[3], R.A. French[4], P.H. Smith[5], J.J. Barnes[5] and D.A. Kring[6], [1]Dept. of Physics, Univ. of Toronto, McLennan Physical Laboratory, 60 St. George St., Toronto, ON, CAN M5S 1A7 (ytian@physics.utoronto.ca), [2]Mullard Space Science Laboratory, Univ. College London, Surrey, UK, [3]Dept. of Earth Science, U.C. Santa Barbara, Santa Barbara, USA,, [4]Dept. of Earth and Planetary Science, Northwestern Univ., Evanston, IL, USA, [5]Dept. of Physical Sciences, The Open Univ., Milton Keynes, UK, [6]Lunar and Planetary Institute, Houston, TX, USA.

Introduction: The National Research Council's (NRC) report *The Scientific Context for Exploration of the Moon* [1] identified four goals to better evaluate the initial and evolved state of the lunar interior: to determine (2a) the lateral variability of crustal thickness and composition, (2b) the structure of the mantle, (2c) the structure and thermal state of the core, and (2d) the overall thermal history. Those investigations can be addressed by one or more geophysical methods. In this report, we evaluate the requirements those goals impose on geophysical systems and where they can be deployed. We then filter those results to develop configurations of instruments that minimize the number of deployed stations while maximizing the amount of science returned by those stations. It should be noted that any data obtained in addressing science goals 2a, 2b and 2c will be relevant in addressing 2d, and vice versa.

Geophysical Methods and Requirements:.

Seismology: This technique has the ability to address all four of the science goals. However, it also requires a multi-station array and, hence, multiple landing sites. For science goal 2a, seismology can provide a representative crustal thickness in each of the four types of lunar terranes [2] to aid inversion of the upcoming GRAIL data [3]. This requires a minimum of four seismometers (one in each terrane) at sites that are not anomalously thick or thin for each terrane and not near terrane boundaries. Science goal 2b requires a minimum four-station network in a tetrahedral configuration for global coverage of seismic activity both laterally and vertically [4]. Science goal 2c requires a minimum of two seismometers: one within areas antipodal to a deep moonquake source [5] and the other 120° away from the first station. Science goal 2d can be indirectly addressed by an understanding of the interior structure, provided by addressing science goals 2a, 2b, and 2c.

Electromagnetic (EM) Sounding: This technique can be used in conjunction with seismology to provide compositional constraints that aid seismic inversions. The magnetotellurics (MT) method of EM sounding can be done at a single site, with no additional requirements for landing site selection [6]. Low frequency ambient magnetic field variation on the Moon makes MT an effective method in probing the deep interior (below to ~200 km) and directly addresses science goals 2a, 2b, and 2c while indirectly addressing 2d.

Lunar Laser Ranging (LLR): LLR has the potential to address science goal 2c by constraining the size and geometry of the core-mantle boundary [7]. Additional LLR stations in future missions should be placed outside of the extent of the current LLR network and in

Method \ Science Goal	2a (Crust)	2b (Mantle)	2c (Core)	2d (Thermal History)
Seismology	- 4 sites - 1 in each terrane - not on anomalously thick/thin crust	- 4 sites - approx. tetrahedral configuration	- 2 sites - 1 antipodal to deep moonquake source - 1 120° away	Will benefit from network used in 2a/2b/2c"
EM Sounding	- 1 site anywhere			
LLR		- 1 site outside the current network span - continuously visible from Earth		
Heat Flow Probes	- 4 sites - 1 in each terrane - not on anomalously thick/thin crust - no shadows - avoid topographic variation - >50 km from basin edges - >200 km from terrane boundaries			

Table 1. Landing site selection requirements for each science goal and the method that directly addresses it.

areas that are continuously visible to the Earth.

Heat Flow Probes: Heat flow experiments are a complementary method for addressing science goals 2a, 2b, and 2c, and the best method for directly addressing science goal 2d. To accurately characterize the global heat flux, the probes should be placed 200 km away from terrane boundaries, 50 km away from impact basin margins, avoid significant local topographic variations, avoid temporary/permanent shadows, and have at least one probe in each of the four terranes [8].

Landing Site Selection: Table 1 summarizes the geophysical requirements for addressing science goals 2a, 2b, 2c, and 2d. By packaging all of the methods together, all of the requirements listed in Table 1 could be met with four (or more) landing sites. Locations where those requirements can be met with a perfectly tetrahedral array are mapped in Figure 1. Locations are color-coded so that the coverage provided by integrated arrays of four stations are visible. Each dot corresponds to three other dots in each of the other terranes to provide the ideal configuration needed to meet the requirements (i.e., one cannot take any four arbitrary sites of different colors and retain a perfectly tetrahedral geophysical array). However, in reality the tetrahedral configuration can be relaxed to allow more flexibility. One might not lose too much information if arbitrary sites of different colors were chosen as a geophysical array due to the clustering of individual colors seen in Figure 1.

In mapping sites that satisify the requirements listed in Table 1, seismology requirement 2c is not included. The sites of deep moonquake sources and antipodal regions are mapped in Figure 1 seperately as red stars and pale-yellow circles, respectively. For an example case study that employs one of these deep moonquake sources, see [9].

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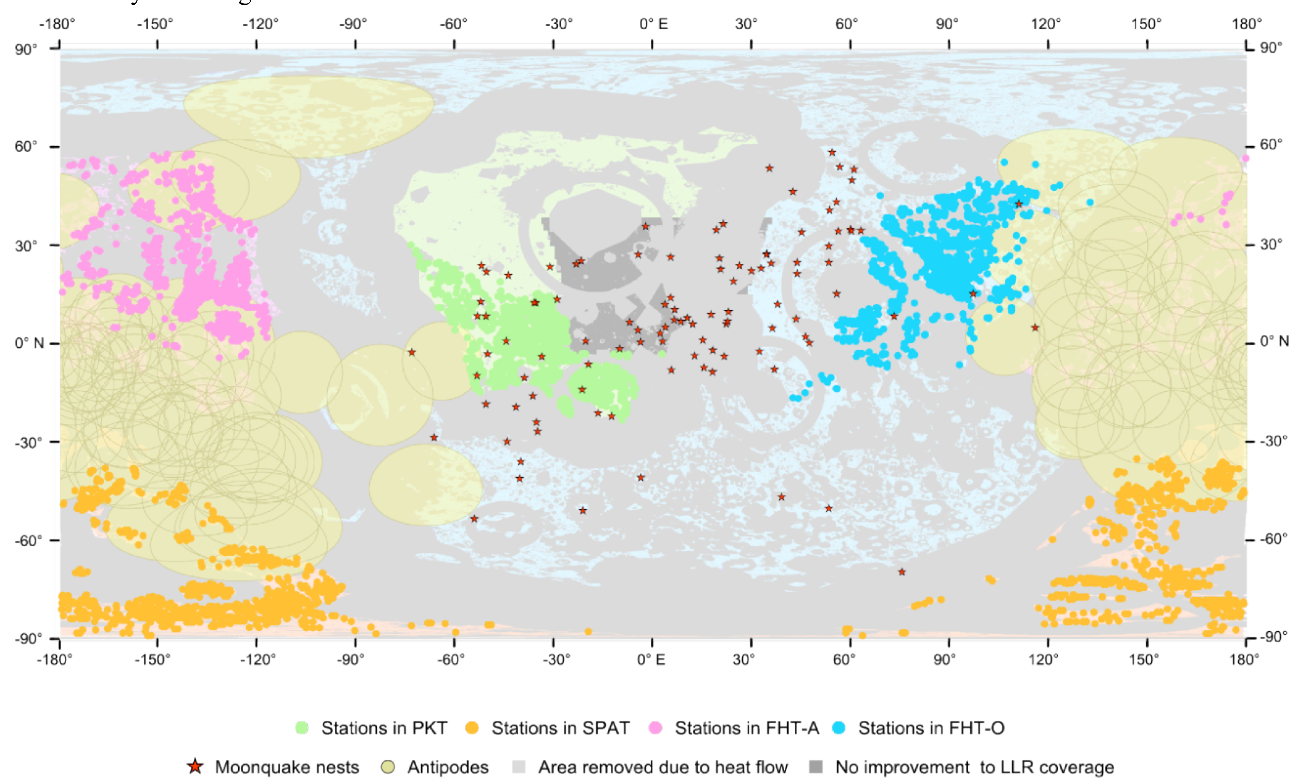

Figure 2. Map of locations where requirements of Table 1 can be addressed, along with tetrahedral arrays that satisfies these requirements (aside from 2c seismology requirements).