APOLLO 17 LUNAR SOUNDER DATA PROVIDE INSIGHT INTO AITKEN CRATER'S SUBSURFACE STRUCTURE. B. L. Cooper[1], [1]Oceaneering Space Systems, 16665 Space Center Blvd., Houston TX 77058 (bonnie.l.cooper@nasa.gov).

Introduction: In preparation for the forthcoming avalanche of data from LRO, we conducted a pilot study to demonstrate integration of multiple geophysical data sets. We applied methods of data integration that are used by the commercial mineral exploration industry to enhance the value of historical data sets and to provide a roadmap for future efforts.

Background: For studies of the lunar near side and polar regions, ground-based radar provides information about texture and thickness of various geologic units [1-4]. It is not possible to obtain ground-based radar data for the far side. However, the Apollo Lunar Sounder Experiment (ALSE) data, which covers the orbital track of Apollo 17, can be used to obtain information about the nature of the subsurface at Aitken crater and other farside locations. These data provide a bridge between ground-based observations and new data such as Lunar Radar Sounder (on Kaguya) Mini-RF (on LRO) and Mini-SAR (on Chandraayan-1).

The ALSE employed synthetic-aperture radar (SAR) to detect subsurface features along the ground track of the command module [5]. The frequencies used were 5, 15, and 150 MHz, and the low-frequency signal had a nominal penetration depth of 1300 m. The lowest-frequency data set, HF-1, was digitized and analyzed by [6] and [7]. The results of [6] for Aitken crater are shown in Figures 1 and 2.

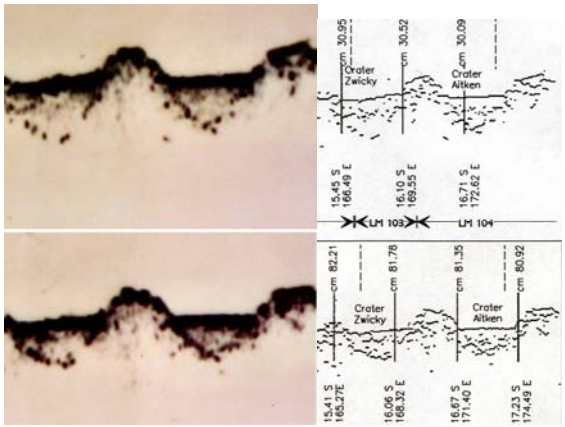

Figure 1. The crater Aitken (16.8ºS, 173.4ºE) is imaged at right in all four panels. (a) Radar images from the Apollo 17 Lunar Sounder Experiment (ALSE). (b) Plots of strongest radar signals, with latitude and longitude correlation marks and ancillary data.

High-quality global radar data are forthcoming from LRO [8] as well as other spacecraft; however, the shorter wavelengths used on these new instruments are chosen for high resolution rather than depth of penetration. The ALSE data, although historically challenging to interpret, offer unparalleled depth of penetration. Work on restoring the ALSE data set was begun by [6]. This year, we plan to digitize the VHF (150 MHz) portion of the ALSE data, which has a shorter wavelength than the HF-1 data, and thus provides a bridge between the ALSE low-frequency data; future orbital radar data; and the nearside gound-based radar data that have been collected in the decades since Apollo.

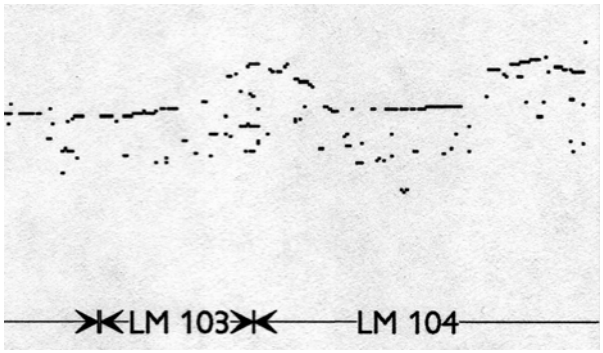

Figure 2. Cross-groundtrack correlation of the two orbits results in an image in which the likelihood of spurious off-nadir returns is greatly reduced, allowing interpretation of possible subsurface features [6].

Significance of this Study: Because data that is not used has no value, tools are needed that will facilitate the use of the ~450 Gigabytes of data that will be received each day from LRO. A commercial mining exploration program, Oasis montaj, is capable of handling terabyte-size data compilations, limited only by computer memory. This software is frequently used for terrestrial mineral exploration, in which large data sets of widely varying resolution are integrated to search for exploitable minerals. Using this software for analysis of Aitken crater provides two benefits: (1) increased knowledge of Aitken crater and the geology of the northern edge of SPA; and (2) an example of how off-the-shelf software tools can be used for planetary geology.

Results: Figure 3 shows magnetic data from the Lunar prospector instrument (gridded using an Oasis montaj algorithm) combined with spectral data from Clementine. A NE-SW trendline in the magnetic data is is seen to diverge around the crater Aitken, suggesting the possibility that the Aitken impact disturbed a deeper structural feature. The Apollo 17 Lunar Sounder data, interpreted in Figure 2, suggest fewer

subsurface reflectors on the SE side of Aitken when compared to the NW side. A correlation between the magnetic high and the paucity of subsurface radar scatterers suggests the presence of a relatively intact rock formation with higher iron content compared to the surrounding area. The disturbance caused by the Aitken impactor into this formation would imply that the magnetic feature predates the Upper Imbrian Aitken impact.

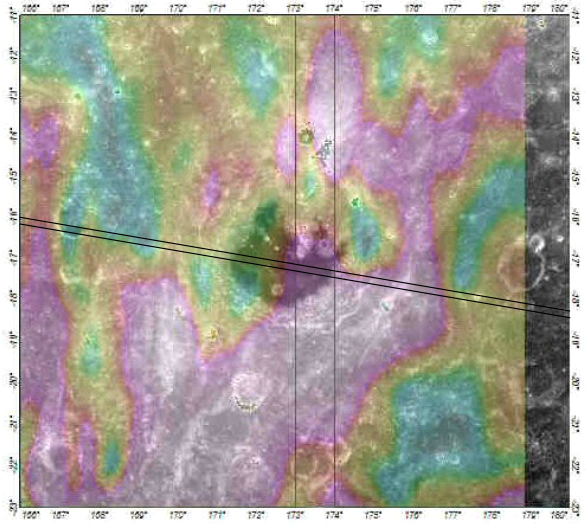

Figure 3. Gridded Prospector magnetic data, created with Oasis montaj software. Clementine 750 nm base map shows surface geology. ALSE groundtrack is shown as black diagonal lines.

The region surrounding Aitken crater has a stronger magnetic field than most other areas of the Moon, and additional study is needed to understand how local Imbrian-age features are related to localized changes in magnetic field strength. Three-dimensional integrated data sets, such as shown in Figure 4, can be used for rapid and intuitive understanding of the relationships between data sets, from which detailed studies can be designed.

Conclusions: The northwest-trending magnetic anomaly shown in Figure 3 may represent a deep structural feature associated with the South Pole-Aitken basin, or with the Keeler-Heaviside basin, which is also pre-Nectarian [9]. The age of the feature that causes the magnetic anomaly is constrained by the age of Aitken crater. Additional analysis of the surrounding area is planned to fully understand the structural implications of the data.

This pilot study provides a better understanding of how the ALSE data can be used for studies of the lunar far side, where terrestrial radar data do not exist. The ALSE data can be correlated with geophysical data from other sources to gain insight into the subsurface structure at Aitken crater, and elsewhere along the Apollo 17 ground track.

References:

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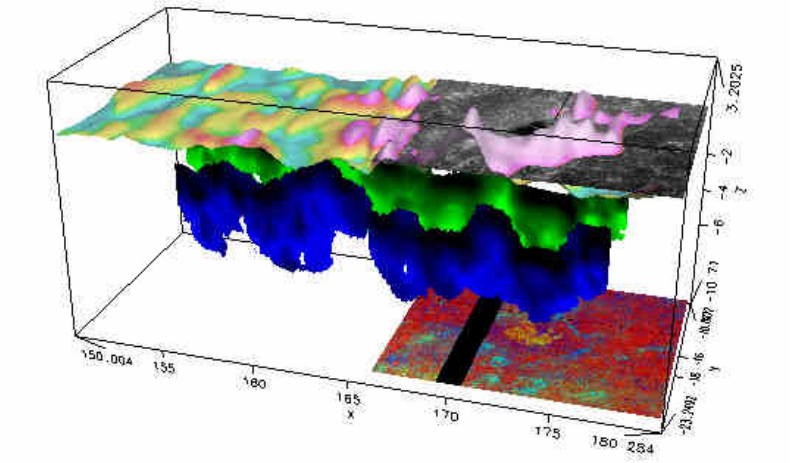

Figure 4. Map showing an example of integrated data sets. Magnetic data from Lunar Prospector and 750 nm grayscale imagery from Clementine are combined in the upper layer. The middle layers, in blue and green, are two lines of Apollo Lunar Sounder Experiment (ALSE) radar data. The bottom layer is a Clementine multispectral ratio image.