MAPPING OF LUNAR SURFACE FROM SIDE-LOOKING ORBITAL RADAR IMAGES

FRANZ LEBERL*

Space Sciences Division, Jet Propulsion Laboratory, Pasadena, Calif., U.S.A.

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Abstract. Side-looking spacecraft radar imagery has thus far been produced only from an orbit around the Moon. This was a part of the Apollo Lunar Sounder Experiment (ALSE) of the Apollo 17 mission in December, 1972. This paper reports results of a radargrammetric evaluation of overlapping Apollo 17 synthetic aperture radar images (wavelength 2 m). The potential to map from single images and to reconstruct 3D stereoscopic models is studied. The relative height accuracy achieved is about ± 100 m and is thus competitive with that obtained with the vidicon camera that is presently used for planetary exploration.

1. Introduction

Topographic surface relief can be measured with an accuracy of ± 100 to ± 300 m using a pair of overlapping side-looking orbital radar images of the Moon. Planimetric accuracy is somewhat lower, resulting in root mean square errors of ± 250 m to more than 1 km. These results are obtained in a radargrammetric evaluation of the mapping potential of existing orbital radar images.

Civilian orbital imaging radar was used for the first, and so far the only, time on the Apollo 17 mission to the Moon. The primary aim of the Apollo Lunar Sounder Experiment (ALSE) aboard the command module was to make radar measurements at wavelengths of 60 m, 20 m (HF) and 2 m (VHF). However, the experiment was designed in such a way that surface profiles as well as side-looking images were produced (Phillips et al., 1973) during two complete lunar orbits.

The 2-m (VHF) radar returns were the most useful for mapping the lunar surface, since they recorded images from features not lying along the spacecraft track. However, even at the 2-m wavelength the lunar surface appears to be rather smooth, so that most returns are specular. The images, therefore, show less detail than with a radar of shorter wavelength.

Segments of overlapping ALSE-VHF imagery produced during orbits 25 and 26 of the Apollo 17 command module over crater Maraldi (19°N, 35.5°E) were the basis for the study of the radargrammetric potential of this data (Figure 1(a) and (b)). Figure 2 shows a portion of an Apollo 17 metric photograph of the same area. The present paper describes methods for the radargrammetric mapping of surface features and analyzes their results. Conclusions from this analysis are of value for radar mapping of previously unexplored areas of the lunar far side and for the exploration of the planet Venus with an imaging radar (Rose and Friedman, 1974).

* NAS-NRC Resident Research Associate.
Fig. 1. ALSE-VHF side-looking orbital radar images of crater and Mons Maraldi on the Moon produced aboard the Apollo 17 command module (a) during revolution 25 and (b) during revolution 26.

Fig. 2. Section of the Apollo 17 metric frame photograph No. 1495 of the crater and Mons Maraldi.