MARE IMBRIUM: A REGIONAL SITE OF ANOMALOUS ELECTRICAL CONDUCTIVITY, G. Schubert*, K. Schwartz**, C.P. Sonett***, B.F. Smith†, D.S. Colburn†, *Dept. of Planetary & Space Science, Univ. of Calif., Los Angeles 90024, **5160 Camino Floral, Santa Barbara, Calif. 93111, ***Dept. of Planetary Sciences & Lunar & Planetary Laboratory, Univ. of Arizona, Tucson 85721, †NASA Ames Research Center, Moffett Field, Calif. 94035.

The Apollo 15 Lunar Surface Magnetometer has observed magnetic field oscillations which, at frequencies above about 5 mHz, and in the plane tangent to the lunar surface, are predominantly fluctuations in a northwest-southeast direction (1). With the Apollo 15 site located on the southeast margin of Mare Imbrium, this direction is roughly toward the center of the Imbrium basin. The Apollo 15 polarization phenomenon, and a similar but weaker one at the Apollo 12 site far to the south of Mare Imbrium (2), have been interpreted as a possible regional influence of the Imbrium structure on lunar magnetic induction (1). We present preliminary model calculations which show that induction in an electrical conductivity anomaly associated with the Imbrium basin can qualitatively explain the observed directional character of magnetic fluctuations at both the Apollo 15 and 12 sites.

The Imbrium electrical conductivity anomaly is modelled by a spherical cap current layer of arbitrary size, electrical conductivity - thickness product $\sigma\delta$, and depth (a-b) beneath the lunar surface. External magnetic fields uniform in space and oscillatory in time with circular frequency $\omega$ induce eddy currents in the cap. The external fields can be either parallel or perpendicular to the cap at its center. Induced magnetic fields are confined to the lunar volume which is assumed nonconducting except for the cap. The major result of these model induction calculations is that the tangential lunar surface magnetic field component which points to the cap center can be anomalously large over the edge of the cap if the external driving field has the parallel orientation. This magnetic field anomaly can be attributed to a concentration of circumferential eddy currents toward the outer margin of the cap.

Figure 1 shows this component of surface magnetic field normalized with respect to the corresponding component of the external driving field, i.e. the magnitude of the transfer function $|A|_\delta$ as a function of angular distance from above the cap center $180^\circ-\theta$ for various cap depths below the surface and for a cap of half-angle $25^\circ$ with $\omega\mu\sigma\delta a=6.87$ ($\mu$ is the magnetic permeability and a is the lunar radius). Figure 2 is a similar plot with $\omega\mu\sigma\delta a$ as the parameter and a cap depth of 100km. The magnetic field anomaly over the cap edge is narrower and larger, the nearer the cap to the surface. The magnitude of the magnetic field anomaly increases with $\omega\mu\sigma\delta a$ for a given cap depth below the surface.

The Imbrium structure could be a site of electrical conduc-

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tivity in excess of the global lunar conductivity or it could be a hole in an otherwise conducting Moon. Either type of conductivity anomaly would produce induced magnetic fields with the observed directional character. Although we have not yet attempted to quantitatively model the observations it seems as though the conductivity anomaly must be deep, i.e. at a depth of about 100 km, if the regional induction is to be felt at the Apollo 12 site. A more conducting structure at the Imbrium location might be associated with magma production at depth subsequent to the Imbrium impact event and the rise of such magma to fill the basin perhaps preferentially beneath the basin margins. A less conducting Imbrium site could be the result of the violent fracturing of a large region around the impact, leaving, to this day, circumferential cracks at great depth. Whatever the physical nature of the Mare Imbrium conductivity anomaly, it is certain from the observations that eddy currents flow preferentially in a direction which is circumferential to Imbrium at the Apollo 15 site.

REFERENCES

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