Geophysical Research Abstracts, Vol. 8, 02667, 2006
SRef-ID: 1607-7962/gra/EGU06-A-02667

Lunar albedo anomalies and paleomagnetism on the moon

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The nature of diffuse albedo anomalies on the lunar surface that look like swirls is one of most interesting mystery in current lunar studies. There are two main classes of hypotheses of the swirl origin: formation of the swirls in the regions antipodal to large impact basins (1), and formation of the swirls in result of cometary impacts (2). The first version of the swirl origin proposed that swirls represent regions whose higher albedo have been preserved due to deflection of the solar wind ion bombardment by strong crustal fields (Hood, Schubert, 1980). Other version explained the swirl appearance as result of the possible cometary impact (Gold, Soter, 1976). The most likely magnetization mechanism was proposed by Hood (1987), in which the ionized vapor cloud produced in a hypervelocity basin-forming impact expands around the Moon and concentrates the pre-existing ambient magnetic field at the basin antipode. The analysis of the swirl distribution carried out by Lin et al. (1988) confirms that the swirl-like albedo markings of the Reiner Gamma class on the far side of the Moon are located near the antipodes of the young impact basins, Imbrium, Orientale, Serenitatis, and Crisium. The data obtained by the Lunar Prospector show that swirl features are associated with magnetic anomalies and they lie on regions antipodal to the Imbrium, Serenitatis, and Crisium basins (Hood et al., 1999). Gold and Soter (1976) suggested a mechanism of a local magnetic field origin on the Moon in result of cometary impact. The local shock produced by collision of the main mass of a comet nucleus with the Moon will indeed occur just when the ambient solar wind fields have been strongly enhanced, as the large partially ionized cometary coma is compressed against the lunar surface. Schultz and Srnka (1980), Bell and Hawke (1987), Shevchenko (1993) considered that swirl patterns on the lunar surface could be related to the imprint of recent cometary impacts. This hypothesis does not suggest correlation between the swirl locations and the regions antipodal to basins. Relative ages and diameters of basins mentioned above were identified by Wilhelms (1984). As known the Orientale basin is youngest. It is related to the younger Imbrian Period (3.2 – 3.8 b.y.). The formation of the Imbrium basin is related to the Imbrian Period too. According to Wilhelms' classification the Imbrium basin is relatively older then Orientale one. Others basins are related to the younger Nectarian Period (3.8 – 3.9 b.y.). They have nearly the same age. However, lunar swirls are covered by most immature soils (Pinet et al., 2000; Shkuratov et al., 2003). According to analysis of Shevchenko et al. (2003) the exposure age of the swirl units may be about 10^7 yr. The more strong correlation is observed for youngest large basins: Orientale and Imbrium. However, swirls are absent in region antipodal to youngest (second age group, more younger than Imbrium basin) but small (320 km) Schrodinger basin. This antipodal region locates on the near side of the Moon. The swirl area is observed on region antipodal to Serenitatis basin, but any swirl markings are absent on regions antipodal to Humorum, Hertzprung, and Humboldtianum basins in spate of similar age and diameter of them. On the other hand, there are two cases of absence of correlation between swirl areas and regions antipodal to impact basins (for small swirl formations). The Reiner Gamma formation is most obvious example of that the correlation mentioned above is not statistically strong and do not exclude the swirl origin associated with external reason, such as cometary impact (Pinet et al., 2000). Nature and origin of the swirl formations are open questions in lunar science. Investigation of them is a good science objective for AMIE/SMART-1 mission.

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