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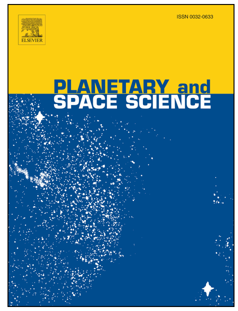

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Rock size-frequency distributions analysis at lunar landing sites based on remote sensing and in-situ imagery

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Abstract: Rock populations can supply fundamental geological information about origin and evolution of a planet. In this paper, we used Lunar Reconnaissance Orbiter (LRO) narrow-angle camera (NAC) images to identify rocks at the lunar landing sites (including Chang'e 3 (CE-3), Apollo and Surveyor series). The diameter and area of each identified rock were measured to generate distributions of rock cumulative fractional area and size-frequency on a log-log plot. The two distributions both represented the same shallow slopes at smaller diameters followed by steeper slopes at larger diameters. A reasonable explanation for the lower slopes may be the resolution and space weathering effects. By excluding the smaller diameters, rock populations derived from NAC images showed approximately linear relationships and could be fitted well by power laws. In the last, the entire rock populations derived from both NAC and in-situ imagery could be described by one power function at the lunar landing sites except the CE-3 and Apollo 11 landing sites. This may be because that the process of a large rock breaking down to small rocks even fine particles can be modeled by fractal theories. Thus, rock populations on lunar surfaces can be extrapolated along the curves of rock populations derived from NAC images to smaller diameters. In the future, we can apply rock populations from remote sensing images to estimate the number of rocks with smaller diameters to select the appropriate landing sites for the CE-4 and CE-5 missions.

keywords: rock populations; lunar landing sites; remote sensing and in-situ observations; power laws; fractal theories

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1 Introduction

It is important for us to understand the rock size-frequency distribution (RSFD) on lunar surfaces. Rock distributions on planetary surfaces can supply fundamental geological information related to the planet's origin and evolution, and the timing of key events (Grant et al., 2006; Ward et al., 2005; Yingst et al., 2007). In addition, large rocks within a landing site represent potential hazards to landers as well as navigational threat to rovers. The better the rock number and fractional area distributions are understood, the better the potential threats to landers and rovers can be known and quantified (Golombek and Rapp, 1997). Therefore, before selecting a landing site, determining the RSFDs on planetary surfaces are necessary and important (Cintala and Mcbride, 1995).

There have been many studies about the RSFDs on Martian and terrestrial surfaces. In earlier researches, Binder et al. (1977) and Moore et al. (1979) considered that size distributions of rock populations at the two Viking landing sites followed power functions. Moore and Keller (1991) suggested that power functions could be used to describe rock populations for diameters greater