Global ^{3}He Distribution over the Moon Surface on the Base of Multispectral Clementine Data

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Introduction

As a part of solar wind ^{3}He accumulates in lunar soil at depths up to few tens nanometers [1]. Concentration of helium in regolith depends on two factors: (1) intensity of solar wind flux and (2) lunar soil degassing processes [2].

In the first case ^{3}He distribution over the lunar surface should depend on selenographic latitudes (irradiation decreases with increasing incidence angle) and longitudes (passing of the Moon through the Earth magnetic tail every month during about a week [3]).

In the second case ^{3}He concentration depends on surface temperature and saturating concentration, which is related with composition and structure of the regolith. ^{3}He abundance correlates with mineral phases containing effective traps (such as ilmenite) and with defectness of crystal lattice (soil maturity). At low temperatures, i.e. high lunar latitudes, ^{3}He e concentration significantly higher than in low-latitude regions.

^{3}He mapping on lunar surface

We believe that the concentration relates just with abundance of ilmenite and with soil maturity. The correlation of the ^{3}He content with the value [TiO_2·Is/FeO] is obtained in [1] using laboratory measurements of Apollo samples. Besides, the greater part of total helium is contained in fines of lunar regolith (the average particles size £ 50 mm).

The optical data we used is the Lunar Multispectral Global Mosaic of the Clementine UVVIS camera. The model for deriving TiO_2 and Is/FeO parameters is based on the Lucey's method, modified in [4]. ^{3}He concentration is mapped using these parameters and the calibration from [1]. The frequency distribution of helium concentrations has non-symmetrical shape due to the modes corresponding to highland and mare types of the lunar surface.

Implication for swirls

We found that ^{3}He concentrations for lunar swirls Reiner-gamma, Mare Marginis and Mare Ingenii are relatively low as compared to their neighbourings. It is derived from low values of product the [TiO_2·Is/FeO]. The low maturity index (unmature material) can be explained in frame of comet impact theory [5]. The great average particles size in unmature soils also decreases the helium content. Low titanium content corresponds to high color-index in visible spectrum range [4]. Such spectrum reddening may be also due to implanting the comet material. Thin layers of organic comet carbonaceous substance in regolith particles may cause spectrum reddening [6] masking effects of titanium content on visible lunar spectra.

References:

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