Airless Moon and air-rich Earth-type planets caused by impact variety on soft and hard target rocks: Atmosphere formed by surface condition

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Abstract

Surfaces of airless Moon and Asteroids are mainly composed with glass and void-rich regolith soils and breccias formed by multiple impacts, which have few chance to hard crystalline rock of crust layers. Carbon and sulfur contents of volatiles are indicators of huge impacts of the Apollo lunar regolith soils and breccias. Global regolith soils with porous and glassy textures originally formed from primordial impacted rocks by global impacts play filtering role for interior resources of volatile gases on the Moon and Earth-type planets. Interior gas and fluid materials stored by impacts through the regolith filtering are globally changed to “CO2-rich degas activity”. Mainly volcanic processes by tidal forces and planetary rotation located along the Equator areas on active or inactive planets (old Earth, and present Mars, Venus and Mercury) and the present Moon.

1. Introduction

Academic lesson of 3.11 (2011) Fukushima Daiichi Nuclear Power Plant Accident is that “new technique should adopt the latest science results, and science should provide the latest result to a technique” [1-15]. Air formation process of Earth-type planets should be checked the details especially from surface materials, which is main purpose of the present study.

2. Surface data for regolith soils as soft target

Material evidences for impact differences on soft target can be explained as follows (Table 1, Figs. 1, 2):

1) *Surface images and data*: Vertical holes (called as pits) without any hard rocks are found on the Apollo surface images explained as small impact crater with vertical deep crater structure (Fig.1) [16-18]. Central peak structure obtained on large crater [16, 17, and 19] is explained as brecciated blocks formed from glassy solid to crystalline blocks, though void-rich regolith soils so not form typical central rock blocks on the airless Moon.

Fig.1. Soils impact craters on the Moon (Left: Apollo 16. Right: NASA-LROC image) [16, 18].

2) *No Earth-type shocked rock and minerals:* There are few reports lunar shatter-cone and lunar shocked quartz because there are no formed from hard (crystalline) rocks on the Moon (Fig. 2), which might be similar features on other bodies of Asteroids, Mars, Mercury and Venus due to main impact process [1, 2, 16, 19].

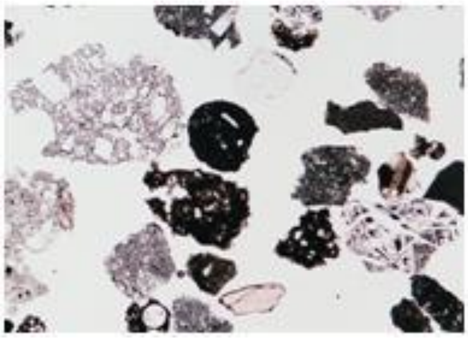

Fig. 2. Apollo 68501 highland regolith soils as its optical micrograph by plane polarized lights with image width 4mm [16, 18]. The remote IR spectral data are mainly based on some crystalline fragments from glassy regolith soils and/or glassy breccias, which suggest glassy minor fragments (not by hard crystalline rocks as in terrestrial continents, but not sure any contents of crystalline grains in this regolith soils) [7-15].

3) *Interior fluid and gas as air:* Air compositions evaporated from hard rock have been discussed mainly by contribution of various projectiles of asteroids and comets [1, 2, 16, and 19]. However, global compositions of any atmosphere are not well explained on various planets because of air-formation by localized impacts [16, 19]. Without any seawater and air-rich planetary system (on the Moon, Mars, Venus and Mercury), light volatile elements are also rich in the lunar interior proved from the Apollo surface soils data (Fig.3, Table 1). Carbon element is also

rich in impact surface of regolith soils and breccias [8-15], which are considered to be form CO_2 gas from volcanic uplift (on air-rich Mars and Venus).

Table 1. Difference of Earth's and lunar rocks [14].

1)*Terrestrial continental rocks:* Formed by interior magma mixing at water-rich plate movement.

2) *Lunar older rocks:* Impact growth from heterogeneous blocks by many impacts.

3. Lunar volatile elements in the lunar interior

In order to analyze the lunar interior volatiles, reported depth profiles of the Apollo drilled core samples (15001-15006) obtained from 16cm to 238cm in depth are used in this study as follows: [13-16, 18] (Fig. 2 and Table 1).

1) All bulk contents of S, C, N, He, H and Fe elements are obtained irregularly to deeper sites (not simply decreased).

2) Solar wind sources of H, He and N elements and meteoritic Fe sources are the richest in shallow sample 16 cm in depth (near surface), but molecular elements of C and S (as sources of CO_2 and SO_2 *etc.*) are the richest in relatively deeper sites of 65cm and 95cm in depth, respectively.

3) Evidence of penetration to deeper sites through porous regolith soils during impacts is proved by two peaks of depth profiles of the six elements with lower second peaks, where heavy elements C, S and Fe are relatively deeper sites of the second rich peaks (168cm to 238cm) which are produced by direct shallow penetration (by smaller extra-lunar collisions), and/or larger mixing on larger impacts on porous regolith with gravitational deposition.

4. Porous regolith soils on the Moon's surface

Hardness for impact extra-lunar materials can be discussed by porosity and density data of the six lunar rocks (four highland and two Mare sites), various six chondritic meteorites and the Apollo lunar regolith soils as follows [8-16] (Fig.4 and Table 1).

1) Porosity and density data of lunar regolith soils (as high porosity and low density totally) are completely different with those of the lunar rocks and various meteorites (as low porosity and high density totally), which indicates multiple impact on brecciated rock broken to fragmental regolith soils.

2) Drilled core samples of the regolith soils reveal bulk estimated values from 15cm to 60cm [1] with decreased porosity and increased density, though porous regolith soils are still the same.

3) The lunar breccias show the same or higher porosity of various chondritic meteorites, which has been misunderstood lunar origin of meteorites.

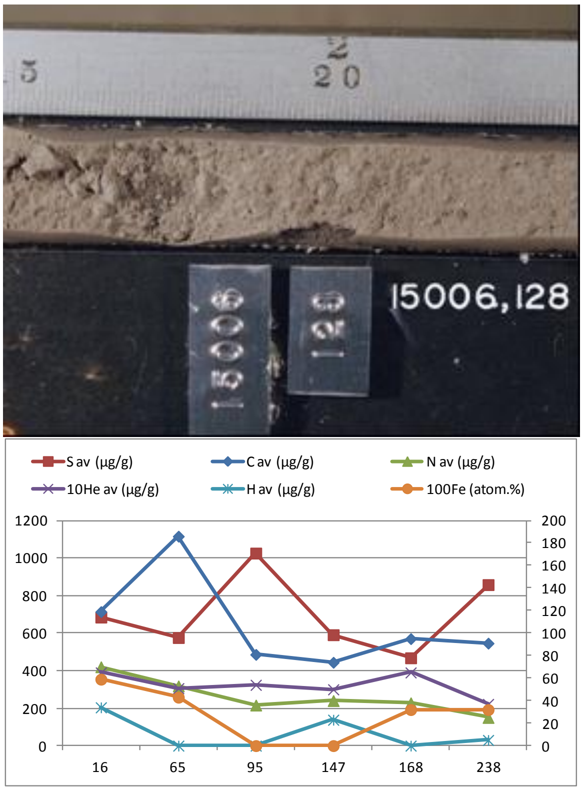

Fig.3. Depth profiles of light elements (volatiles) and Fe contents of the Apollo drilled cores 15001-15006 [1, 9 and 10]. Photo is drilled regolith soils (Fe-bearing pale brown) of 15006,128 core sample [1, 10].

4) The lunar highland crystalline rock (15418 anorthosite) is similar with the CO carbonaceous chondrite which suggests now similar texture.

5) The lunar Mare basalts reveal the lowest porosity (some similar achondrite) and the highest density (similar H and L chondrites) which suggests melted magmatic origin of the interior.

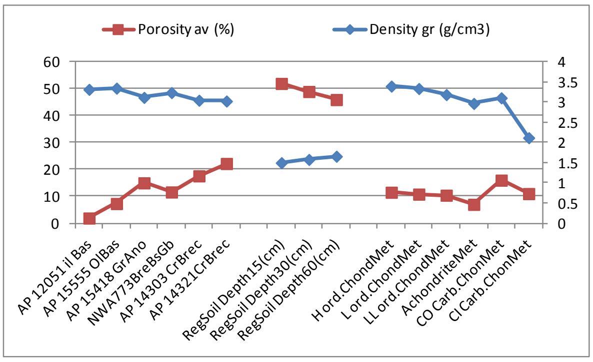

Fig. 4. Porosity and density data of six Apollo lunar rocks, six chondritic meteorites and three Apollo lunar regolith core soils [10-16, 18].

5. Volatiles filtering and reservation by impact

Global regolith soils with porous and glassy textures originally formed from primordial brecciated rocks by global impacts play filtering role for interior resources of volatile gases on the Moon [5-15], as shown in Table 2.

Concentrations of volatiles and heavy elements from primordial collision of the Earth-type planets might be obtained by size of the planets and the Moon due to volatile resources are related with whole size of the planetary body by global continuous impacts.

In fact, the largest planets of the Earth-type planets (Earth and Venus) show concentration of volatiles and Fe-bearing heavy elements with the largest density. On the other hand, the smallest body of the Moon shows the lowest density with volatiles and possible remnants of planetary impacts (*i.e.* giant impact to form the Moon with primordial Earth [16-18]). Mars data are explained as intermediate value between the Moon and Earth (Fig.5), which suggests Mars has similar heterogeneous surface textures with major volatile filtering and storage in the interior [13-15].

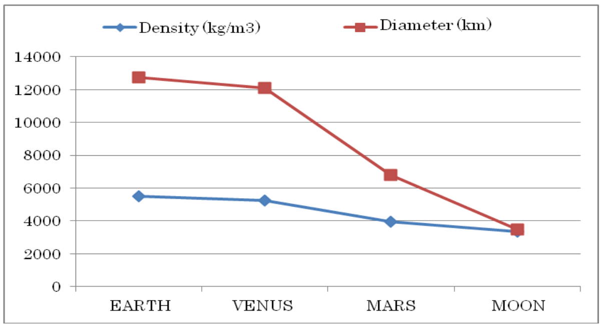

Fig.5. Density and diameter of Earth, Venus, Mars and the Moon.

6. Volcanic degassing to air-system of planets:

Interior gas and fluid stored by impacts through the regolith filtering are globally changed to "CO_2-rich outgas activity" mainly volcanic processes by tidal (gravitational) forces and planetary rotation located along the Equator areas on active or inactive planets (Mercury, Venus and Mars) and the Moon [8-15] as listed in Table 2.

In this model of global process, an air- and water-rich Earth produces homogeneous hard continental rocks finally on global water-rich system (not local water) triggered by the plate movements in the sea-water bottom to be melted with shock waves of earthquake and volcano [2], where air-system on the planets of Venus and Mars are not formed by meteoritic impact on hard rocks but impact and interior volcanic outgas process due to no continuous water-system of the Earth-type with thick and deep system for long Earth's history [13-15].

Table 2. Formation steps of air-planets [10-15]

1) Impacts on brecciated rocks into soils.
2) Interior volatiles erupted by volcanisms.
3) Global air system formed by volcanism

7. Summary:

The present study is summarized as follows:

1) Surfaces of airless Moon and Asteroids are mainly composed with glass and void-rich regolith soils and breccias formed by multiple impacts, which have few chance to hard crystalline rock of crust layers.
2) Carbon and sulfur contents of volatiles are indicators of huge impacts of the Apollo lunar regolith soils and breccias.
3) Global regolith soils with porous and glassy textures originally formed from primordial impacted rocks by global impacts play filtering role for interior resources of volatile gases on the Moon and Earth-type planets.
4) Interior gas and fluid materials stored by Impacts through the regolith filtering are Globally changed to "CO_2-rich degas activity" Mainly volcanic processes by tidal forces and planetary rotation located along the Equator areas on active or inactive planets (old Earth, and present Mars, Venus and Mercury) and the present Moon.

Acknowledgements: Author thanks to Em. Profs. T. Kato (Yamaguchi University), and Dr. T. Tanosaki (Nat.Envnm. Inst.) for carbon-bearing and meteorites and impact materials in the study.

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