CARBON ON THE MOON: CONTRIBUTION OF DARK COLOR FOR MOON SURFACE ROCKS. Y. Miura (Yamaguchi University, Yamaguchi, 753-0074 Japan. yasmiura50@gmail.com) and T. Tanosaki (Kogakuin University, Tokyo, Japan).

Introduction: Black and white colors on the Moon surface have been explained by topographic albedo and colors of minerals in the rocks [1-2]. New contribution of color on the Moon surface is discussed by significant carbon contents of the Mare and Highlands based on black carbon contents from bulk composition and comparative carbon-bearing textures formed naturally and experimentally as main purpose in this study.

Previous explanation of Moon colors: The Albedo values obtained from visible electromagnetic radiation reflected are based on surface topography explained as low value on the Mare and high value on the Highland. From materials, the Mare rocks of black minerals in the basalt show dark colors caused from pyroxene, olivine and metals. whereas the light color of the Highlands are silica-rich rocks (anorthosite etc.) relatively as seen in Fig.1[1-3]. The problems of Moon minerals are explained by clear stoichiometric crystals formed after separation of volatile elements on water-planet Earth [4].

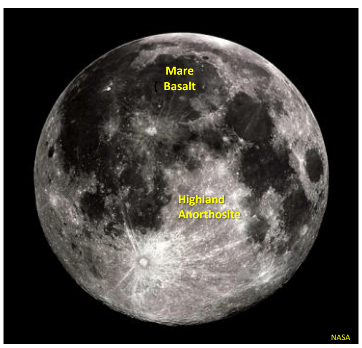

Fig. 1. The moon surface with dark Mare and light Highland cause by topographic reflection and mineral colors [1-3]. Colors in polarized thin section are optical.

Anomalous minerals of the Moon: Moon minerals obtained from the Apollo samples and lunar meteorites show anomalous minerals compared with clear Earth's crystals as follows [2-4]:

1) Numbers of Earth's minerals are exceedingly higher than Moon's materials, which suggests that Moon activity of fluid condition is less than water-planet Earth.
2) Hydrogen-bearing minerals show higher kinds of minerals among volatile-bearing minerals in global water-Earth, which are higher than dry Moon's rocks.
3) No continuous formation of K-Na-Ca feldspar and silica quartz are observed on less active Moon's rocks.
4) All Earth's rocks and minerals cannot be found on the Moon, which indicates that fluids on the Moon are locally isolated. The anomalous data are explained as less activity of the Moon, where poor-crystallized materials with significant volatile elements (esp. carbon) are obtained on the Moon's minerals and rocks [5-7].

Carbon contents of Moon rocks: Carbon contents of reported Moon's rocks are exceeding higher in soils-regolith breccias and polymict breccias than Mare basalts, which indicates that impact process produces higher carbon-bearing rocks, as shown in Fig.2 [2, 7].

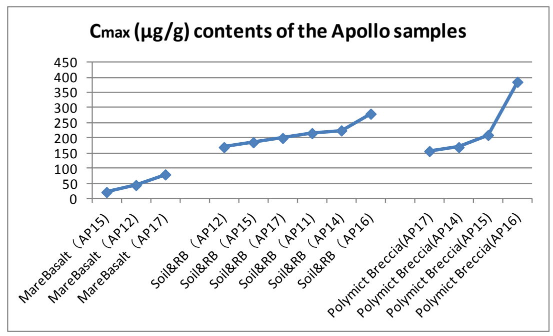

Fig. 2. Maximum carbon (Cmax) contents of Mare basalts (Apollo, AP-12, 15, 17), soils and regolith breccias (Apollo 11-12, 14-17) and polymict breccias (Apollo 14-17) reported [2, 7]. This indicates that carbon contents are higher in impact-mixed samples.

Carbon contents of Earth's main rocks:: We have investigated carbon contents of 1,500 Earth's samples (in Japanese and world rocks) by recent XRF instruments with carbon detection, where significant carbon contents (more than 2wt.% CO_2, except carbon-rich limestone carbonates) can be obtained on representative Earth's rocks classified from light to dark colors based on crystalline minerals as follows (Fig.3):
1) Whitish light-color rock of silica-rich plutonic granite has few carbon content, though quenched volcanic rock (rhyolite) shows higher carbon content.
2) The same data of higher carbon content in fine volcanic rocks than coarse plutonic rocks are obtained at other rocks of diorite-andesine, gabbros (anorthosite) - basalt, and peridotite - kimberlite in this study (Fig.3).

As color and carbon content of the Earth's rocks, it is obtained in this study that higher carbon contents are found in dark rocks relatively and less carbon amounts in quenched volcanic rocks with fine textures [6, 7].

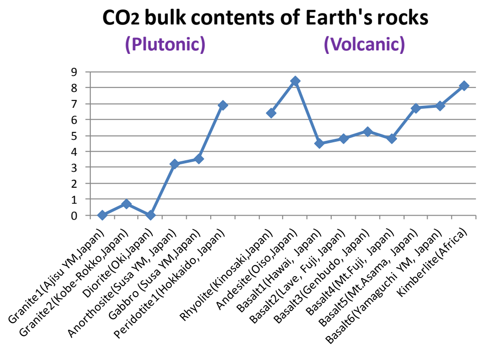

Fig. 3. Bulk carbon contents of representative Earth's rocks from silica-rich to poor chemistry, light to dark colored optics, and coarse plutonic to fine volcanic texture. The bulk data have been measured with recent XRF instrument (with carbon analyses) [6, 7].

Artificial formation of carbon-bearing textures: Senior author has been used laser instrument to form carbon-bearing micro-textures with mechanical breaking and widely melted processes [5-7]. 1) Mechanical breaking texture shows linear micro-grains (10 to 100μm in scale) with local nano-grains (10-100nm in size) as minor products. 2) Fluidal melting with irregular solidified micro-texture (10 to 100μm in scale) and nano-grains (10 to 100nm in size) as major products. The present impact results are applied to the data of higher carbon-contents in quenched volcanic rocks on Earth and the Moon rocks in this study [5, 7].

Nano-grains of Moon's rocks by the FE-ASEM: In order to observe lunar carbon-bearing texture, we have observed carbon-bearing solidified texture and contents of lunar meteorites of Northwest Africa 4483 (NWA4483 breccias) and Antarctic Yamato 86032 (Y-86032) as shown in Fig.4 [5,7].

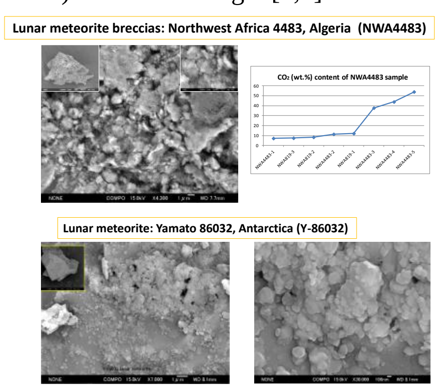

Fig. 4. Carbon-bearing nano-grains of lunar meteorites (Northwest Africa 4483, NWA4483 breccias and Antarctic Yamato 86032, Y-86032) with the FE-SEM with the ZAF calculation [3, 4]. This indicates that carbon has been reserved through impact fluids to solidified texture of the lunar samples.

Origin of black and white Moon rocks: The present data indicate comparatively that the Moon surface formed by continuous impacts shows carbon contribution for black colors in "quenched rocks of Mare basalt" and "quenched breccias of the Highland" [5,7].

Summary: The present study are summarized as follows [5-7]:

1) Origin of color on the Moon surface has been explained by silica-contents of the Moon rocks based on crystalline material database of water-planet Earth. However, the present study of Moon color has been discussed by carbon content supplied from impact quenched reaction on the Moon's brecciated rocks.

2) Carbon content of the Moon's rocks has been discussed significantly, because the Moon's minerals and rocks are different from crystalline samples of global water-Earth, which can been obtained from anomalous data of less kind for lunar minerals and plutonic rocks, less hydrogen-bearing minerals, less ternary feldspar and large quartz, and irregularly located fluids-related rocks and geology on the Moon.

3) Carbon contents of Moon's rocks are caused by impact process, because higher carbon in soils-regolith breccias and polymict breccias than Mare basalts.

4) Representative Earth's rocks widely studied show comparatively higher contents in dark colored and silica-poor volcanic rocks with fine texture as significant contribution of color character of the Moon's rocks.

5) Artificial formation by laser sputtering process indicates that carbon-bearing textures have been solidified by melted process, which is obtained in lunar samples.

6) Lunar carbon-bearing nano-texture and significant carbon contents have been obtained at lunar meteorites (NWA4483 and Y-86032) with the FE-ASEM method.

7) The present comparative data indicate that the Moon's impacted surface shows carbon-bearing dark colors and quenched and brecciated rocks with carbon.

Acknowledgements: Authors thank to Em. Prof. Dr. T. Kato for discussions of carbon in this study.

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