PLANETARY SIGNIFICANCE OF FORMED AND BROKEN LIEMSTONES BY IMPACT CYCLES.

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Introduction: Limestone carbonates with elements of carbon and oxygen are considered to be remnants of cyclic changes of solidified rocks on planetary bodies (especially on the Earth and Mars) [1-3]. The main purpose of this paper is to elucidate the formation and breaking of limestone carbonates rocks on planetary bodies with local and global fluid phases to explain astrobiology, climate changes, and planetary exploration from carbon-bearing phases.

Previous model of climate, volcano with carbon: Although previous model of climate warming with exceeding carbon dioxides (CO_2) is mainly produced by volcanic activity with plate-movement, but volcanic places are localized on the Earth. Global sedimentation of limestone carbonates should be discussed by main sources of carbon with dynamic cycle (with impact shock) which can be applied to other planetary bodies (*cf.* Table 1).

Cave formation in limestone blocks: As carbon-bearing limestone is one of breaking process of limestone sediments, then limestone is used to be weathered by forming caves on "short period" of a few hundred thousand years [4, 5]. In this sense, formation and breaking of limestone carbonates are significant to apply on other planetary bodies with fluid phases.

Main carbon dioxides sources on water-Earth: Although main sources of CO_2 gas on dynamic water-Earth in long history (as "gas state transportation" without life activity) are considered to be volcanic activity induced by plate-movements, but few limestone sediments and carbon chemical sources with three state-changes VLS (Vapor-Liquid-Solid) are considered in details [1]. Global model of carbon-bearing change should be considered to be applied from water-Earth to planetary exploration in future (*cf.* Table 1). In fact, rapid increase and decrease of CO_2 gas in the old terrestrial air have been obtained so far; for examples, at the Appalachian limestone (U.S.A.) formation of the Cambrian-Ordovician geological boundary (ca.500Ma) on water-planet Earth. This indicates that CO_2 gas is considered to be produced on sea-water impacts on limestone layers, and decreased CO_2 gas after impacts to form limestone by water reaction.

Main oxygen sources on water-Earth: Although main sources of oxygen (O_2) gas on dynamic Earth are considered to be life activity of photosynthesis on surface of water-planet Earth, but few oxidized rocks and oxygen chemical sources with three state-changes (VLS) are considered due to "main gas state transportation". Global model of oxygen-bearing production should be considered from the water-Earth to planetary exploration (*cf.* Table 1). In fact, rapid increase and decrease of O_2 gas in air of the Earth have been obtained at the Carboniferous-Permian geological boundary (ca.300Ma); for example, at the Carlsbad and Arizona (U.S.A.), and Akiyoshi (Yamaguchi, Japan) lime formation on the water-Earth [4, 5]. This indicates that O_2 gas production is originated on any oxygen-bearing rocks, and decreased O_2 gas after impacts are formed as oxygen-bearing rocks.

Table 1. Main cyclic sources of CO_2 and O_2 gases.

1) Carbon dioxides (CO_2) as state-changes VLS:
Sea-water impact reaction to form and break carbon-bearing the limestone- carbonates.

2) Oxygen (O_2) as three state-changes VLS:
Surface impacts to form and break O2-rich rocks.

Carbonates formation on the Earth and Mars: Wide layered limestones can be formed at water-rich planet (Earth) due to global multiple state-changes (including impacts). On the other hand, local carbonates can be formed at any planetary bodies (Mars etc.) due to localized state-changes VLS. In this sense, cave formations are considered to be 1) weathering process near the surface (Earth etc.), or 2) relict of three state-change VLS in any localized places (Mars etc.) [4, 5].

Astrobiological exploration by carbonates: Carbon-bearing cyclic processes can be found at four cases of limestone with and without nitrogen, carbonates with any cations, and carbon graphite/diamonds. Strong astrobiological evidences can be obtained with data of limestone with nitrogen [2].

Summary: The present results are summarized as follows: 1) Impact cycles on CO_2 and O_2 gases can be applied at formation and breaking of limestone carbonates and oxidized rocks in long Earth history and other planetary bodies. 2) Cave formation is one step of CO_2-bearing state VLS changes. 3) Strong astrobiological evidences can be discussed from limestone with nitrogen.

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