MATERIAL INDICATORS OF OCEAN IMPACTS BY HALITE AND CALCITE IN COMPOSITION. Yas. Miura, Yamaguchi University, Yoshida 1677-1, Yamaguchi, 753-8512, Japan. dfb30@yamaguchi-u.ac.jp

Introduction: Main material indicators of impact-related mineral material with optical microscopic observation are studied on impacts on dry lands as remained samples of Earth, Moon, Asteroids and Mars. Almost all impact materials (including meteorites) on sea-water are considered to be broken to melt away on the water-planet Earth. The present main purpose is to elucidate any microscopic evidences of ocean sea-water impacts, which are not original impact materials but solidified to other combined materials with supplied elements during impact process [1-5].

Samples of impacts on dry rocks and sea-water: Remained impact materials which are previously studied so much, are mainly metamorphic solids of dry target-rocks as silica-rich rocks (silicates or oxides) and carbon-rich rocks (limestone or carbonates), together with meteoroids projectile as iron-rich oxides etc., which can be found so far on Earth, the Moon, Asteroids and Mars. However, meteoroids (asteroids) collided to ocean sea-water (ca.70 vol.% of Earth's surface) are almost broken and melted away in water condition after impact event. Therefore, previous material evidences on sea-water impact are summarized as follows:

1)"Dark-brownish thin-layer of geological boundary" (the KTB or PTB) with iron-rich oxides or sulfides etc. [1].
2) "Bulk elemental concentration event " of Pt-group elements (including Ir) after concentration during formation of geological boundaries.
3) Glasses and minerals of graphite- diamond carbon, shocked quartz, shocked calcite or zircon etc. which are mainly based on target rocks of ocean sea-bottom if it is large impact.

The above-mentioned impact-related materials are not direct information of sea-water impact, because these are based on re-formed materials of meteoritic or dry target rocks. There are few evidences of sea-water composition or sea-bottom rocks by impact.

Impact glasses and breccias on sea-water impact: After sea-water impact which almost all fragments are broken immediately in the water, only remained materials of sea-water impact are impact glasses and/or breccias formed as quenched process during impact as follows [3-5]:

1) Sample: direct impact glassed and/or breccias.
2) Size: nano-grains (as 100nm aggregates).
3) Composition: halite (solidified from sea-water), or carbonates of calcite etc. (from shallow sea-bottom rocks).

Chlorine-bearing materials in impact glasses: Significant amounts of chlorine are found from solidified materials of fine halite from salty sea-water from shallow to deep impacts (Fig.1). This is mainly because chlorine-bearing minerals by direct collision by meteoroids (in air or target rocks) are akaganeite in composition by contribution from meteoritic projectiles [3-5].

Fig.1. The ASEM in-situ electron-micrograph (BEI) of the LDSG tektite sample with C, Mg, Al, K, Cr and Fe (back) [4], together with Na and Cl (white grains). Impact halites are aggregates of nano-particles (10nm in size). The scale bar is 100nm.

Carbon-bearing materials by impacts: Significant amounts of carbon (C) are found in the following materials with different C contents:

1) Glasses quenched during impact with low C content,
2) New quenched deposits of carbon-bearing fine particles with medium C content, and
3) Carbon solids formed by dynamic impact reaction with high C contents [3-5].

Fine particles with carbon-bearing materials show the following characteristics:

1) Irregular shapes and nanometer sizes, and
2) Various aggregates with micrometer to 100nm in size.

The above characteristics indicate rapid cooling during impact from target rocks of carbonates from sea-bottom sediments.

Therefore, carbon-bearing particles with nano-particles with irregular shape are considered to be formed by sea-water impact, together with chlorine-rich halite with fine nano-particles by quenching in sea-water (Fig.2).

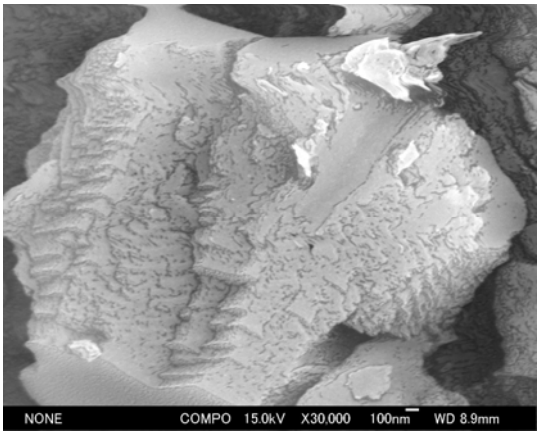

Fig.2. The ASEM in-situ electron-micrograph of the LDSG tektite sample of fine Ca-carbonates (calcite) in composition (white) [4]. Impact calcite carbonates in sea-water impact are aggregates of nano-particles (10nm in size) in quenching in sea-water. The scale bar is 100nm.

Impact carbon- and chlorine-bearing grains:

Fine carbon- and chlorine-bearing particles are found in samples of sea-impacts of the drilled core and glasses as followed (see Table 1):

1) Takamatsu (Kagawa, Japan) in drilled grains as shown in Fig.3,
2) The Akiyoshi (Yamaguchi, Japan) in drilled core,
3) Libyan desert silica glasses LDSG (Libya, Africa) in cavity or vein, and
4) Congo diamond (Africa) in vein and cavity,
5) The KT and PT geological boundary samples (Spain, and Meishan China) [3-5].

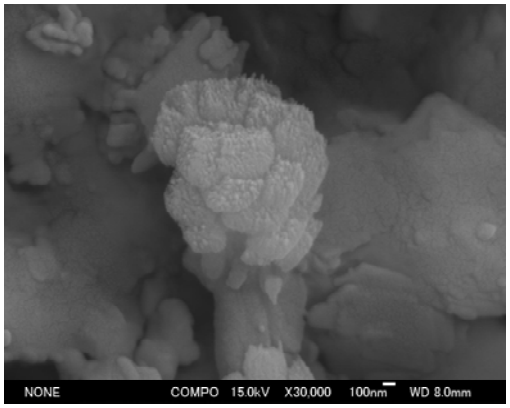

Fig.3. High-resolution (FE-SEM) electron micrographs of fine carbon-bearing particles on the Takamatsu drilled breccias sample of 950m in depth formed by impact on sea-carbonates. Previous results on impact on granitic rocks have few calcite or carbon-bearing rocks, though there are different sea-bottom carbonate-rocks with carbon. Bar is 100nm in scale [5].

Table 1. Origins of carbon & chlorine in sea-water impacts [3-5].

Carbon:	Shallow origin from carbonate rocks (calcite etc.). Deep origin from sea-water (carbonate ions etc.).
Chlorine:	Sea-water origin to solidified halite. (cf. Meteoritic origin to solidified akaganeite-like materials).

Summary: The present study is summarized as follows:

1) Material evidences of sea-water impact are obtained as carbon-bearing fine-particles with irregular shapes from carbonate rocks (with calcite) or deep sea-water, together with fine halite-particles from chlorine-bearing sea-water, though chlorine-bearing meteoritic source is found as akaganeite minerals in composition.
2) Typical examples of fine carbon- and chlorine-bearing particles are found in the Takamatsu (Japan), the Akiyoshi (Japan), the Libyan glasses (Libya, Africa), Congo diamonds, and the KT and PT geological samples (Europe and China), almost which are related with sea-water impact (including shallow crust explosion in liquid states in the Congo diamonds).

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