

# SIFGNIFICANT ROLES OF LIGHT (H<sub>2</sub>O, OH)-BEARING PHASES BY THREE PHASE-STATE CHANGES: MACRO TO NANO-PHASES ON PLANETS, SATELLITES AND ASTEROIDS

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**Introduction:** New methods of 1) more detailed analyses on **the water fluids** or **gas** (H<sub>2</sub>O or OH), and 2) reconsideration of Earth's ocean-water system are required for **life affairs** by using **three phase-states** of **vapor-liquid-solid** phases (called as **the VLS**) [1-4]. The main purposes are to elucidate the roles of 1) **volatile molecules** (H<sub>2</sub>O & OH) of **three phase-states** in solid-rich rocks, and 2) **ocean water system** used by **water PT phase diagram**.

**Water phase diagram with three VLS states:** Water (H<sub>2</sub>O, OH) **PT diagram** (Fig.1) reveals **dynamic phase-state changes** of H<sub>2</sub>O (+OH) VLS changes with different PT triggered by high & quick shock-wave impact conditions of **VLS at high T** (No.1), **high PT-VLS changes** (No.2), quick **low PT-SV** (No.3) & quick **high P-low T-SV** phases (No.4).

**Discussion of water molecules in H<sub>2</sub>O and OH:** Water (H<sub>2</sub>O, OH) molecules (Fig.2) indicate that 1) **phase H<sub>2</sub>O** is existed in **three states** of **vapor gas** (wide T), **solid ice** (wide P) & **liquid water** (wide PT) in **water Earth**, and 2) **hydroxyl OH** molecules in minerals (apatite etc.) are remained in **quick cooling** or **depression** from **gas-melting** ranges (**high PT**), which are **not evidences** of **global ocean water** (stable low PT) from scale changes.

**Formations of solid, liquid water & air in H<sub>2</sub>O:** Three H<sub>2</sub>O states are summarized (Fig.3):

1) **Vapor state of H<sub>2</sub>O**: Wider temperature (**low to high T**) with **low P** for **air planets** of Venus, Earth and Mars (triggered by **meteoritic impacts** & volcanic **uplift process**).

2) **Solid state of H<sub>2</sub>O**: Wider pressure (**low to high P**) with **low T** for **solid ice** of all planets, the Moon & Asteroids (triggered by **meteoritic impacts** & **shock-wave** reactions)

3) **Liquid state of H<sub>2</sub>O**: **Intermediate PT** range between **air** & **ice** is **not stable** at **low PT**.

**Ocean water** of Earth can be kept at **dynamic VLS pass** (even in **low PT**). **Local fluids** – originated solids (**micro-nano** scale) are formed at **shock-waves** (impacts, uplifts & quake).

**Formation of ocean water system of planet Earth:** **Ocean water** of Earth is unusual system, because 1) **unstable liquid H<sub>2</sub>O** is shifted to **stable ice** (**high P**) or **vapor** (**high T**), and 2) **liquid H<sub>2</sub>O** can be remained only by **quick stopping** of **depression** & **quenching**.

**Formation of ocean water by giant impacts:** New model of **continued ocean water** system is “**Interior fluids** triggered by **giant impacts**” with three steps of (1<sup>st</sup>) **Impact fluids with much H<sub>2</sub>O** by planetary interior, (2<sup>nd</sup>) **interior uplift of H<sub>2</sub>O** by the impacts, and (3<sup>rd</sup>) **global quick liquid-stopping** during the impact [1-4], which can be kept **ocean water** finally.

**Formation of liquid H<sub>2</sub>O in any bodies:** The **three steps model** of **fluid** formation can be applied at **any impacts** on planetary bodies with **regolith** and **interior reservoir**. **Large ocean water** is formed mainly at **special giant planetary impact process** with three steps.

**Summary:** The results are summarized. 1) **H<sub>2</sub>O phase** can be discussed in **the phase diagram** even in **quick & huge** reaction process. 2) **Intermediate H<sub>2</sub>O liquid (high PT)** are **unstable** during **continued** and **dynamic processes** in any surface, though H<sub>2</sub>O vapor (any T) and solid ice (any P) are formed at any stable surfaces. 3) Only case to form & keep **huge amount of ocean water** system is **global giant impacts** (by **planets** and/or **Asteroids**).

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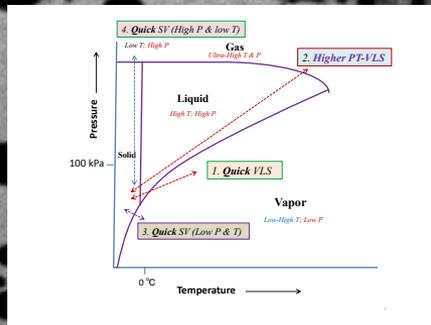


Fig.1. Phase-state three VLS diagram of H<sub>2</sub>O.

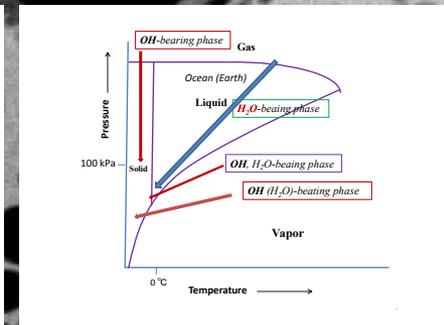


Fig.2. Phase-state diagram of H<sub>2</sub>O with OH molecule.

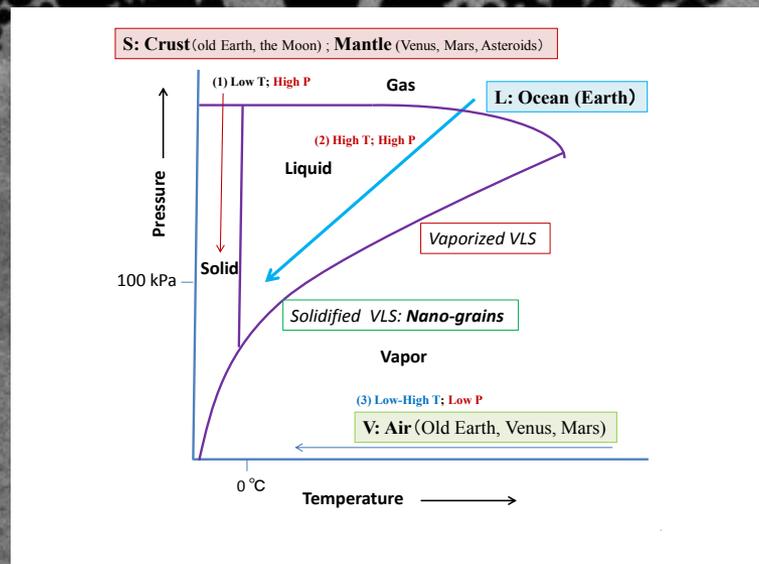


Fig.3. Phase-state changes of the H<sub>2</sub>O phases.

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