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Follow the high subcritical water

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Abstract

"Follow the water" is the expression used to recognize inside the universe, life as it exists on Earth. The present results show that the expression *"follow the high subcritical water"* can be used to recognize the ferric minerals that can form in alkaline high subcritical water, in the absence of UV light, oxygen, and microorganisms. The observation of ferric minerals on early Earth and extraterrestrial objects does not mean that life existed at the time of their formation. Results notice also that the CO necessary for the synthesis of organic molecules of life requires hsubc water to form from CO_2. The case of water in the oceans located in the subsurface of icy moons is presented and a water cycle is proposed for Enceladus.

1. Introduction

The importance of the domain of water called high subcritical, hsubc, (Fig. 1) has been newly proposed since 2013, for the continuity from the mineral world to the emergence of life [1-6]. It has been shown that ferric oxides and silicates can form in anoxic water at temperature ~300-350 °C, pressure ~10-25 MPa, densities ρ ~700-600 kg/m^3 and pH ~9.5-14, leading to the minerals that are observed in the Archean to early Paleoproterozoic banded iron formations, BIFs. The consideration of this specific domain of water has also been described for the Saturn's icy moon Enceladus [6].

2. High subcritical water/Fe-rock interaction

Results show that five processes occur in hsubc water to form ferric minerals, and CO, the link to molecules of life (Fig. 2, 3). The hydrolysis and carbonation of Mg-silicates are highly exothermic, increasing thus the heat produced by the carbonation of Fe-silicates, and allowing the endothermic reaction of hydrolysis of Fe-silicates to proceed [1,2,4]. H_2 is released and hydrogenates CO_2 in hsubc water. By the action of CO, molecules of life can form either by irradiation at low T or through Fisher Tropsch Type reactions which can be called [5,6] Sabatier type reactions. FTT reactions are known to be highly exothermic. This scenario can be the case in icy moons such as Enceladus, where a pressure of 10 MPa is calculated at a depth of ~67 km below the surface [6] as illustrated in Fig. 4 which shows a hypothesized water cycle in Enceladus. The south pole is filled with Fe,Mg-silicates hosted in peridotite type rocks containing olivine and pyroxene. With an ice crust of 35 km, and a liquid water layer of 1 km, the peridotite rock is calculated to be thicker than 31 km. Water is first set into the liquid state by the heat produced during radioactive decay. It percolates trough the rock, interacting in exothermic reactions until it reaches the hsubc domain where H_2, CO and organic molecules are produced and then ejected through conduits to form geysers and plumes. The bottom of the ice crust melts and replaces the ejected water.

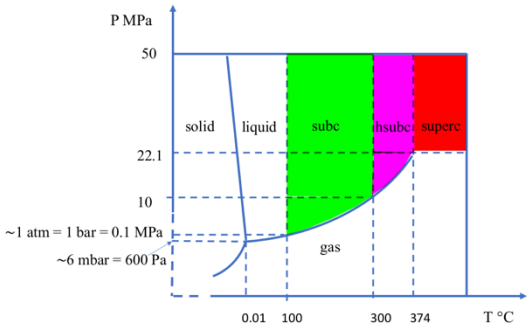

Figure 1: The high subcritical domain of water.

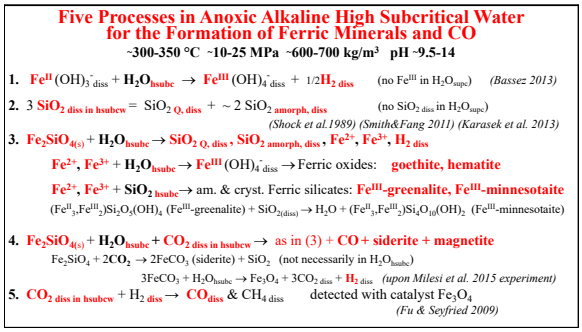

Figure 2: Five processes in high subcritical water.

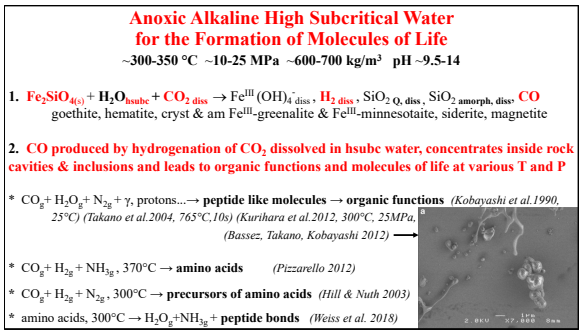

Figure 3: The synthesis of molecules of life following the hydrogenation of CO_2 in hsubc water.

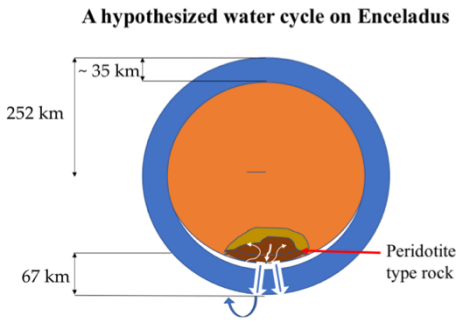

Figure 4: High subcritical water at a depth of 67 km below the surface of Enceladus

4. Summary and Conclusions

Results show that the observation of ferric minerals in anoxic geological environments, does not necessary mean that microorganisms existed at the time of their formation. On Earth, such observation may lead to postpone the dates of the atmosphere oxygenation and of the emergence of O_2-producing and Fe^{II}-oxidizing microorganisms. On icy moons, the observation of H_2, SiO_2, and organic molecules may lead to the conclusion that alkaline high subcritical water at pH ~9.5-14, reacted with Fe,Mg-silicate rocks at ~300-350°C, ~10-25 MPa and ρ ~700-600 kg/m^3. Therefore, the future models that will be developed for early Earth and the icy moons may envision to include the hsubc domain of water. The presentation aims to demonstrate that alkaline water in the high subcritical domain constructs the continuity from rocks to molecules of life in the process of geobiotropy [3-6]. In other words, the presentation follows the esthetic sentiment of grace developed by Henri Bergson: *"la grâce préfère les courbes aux lignes brisées...et le plaisir...de tenir l'avenir dans le présent* [7]".

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