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# Comparative mineralogy in the Solar system: Water-related minerals and habitability

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## Abstract

Life, as we know it, needs liquid water because its unique physical chemical properties. The presence of liquid water in a planetary environment anytime during its geological history may be evidenced studying the present mineralogy. While some minerals incorporate water molecules directly in their structure when crystallize from liquid, some anhydrous need the aqueous environment to be formed primarily or by alteration. Salt hydrates (sulfates, chlorides), clathrate hydrates, hydrated silicates (clays, zeolites) and oxides are some examples of these minerals conspicuous for their interest on Astrobiology. Here we support water-related minerals as indicators of planetary habitability and revise their occurrence in the solar system.

Investigations of terrestrial analogue materials, both in the laboratory and in situ are needed in order to interpret the data from the space missions properly. Phase stability and physical chemical properties data of the minerals are being obtained and used to infer specific characteristics of the past and the present of potential habitable environments.

Water-related minerals have been observed at different solar system objects such as: a) meteorites [1] and asteroids [2]. b) the surface of terrestrial planets like Mars [3, 4, 5]. c) some icy satellites [6, 7, 8, 9].

a) The hydrated mineral inventory in meteorites and asteroid helps to both, infer the origin of Earth's water, and decode the water/organic processes interaction occurring during the earliest times in solar system history.

b) Main climatic and geological global changes of Mars have been established by some authors [3] from the abundance of some hydrated species as sulfates or clays. Some detected sulfates, like the jarosite has been used even to indicate the extreme acidity of the aqueous environment from where they were precipitated. Studies on terrestrial extreme environments have shown that if hydrothermal samples are present on Mars, like carbonates, they might be useful as indicators of past life or habitability.

c) Hydrated salts are particularly important in icy satellites. It has been proposed that the origin of the hydrated sulfur-bearing species observed at the surfaces of Europa or Ganymede is their putative internal oceans. These salts would be the responsible for the induced magnetic fields of both satellites. They may incorporate the essential elements for Life, and preserve biosignatures in their layers. They crystallize at deep aqueous environments under pressure, conditions different from the typical evaporites at the surface of the terrestrial planets, so some properties such as isotopic signatures may vary. Some salt and clathrate hydrates have distinctive thermal properties that may activate some geological processes at these icy bodies. Their own formation or destruction involve relevant physical chemical changes that might be reflected in the geological activity.

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