

How many conditions must be satisfied to produce a habitable planet?

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<Purpose>

Concept of habitable zone (HZ below) is regarded as the presence of stability field of liquid water on the surface of planet. HZ is regarded as the most important condition to produce a habitable planet. However, we think the presence of liquid water is not enough to be habitable. We list up other necessary conditions (6+5=11) to produce a habitable planet in the Universe.

<Method>

The best studied habitable planet is the Earth. Therefore, based on the research results of the Earth, we consider necessary conditions. Key points are chemical composition of primordial atmosphere and biosphere.

<Result>

Based on the research of the Earth, I propose there are at least 6 conditions to be a habitable planet in case of the solar system. (1) a planet must be given totally 400 bars CO₂, 300 bars water, and 50-60 bars N₂ as minimum values. In addition, such an amount is given gradually with time (ABEL model) not to become Venus-state, (2) the presence of extremely small amount of ocean water (3km ±1 km thickness), (3) the presence of huge landmass (continent above sea level) to finally provide habitable trinity condition to drive the material circulation to give nutrients through water-rock interaction to feed primordial life. (4) Initiation of plate tectonics to keep dynamic equilibria not to become Venus state. (5) selective transportation of CO₂ into mantle, while H₂O remains on the surface, and N₂ remains all in atmosphere, (6) the presence of biosphere, if not, fixation of atmospheric CO₂ is restricted only to inorganic carbonates that would be insufficient to prevent evolving into Venus-state.

<Discussion>

These six conditions are deduced from the history of the Earth. However, if we enlarge the concept to exoplanets based on the research of the solar system, the following five conditions are added; (7) the distance from the central star, (8) the abundance of atmosphere, (9) mass and composition of central star, (10) size and composition of planet, and (11) circular orbital path.

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