Search for life in the Solar System

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The goal of this lesson is to point out those objects of our Solar System that have conditions suitable for sustaining life. Parameters that should be taken into consideration are:

1. Biosignatures present in the atmosphere (presence of O_2, O_3, CH_4, H_2O).
2. Presence of liquid water on or underneath the body's surface.
3. Daily and/or annual temperature changes on the body's surface (we have to assume that those sufficient for life to form balance between -70° and +80°).
4. In spite of the presence of certain biosignatures or suitable temperature range, we also have to take note of the presence of toxic substances, like sulphuric acid (H_2SO_4), or nitric acid (HNO_3) in the atmosphere or on the surface. Their presence makes a given body unsuitable for life.
5. We also have to take note of potential lack of magnetosphere (its presence protects the body from harmful radiation).

Celestial bodies to be researched by students:

1. Planets: Mercury, Venus, Mars, Jupiter, Saturn, Uranus, Neptune.
2. Planets' moons: Earth's Moon, Jupiter's moons (Io, Europa, Ganymede, Callisto), Saturn's moons (Titan, Enceladus, Iapetus).
3. Other bodies, e.g. Ceres, Pluto.

Analysis examples

Example I

A certain celestial body's atmosphere contains O_2 and H_2O in the amounts of respectively 1% i 0.3%. Other components are N_2 (50%) and CO_2 (about 49%). This object has a temperature of -110°C and no magnetosphere.

Analysis: although there are biosignatures in this body's atmosphere, the temperature and lack of magnetosphere make the conditions of this object unfit for life to exist on its surface. We should see if it has any water containers underneath its surface. If it does, it should be considered habitable. However, if it doesn't (or if we have no data about it), we have to assume that it's unsuitable for life and no living organisms are to be found there.

Analysis examples

Example II

A certain celestial body's atmosphere contains N_2, O_2 and CH_4 appear seasonally in small amounts (under 2%). Other components are CO_2 (about 97%) and noble gasses like Ar and Xe (neutral for life). The object has a temperature of -90°C at night and +10°C at day. There is no data concerning liquid water under the surface nor magnetosphere.

Analysis: there are biosignatures in the atmosphere and the temperature during the day exceeds 0°C. Seasonal changes of the biosignatures can (but doesn't have to) relate to biological processes connected to organisms' metabolic functions. This body can be considered potentially suitable for life on exist on its surface or underneath it (we don't know whether there is magnetosphere, however, assuming there isn't, we suppose that potential organisms hide beneath the surface from harmful radiation).

Results of the analysis

Table: The possibility of life's presence on objects of the Solar System

		The possibility of life's existence				
Nr	Name of the body	NO	RATHER NO	HARD TO SAY	RATHER YES	YES
1	Body I	X				
2	Body II				X	
3	Different body					

Note: For Body I (body from Example I) we assumed that there is no possibility of any life's existence. If the body held liquid water containers underneath the surface, we would have to assume that life might appear there (we pick option RATHER YES in the table).
For the body from Example II the option RATHER YES was picked because both biosignatures and positive temperatures are present there (however they don't match the -70°- +80° range and we know nothing of its magnetosphere or liquid water under the surface).
It is also worth noting that the boundaries between NO and RATHER NO or HARD TO SAY and RATHER YES etc. are often quite fluid and hard to determine, which means that answers given by students may slightly differ from one another. However, there should be no extremely different answers, e.g. for the same body some students picked YES and others picked NO.

Information necessary for the analysis

Links:
https://pds.jpl.nasa.gov/planets/special/planets.htm
https://nssdc.gsfc.nasa.gov/planetary/factsheet/
https://space-facts.com
http://lasp.colorado.edu/education/outerplanets/moons_op.php#saturn
http://nineplanets.org
https://solarsystem.nasa.gov/planets
https://www.astrobio.net/news-exclusive/the-chance-for-life-on-io