THE PLANET TOO111

Life in Darkness

INTERNATIONAL SPACE APPS CHALLENGE

INSIDE-OUT

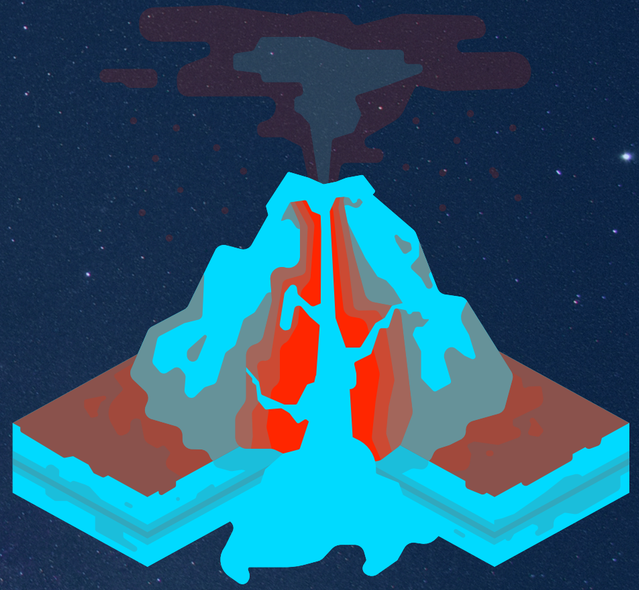
- Core: Radius - 1,500 km, Composition - Mostly iron (Fe) and nickel (Ni) with trace amounts of sulfur
- Mantle: Thickness - 2,900 km, Composition - Rich in silicate minerals, iron, and magnesium.
- Oceanic crust: Thickness - 40 km

- Gravity ~ 9m/s^2

Specialty : No star

HYDROTHERMAL VENTS

- Location: Found across the ocean floor, primarily near tectonic plate boundaries.
- Chemical Output:
  - Emissions include Fe^{2+} ions, H_2S, and methane (CH_4).
  - These compounds are essential for the chemosynthetic bacteria, the first link in the food chain of this planet.



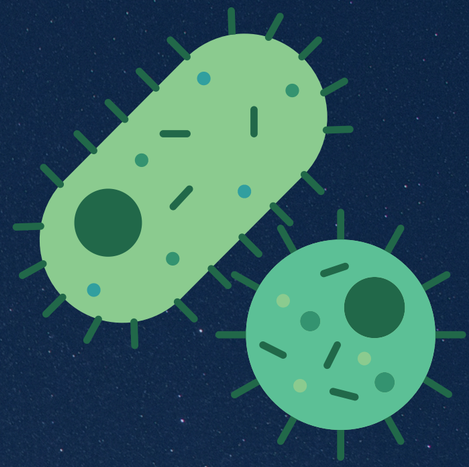
Primary energy source for the organism in the planet T00111 is Hydothermal vents

CHEMOSYNTHESIS:

Primary Reaction:

- CO2+4H2S→CH4+4S+2H2OCO_2 + 4H_2S → CH_4 + 4S + 2H_2OCO2+4H2S→CH4+4S+2H2O This reaction supports life at the base of the ocean's ecosystem, converting carbon dioxide (CO_2) and hydrogen sulfide (H_2S) into methane (CH_4) and elemental sulfur (S).

- These bacteria form the foundation of a thriving ecosystem where larger organisms feed on them.



ATMOSPHERIC AND CLIMATE

Atmosphere Composition:

- Nitrogen (N_2): 65%
- Carbon Dioxide (CO_2): 20%
- Methane (CH_4): 10%
- Sulfur Compounds: 5%, drastically reduced due to chemical reactions with Fe^{2+} ions.
    - Sulfur Chemistry:
        - The H_2S emitted from the hydrothermal vents reacts with Fe^{2+} to produce FeS, reducing sulfur compounds in both the atmosphere and ocean.
        - This creates a stable, low-sulfur environment that minimizes the toxic effects of H_2S.

Tidal Heating and Atmospheric Gases:

- The planet's moon exerts a gravitational pull, creating tidal forces that heat the oceans and contribute to the circulation of gases like methane and CO_2, sustaining warm oceans despite the absence of sunlight.

MOON COMPOSITION AND EFFECT

- Core Radius: 1,500 km
- Mantle Thickness: 2,000 km
- Effect on Tides:
  - The moon’s gravity influences tidal patterns, maintaining the flow of hydrothermal vent emissions and the distribution of chemicals in the oceans.
  - Tidal heating generated by the moon’s gravitational pull keeps the oceans warm, allowing life to thrive in the absence of sunlight.

Volcanic Activity and Geysers

- The moon experiences volcanic activity and geysers that release sulfur compounds, ice, and gases, further enriching the planet’s atmosphere.

THE GIANT SURFACE VOLCANO

Volcano Characteristics

- Size: A massive volcano stands on the ocean surface, towering over the dark oceans.
- Constant Eruption:
  - The volcano emits gases such as SO_2, CO_2, and water vapor (H_2O), contributing to the planet's atmospheric composition.
  - The sulfur compounds from the volcano play a role in chemical reactions that sustain the ecosystem.
- Chemical Emissions from Eruptions:
  - Sulfur Dioxide (SO_2): Combines with water vapor to form sulfuric acid (H_2SO_4), contributing to the planet's chemical cycles.
  - Carbon Dioxide (CO_2): Dissolves in the oceans, forming carbonic acid, which interacts with other compounds to support life.

EVOLUTION AND SURVIVAL

Bioluminescence as Survival Strategy

- Role in Ecosystem:
- Bioluminescent organisms have evolved to produce light in the absence of sunlight, aiding in communication, mating, and hunting.
- Chemistry of Bioluminescence:
- Organisms produce light through reactions involving luciferin and luciferase, with oxygen playing a crucial role.
- In the oxygen-limited environment, organisms adapt to use methane or other compounds to drive these chemical reactions.

Ecosystem Hierarchy:

- Chemosynthetic Bacteria: Form the base of the food chain, converting H_2S and CH_4 into energy-rich molecules.
- Bioluminescent Fish: Feed on the bacteria around hydrothermal vents, using their light for hunting and attracting mates.
- Bioluminescent Whales: Apex predators that hunt fish using sophisticated light signals for communication and navigation in the deep, dark oceans.

A PLANET OF CHEMICAL WONDERS AND BIOLUMINESCENT LIFE

Unique Conditions:

- No sunlight, a dense atmosphere, and deep oceans sustained by chemical reactions around hydrothermal vents create a rich, glowing ecosystem.
- Bioluminescent life forms have evolved to thrive in this environment, utilizing chemical energy and glowing light for survival.

Chemistry at the Core:

- The planet’s ecosystem relies on sulfur, iron, and methane-based reactions, driving chemosynthesis and supporting life from bacteria to whales.
- The moon’s tidal forces and the volcano’s constant activity sustain the dynamic and thriving oceans.

CORE CHEMICAL REACTIONS ON T00111

Hydrogen Sulfide Oxidation (H_2S Alternative Pathway):

On T00111, chemosynthetic bacteria around hydrothermal vents utilize hydrogen sulfide (H_2S) without oxygen. Instead, they rely on iron compounds (Fe^{2+}) and sulfur-based reactions.

Reaction:

$$H_2S + Fe^{2+} \rightarrow FeS\ (solid) + H_2$$

Here, H_2S reacts with Fe^{2+} ions, resulting in the precipitation of iron sulfide (FeS), releasing hydrogen gas (H_2) as a byproduct. This process drives energy for the organisms without any reliance on oxygen. This is the digestion process of organisms.

Methane Utilization (CH_4):

- Methane (CH_4) is abundant due to volcanic and hydrothermal activity. Methanotrophic bacteria use methane for energy, interacting with metal ions (like Fe^{2+}) instead of oxygen-based pathways.
- Alternative Reaction:

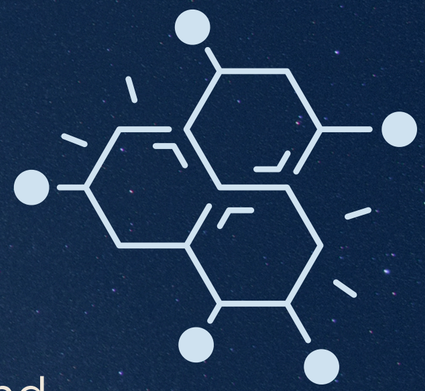
$$CH_4 + Fe^{2+} \rightarrow FeCH_3 + H_2$$

- This reaction produces methylated iron compounds ($FeCH_3$) and hydrogen gas (H_2) as byproducts. It enables energy generation in the absence of oxygen, with iron acting as an electron acceptor.

Iron and Sulfur Reaction (Fe^{2+} + H_2S):

- Iron(II) ions (Fe^{2+}) emitted from hydrothermal vents react with hydrogen sulfide (H_2S) to form solid iron sulfide (FeS), which precipitates out of the water.
- Reaction:

$$\mathbf{Fe^{2+} + H_2S \rightarrow FeS\ (solid) + 2H^+}$$



- This process continually reduces sulfur content in the ocean and atmosphere, driving iron deposition. This is the process to control and sulphur content

Carbon Disulfide Production (CS_2):

- Methane (CH_4) and hydrogen sulfide (H_2S), under the high temperatures near hydrothermal vents, combine to form carbon disulfide (CS_2), a gaseous byproduct.
- Reaction:

$$CH_4 + 2H_2S \rightarrow CS_2 + 4H_2$$

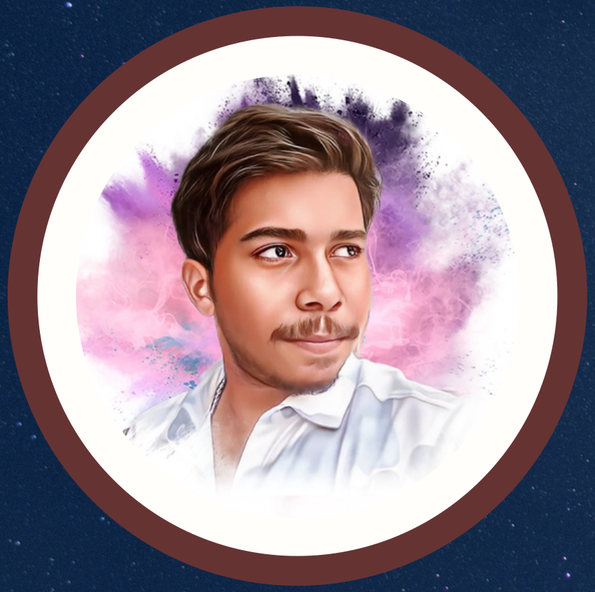
- CS_2 is volatile and contributes to the planet's atmospheric composition, particularly influencing sulfur-based gaseous cycles.

Sulfur Depletion in Atmosphere

- The Fe^{2+} + H_2S reaction reduces sulfur content in the planet's oceans and atmosphere by continuously converting H_2S into solid FeS, resulting in a sulfur-poor atmosphere.

THANKS FROM TEAM COCONUT

THE TEAM COCONUT



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