



Natural Hydrogen

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Why in News?

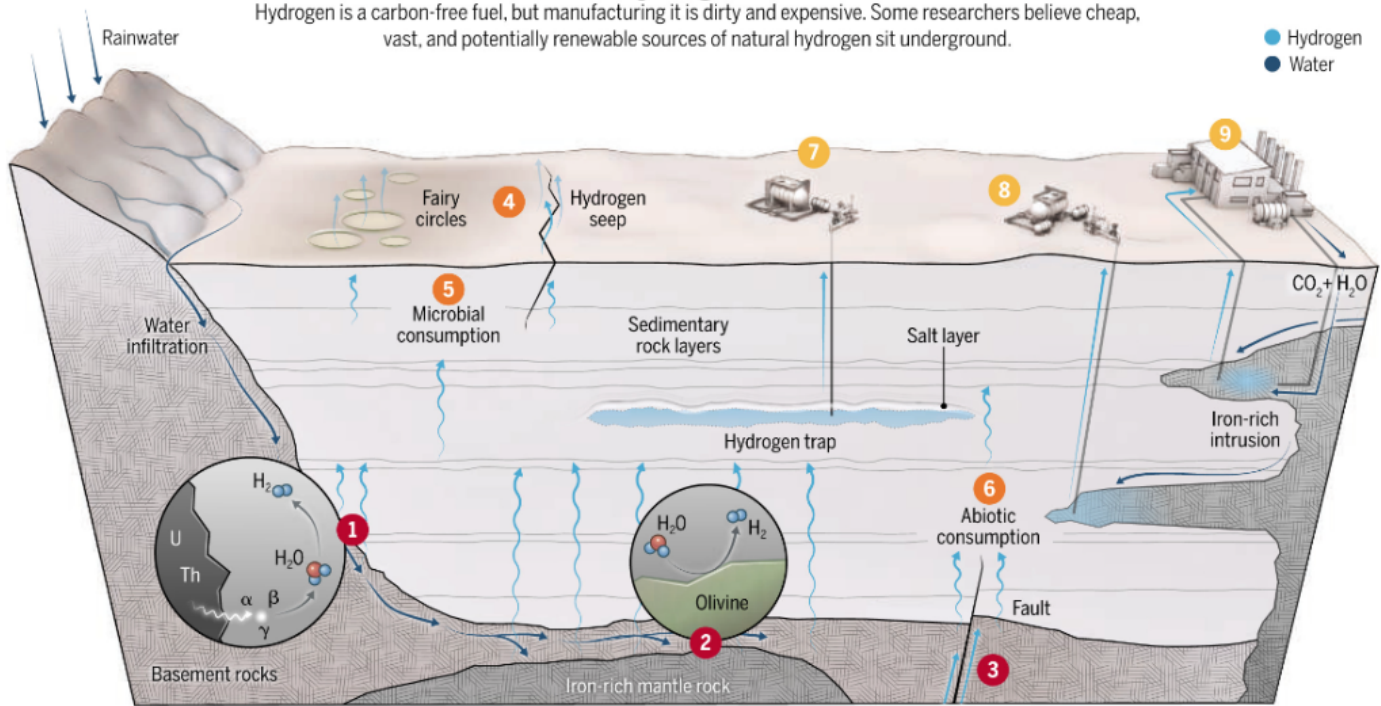
Natural hydrogen, a potentially **clean, abundant, and low-cost energy source**, is gaining global attention as a **game-changer in the transition to green energy**.

What are Key Facts About Natural Hydrogen?

- **About:** **Natural hydrogen**, also called **geologic hydrogen** or **white hydrogen**, refers to **hydrogen gas (H_2)** that is **naturally produced** and stored in the Earth's crust.
 - Unlike manufactured hydrogen (from fossil fuels or renewables), **natural hydrogen is produced geologically**—raising hopes for a **sustainable energy revolution**.
- **Formation:** Natural hydrogen **exists freely underground**, and formed through **natural geological processes like**-
 - **Serpentinisation:** Reaction of **water with iron-rich rocks**.
 - **Radiolysis:** Splitting of water by **radioactive rocks**.
 - **Organic Decomposition:** From **deep burial of organic matter**.

Earth's hydrogen factories

Hydrogen is a carbon-free fuel, but manufacturing it is dirty and expensive. Some researchers believe cheap, vast, and potentially renewable sources of natural hydrogen sit underground.



Generation

1 Radiolysis

Trace radioactive elements in rocks emit radiation that can split water. The process is slow, so ancient rocks are most likely to generate hydrogen.

2 Serpentinization

At high temperatures, water reacts with iron-rich rocks to make hydrogen. The fast and renewable reactions, called serpentinization, may drive most production.

3 Deep-seated

Streams of hydrogen from Earth's core or mantle may rise along tectonic plate boundaries and faults. But the theory of these vast, deep stores is controversial.

Loss mechanisms

4 Seeps

Hydrogen travels quickly through faults and fractures. It can also diffuse through rocks. Weak seeps might explain shallow depressions sometimes called fairy circles.

5 Microbes

In shallower layers of soil and rock, microbes consume hydrogen for energy, often producing methane.

6 Abiotic reactions

At deeper levels, hydrogen reacts with rocks and gases to form water, methane, and mineral compounds.

Extraction

7 Traps

Hydrogen might be tapped like oil and gas—by drilling into reservoirs trapped in porous rocks below salt deposits or other impermeable rock layers.

8 Direct

It might also be possible to tap the iron-rich source rocks directly, if they're shallow and fractured enough to allow hydrogen to be collected.

9 Enhanced

Hydrogen production might be stimulated by pumping water into iron-rich rocks. Adding carbon dioxide would sequester it from the atmosphere, slowing climate change.

- **Discovery:** In **1987**, a borehole in **Bourakébougou, Mali**, revealed a mysterious flame—later found to be **98% pure hydrogen** in 2012.
 - Major discoveries in **France (Lorraine & Moselle)** revealed **92 million tonnes** of hydrogen (**half of global production**).
- **Major Reserves:** **Hydrogen seeps** have been documented in more than 10 countries, including Australia, the **USA, France, South Korea, Canada, and Spain**.
- **India's Natural Hydrogen Potential:** India's geological structures make it a **high-potential zone** for natural hydrogen:
 - **Ultramafic and mafic rocks, ophiolite belts, and greenstone formations.**
 - **Sedimentary basins** in Vindhyan, Cuddapah, Gondwana, and Chhattisgarh.
 - **Hydrothermal systems** and hot springs signal possible underground generation
- **Potential Impact:** If only **2%** of global geological hydrogen is **recoverable**, it could match **twice the energy of all known natural gas reserves** and meet global hydrogen demand for **200 years**.
- **Cost Efficiency:** Production cost is estimated at **USD 1/kg or less, cheaper** than both **green and grey hydrogen**.
 - A global **"hydrogen rush"** is underway, with companies exploring natural hydrogen rising from **10 in 2020 to 40 in 2023**.

Note: Hydrogen makes up about **75% of the universe's mass**, but only **0.5-1.0 ppm (parts per million)** of **Earth's atmosphere**. In **Earth's crust**, it accounts for **0.75% by weight**.

What is Green Hydrogen?

Click Here to Read: [Green Hydrogen](#)

UPSC Civil Services Examination, Previous Year Question (PYQ)

Prelims

Q. Which of the following is the exhaust pipe emission from Fuel Cell Electric Vehicles, powered by hydrogen? (2024)

- (a) Hydrogen peroxide
- (b) Hydronium
- (c) Oxygen
- (d) Water vapour

Ans: (d)

Q. Hydrogen fuel cell vehicles produce one of the following as “exhaust” (2010)

- (a) NH_3
- (c) H_2O
- (b) CH_4
- (d) H_2O_2

Ans: (c)

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