

Natural Hydrogen

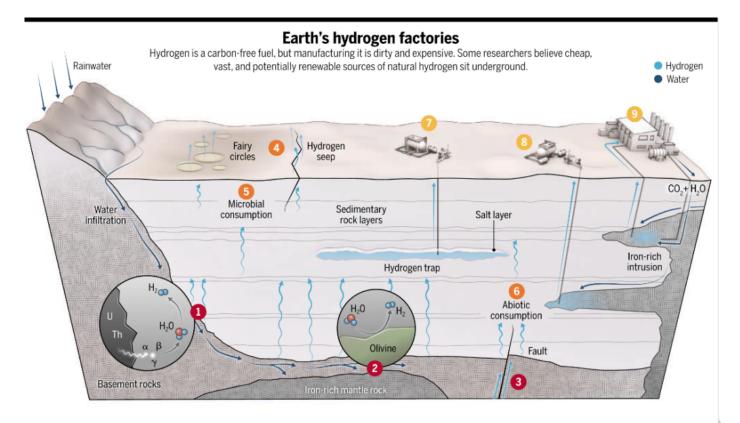
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Why in News?

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 (H₂) 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.



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 Seens

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)

<u>Prelims</u>

Q. Which of the following is the exhaust pipe emission from F	uel 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) NH3
- (c) H2O
- (b) CH4
- (d) H2O2

Ans: (c)

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