

Catalysis of radiolytic hydrogen production by marine sediment, zeolites, and clay

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Radiolytic H₂ is a well-known hazard in the nuclear industry. It has been identified as the primary electron donor (food) for microorganisms in continental aquifers kilometers below Earth's surface [1]. It may also be significant for sustaining life in Earth's subseafloor environments and subsurface environments of other planets. However, full rates of radiolytic H₂ production in geological environments have been poorly constrained, due to incomplete understanding of radiolytic chemical yields in wet natural materials. To address this limitation, we slurried and exposed marine sediments (deep-sea clays, carbonate ooze, silicious ooze, organic-rich clastic sediment), pure minerals (the zeolites mordenite and clinoptilolite, montmorillonite [clay], zirconium [IV] oxide), and seawater to either a ¹³⁷Cs gamma-ray source or 5.3 MeV alpha particles from a ²¹⁰Po source [2]. All the marine sediment types and mineral species catalyzed radiolytic H₂ production, amplifying yields by up to 27X relative to pure water. Yields in seawater were indistinguishable from yields in pure water. This mineral catalysis of radiolytic H₂ production presents a challenge for the nuclear industry, which uses zeolites and clays widely for handling and long-term disposal of radioactive materials. It also constitutes a boon for subsurface life; water radiolysis appears to be the principal source of biologically accessible energy for microbial communities in marine sediment older than a few million years [2].

References

[1] Lin, L.-H., et al. (2006), *Science* 314, 479–482.

[2] Sauvage, J.F., et al. (2021), *Nature Communications* 12, 1297.