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Using Thermal Conductivity To Differentiate Hydrogen From Methane In The Subsurface

Stanford scientists have established a modeling based proof-of-concept for a subsurface logging method that reliably distinguishes hydrogen from methane using thermal conductivity, overcoming a major limitation of existing oil-and-gas logging technologies. Current well-logging and seismic methods, including neutron, NMR, resistivity, mud logging, and AVO analysis, were designed for hydrocarbon exploration and struggle to tell hydrogen and methane apart because the two gases produce similar physical responses. This makes it difficult to identify and evaluate natural hydrogen reservoirs at depth.

The technology exploits the large, intrinsic difference in thermal conductivity between hydrogen and methane and shows that this contrast produces measurable differences in the bulk thermal conductivity of fluid-saturated rocks. Multiphysics rock-physics modeling demonstrates that brine-, hydrogen-, and methane-saturated rocks occupy distinct thermal conductivity ranges across typical reservoir porosities. This approach offers a way to identify hydrogen in the subsurface and distinguish it from methane using standard logging workflows, addressing a challenge in hydrogen reservoir evaluation.

Applications

- Natural hydrogen exploration and reservoir evaluation
- Differentiation of hydrogen from methane in subsurface reservoirs
- Re-logging and reinterpretation of existing wells for hydrogen potential
- Subsurface resource assessment by energy companies, researchers, and regulators

Advantages

- Reliably distinguishes hydrogen from methane where conventional logs fail
- Leverages a strong, intrinsic physical contrast between hydrogen and methane
- Requires only a single additional measurement added to standard logging workflows
- Compatible with existing elastic or density logs
- Provides depth-accurate, in situ subsurface information

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