



Well Integrity Innovations – Geothermal

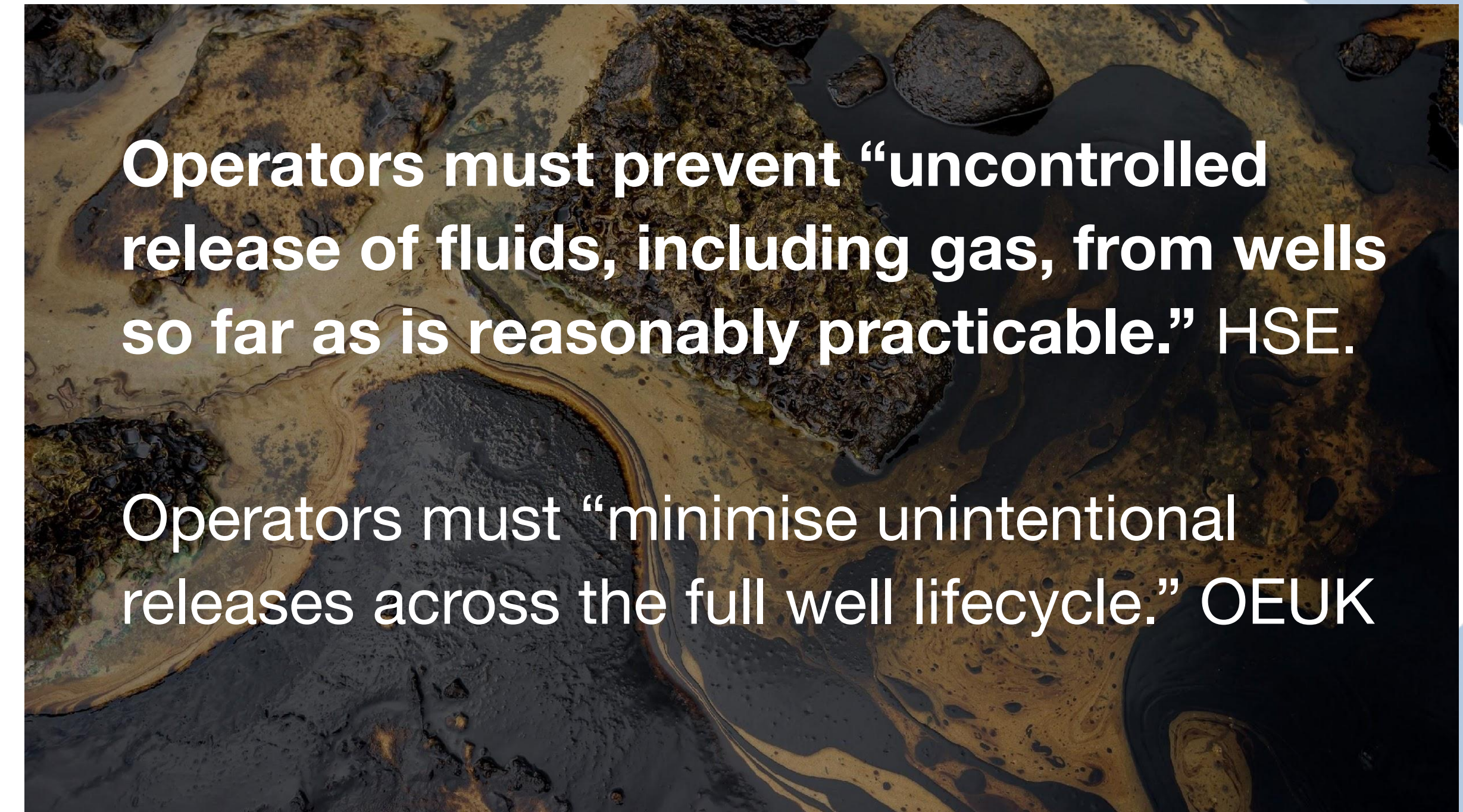
ENVIRONMENTALLY PROTECTIVE SUBSURFACE BARRIERS

Well Integrity Failures – Why We Must Improve

Traditional methods are not adequate for Geothermal Wells

- Historical well construction exists to extract oil and gas.
- Wellbores provide a conduit to surface
- Cement is traditional structural & sealing material
 - Cement has high failure rates
 - Gas can form a flow path before it sets
 - Cement shrinks and cracks

Loss of integrity leads to emissions to atmosphere, and contamination of land/water table

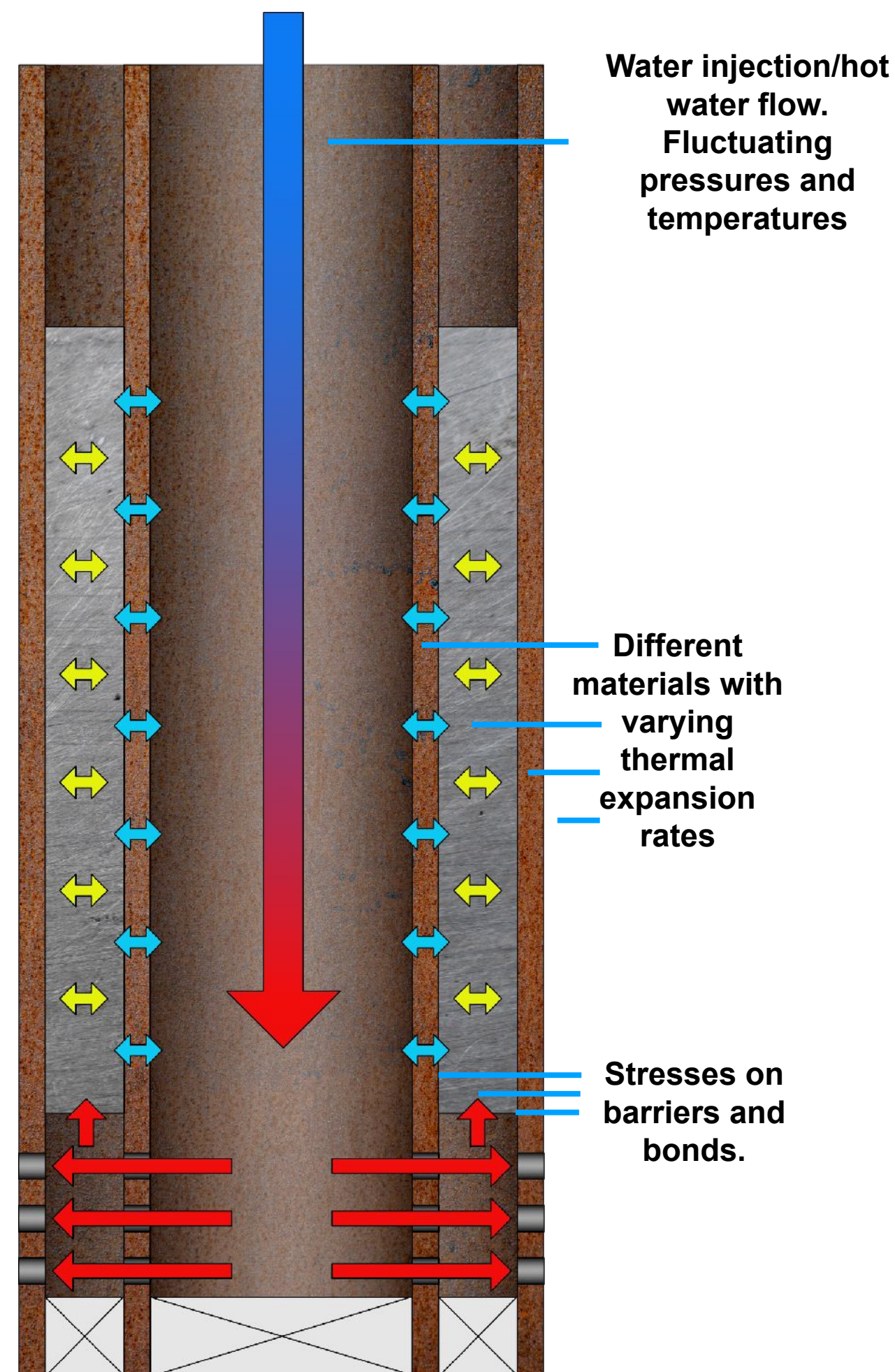


Operators must prevent “uncontrolled release of fluids, including gas, from wells so far as is reasonably practicable.” HSE.

Operators must “minimise unintentional releases across the full well lifecycle.” OEUK

Why Traditional Barriers Fail

Cracking-Up under the strain.



Geothermal:

EPG suitability lends well to both applications.

Solid state barriers like cements, alloys and resins will struggle to cope with two vital characteristics of both; *fluctuations in temperature and pressure*.

Thermal expansion coefficients of the different solid materials will logically lead to failures; e.g. alloy/casing will expand/contract at different rates, causing barrier breakdown.

Dynamic barriers like EPG can cope better with pressure & temperature fluctuations. Combine with cement for low cost, high function barrier.

Testing to be undertaken in Resolute 10kpsi test cell system.

Dynamic Barrier Layer - flexible, self-healing Resolute EPG



Solid State Barrier - crack formed in cement

A Different Approach

Dynamic Barrier Materials

- **EPG: Expanding Polymer Grain**
- A dynamic, fast acting, impermeable, **flexible** and **self-healing** barrier
- Temperature resistant – 200-300 degC
- Fluid deployed, using standard industry equipment
- Small volumes required, small footprint
- Environmentally friendly material



Fine, dry, EPG particles



Mixed in a carrier fluid



React with second fluid to create dynamic plug



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