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On using 3D-print technology to improve permanent cement plugs for P&A operations

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Setting a formation to formation cement plug in a well needing to be abandoned is a necessity, and the number of wells where this operation will have to be carried out increases each year in the North Sea. Paradoxically, where the mechanical and hydraulic integrity of this barrier matters most is also where these plugs are potentially weakest with today's placement methods. This is in the shallower parts of the well to be plugged, serving as the last barrier for hindering a leakage to sensitive layers near the sea bottom. These plugs tend to vary in cement strength and stiffness, both radially out and from top to bottom. This is due to the feeble confinement and restricted spacer fluid density use at shallow depths, combined with potential damage during scraping of top of plug for verification of set cement.
This talk will outline the benefits of adopting rapidly evolving technology from 3D printing of materials and in particular concrete in the building industry. The potential advantages of this technology are:
- Constructing the plug layer by layer with identical properties for each layer
- Remove the need for spacer fluid flushes, since only small volumes will be cemented in each layer
- Continually controlling the compressive stress at which each plug layer is setting
- Perfect plug dimensions and geometry can be pre-programmed
- Hydration time, conditions and temperature can be controlled continually at the local scale.
Cost reductions can be envisaged by certifying quality and reproducibility of such printed cement plugs, thus removing the need for lengthy plugs and reducing the redundancy in the number of required plugs.

References

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