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Cement placement in damaged shale rocks: effect of shale properties

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To establish and maintain well integrity to avoid leakage through wells is vital for production wells relevant for the petroleum industry, and for injection wells used for CO2 sequestration. To ensure that stored CO2 remains underground in a long-term perspective it is of the utmost importance to optimize the integrity of both active and abandoned wells. The properties of well barriers such as drilled rock, annular cement and casing steel, and the interplay between them are important considerations during the planning and execution of the drilling phase. Failure of any of these individual materials, including interfaces between them, can lead to leakage.

The bonding quality of cement to rock and steel is thus of crucial importance for long-term well integrity. Several studies have been made of this in the past, but none have taken into account that the drilled rock can be fractured and damaged during drilling. Especially a caprock fractured in the near-well zone can jeopardize well integrity and cause CO2 leakage. In our work we have experimentally investigated the effect of drilling-induced caprock damage on the quality of well cement placement and bonding. Both intact and fractured shale rocks of varying properties was cemented under realistic temperature and pressure, and the quality of the bond was examined using X-ray computed tomography (CT) scanning.

The motivation for this study was to place cement at a wellbore wall with realistic fractures and damage, rather than an ideal wellbore wall with circular cross section. The rock surfaces applied in all previous cement bonding studies were smooth, laboratory prepared rock surfaces. This is unrealistic with respect to a real downhole borehole surface. The shale rock can be damaged by the drill-bit during drilling, or later as a result of impact and smearing from the rotating drill-string and stabilizers. Another important factor is the interplay between the drilling fluid properties and the shale characteristics, which can influence the degree and character of the wellbore wall damage. Since it is of the outmost importance for well integrity that the cement-caprock bond is tight, the ability of cement to seal sufficiently towards realistic shale interfaces is especially interesting to study.

References

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