Subsidence and Plugged / Decommissioned Wells: New Plugging Materials to Counteract the Negative Effects

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The production of oil and gas from sedimentary reservoirs has led to compaction and subsidence in many different fields, ranging from the North Sea, to Venezuela, and to the western coast of the US. Subsidence is a tremendous problem as evidenced in many fields, most notably at the Wilmington and Ekofisk oil fields where the magnitude of subsidence couples with a high cost of remediation. In the meantime, subsidence is a poorly understood but potentially devastating threat to many other reservoirs.

The Ekofisk subsidence, being extreme, does give some very important information. The reservoir has subsided about 9 m (29.5 ft), while the seabed has moved 8 m (26.2 ft), about 11% less. We have a differential subsidence were all beds move and compact differently.

In average all ordinary sandstone reservoirs subside about 30 cm (1 ft) during the production period and the surface, 11% less.

The issue of subsidence is particularly acute in the case of plugged wells. While most consider a plugged well as benign, history has demonstrated, time and again, that subsidence can have devastating effects on plugged wells, causing them start leaking noxious chemicals and quietly contaminating groundwater, surface impoundments, the atmosphere, and more. Again, considering the natural continuous compaction and movements caused by tide, waves, atmospheric pressure changes and earthquakes, a solid well plug will always fail with time.

In this situation, wells must be plugged in a way that is more permanent and durable. Research at Cambridge University supported by Schlumberger, suggest that cement must be replaced by a material that is a Non-Newtonian fluid (thixotropic).

Quick Clay is naturally deposited in abundant quantities in coastal areas in Sweden, Norway, Alaska and Canada (Leda Clay), A mixture of clay was deposited when the ice melted 10000 years ago. Following the isostatic rebound, a lot of the sediments ended above current sea level, and is created by the freshwater desalination of clays comprising mainly illite and chlorite. It is markedly thixotropic, and this enables it to be pumped and placed in a similar fashion to cement, without setting time constraints. Furthermore, it is chemically inert over geological timescales and will not set to form a brittle solid that cracks and allows leakage through the plug as the well and casing deform. Lucas Hand at Strathclyde university have just completed his PhD; Carbon Geological Storage: Quick Clays for Improved Well Integrity and Sealing. He has proven that Quick Clay are a Non-Newtonian fluid with a density of 2 g/cc.