Arrested phase separation and gel collapse in oil-continuous drilling fluids.

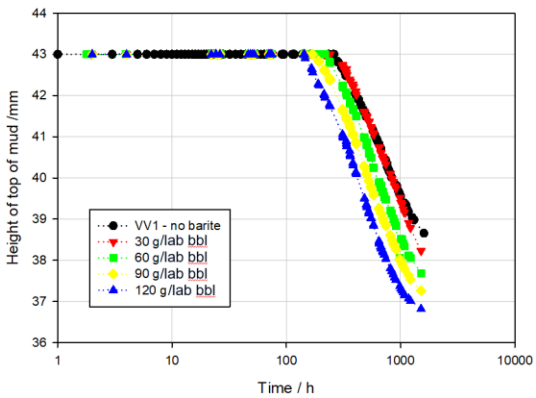
Andrew Clarke, Elizabeth Jamie, Louise Bailey, John Staniland,

Schlumberger Cambridge Research

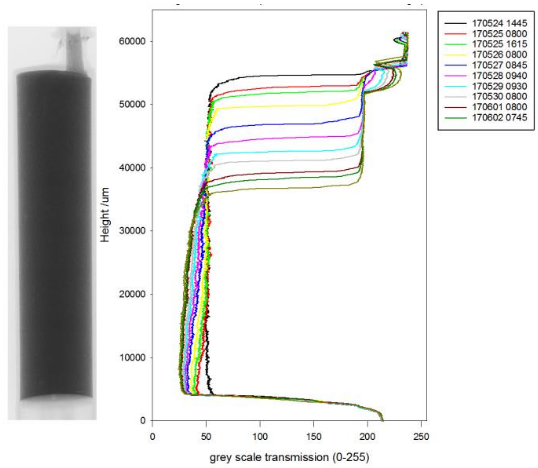
andrew.clarke@slb.com, preference for regular oral presentation

Drilling fluids are designed to fulfil many functions over a wide range of temperature and pressure. Key amongst these functions are (i) providing a hydrostatic balance between the wellbore and formation during drilling, and (ii) carriage of the drilled cuttings to the surface. Hydrostatic balance is usually achieved by "weighting" the fluid, that is adding dense particles so that the overall fluid density is comparable to the formation density. Hence the fluid comprises both dense particles that are part of the formulation and less dense particles, i.e. the cuttings. For both sets of particles, when the circulating drilling fluid stops, they should remain suspended; i.e. the fluid is required to be viscoplastic.

Oil-continuous drilling fluids typically contain at least an oil, a brine emulsion and clay together with emulsifiers and dispersants. These formulations form a strong gel which exhibits the phenomenology of delayed gel collapse commensurate with much simpler depletion flocculated systems described in the recent literature. Here we present a range of data illustrating drilling fluid gel collapse through simple disperse-phase height evolution (a) and x-ray tomography (b), appearance of temperature dependent dual length-scales consistent with arrested phase-separation (c) and intermittency in the gel collapse process consistent with coarsening (d). Thus we interpret our results, and therefore the behaviour of our complex formulation, in the context of experimental and theoretical results found in the literature for simpler arrested phase-separating systems.



(a)



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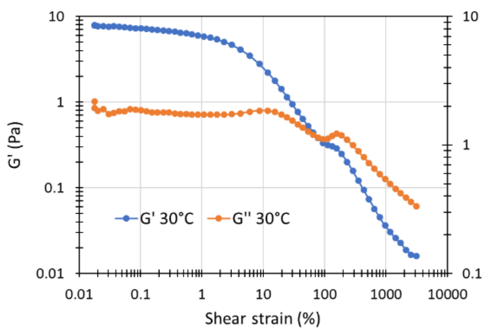
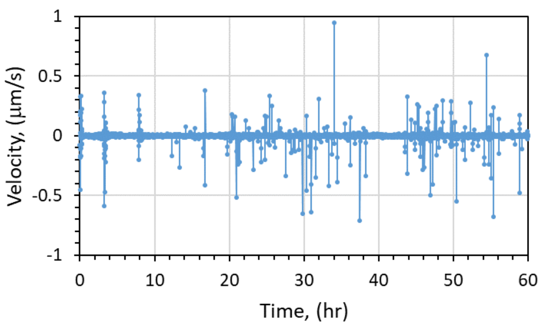


(c)



(d)