Geochemical Solutions to Assess the Provenance of High Casing-Casing Annulus Pressure Fluids

Peter Birkle, Hamdi AlRamadan

Saudi Aramco

Abstract

Cement is applied to seal the annulus between two casing strings as part of the completion process in drilled wells. This seal is required to permanently shut off water penetration into the well and enhance the integrity of the wellbore. The buildup of high casing-casing annulus (CCA) pressure compromises the well integrity and can lead to serious incidents if left untreated. Potential sources of water causing the elevated CCA pressure are either trapped water in the cement column or water from a constant feeding source. The inflow of formation fluid into the annulus is mainly caused by poor cement bond in the outer casing strings. This study provides a workflow to determine the provenance of CCA produced water to trace high CCA pressure in newly drilled wells. The methodology applies geochemical fingerprinting of CCA-produced water against representative drilling fluids (mud filtrate, completion brine, supply and raw water) from the target well site, and formation water from local and regional wells. Affinities in the hydrochemical (major, minor and trace elements) and stable isotopic composition ($\delta 2H$, $\delta^{18}O$, $^{87}Sr/^{86}Sr$) are monitored to identify single fluid types, multi-component mixing and secondary fluid alteration processes. The compositional coincidence of CCA water with formation water will imply the inflow of dynamic groundwater from a specific horizon, while common features with drilling or cementing fluids indicate the presence of entrapped water. The methodology was successfully tested on three wells, resulting in compositional affinities of CCA water with a specific groundwater horizon. In this application, the non-reactive elements (Na, Cl) and stable deuterium and oxygen isotopes were found to be most suited tools for fluid identification. The developed workflow in this study enables the detection of high CCA pressure sources, thereby allowing workover engineers to plan for potential remedial actions prior to moving the rig to the affected well, hence significantly reducing the operations cost.