**Durability of Wellbore Cements Under Cyclic Loading Temperatures: Comparison of Graphene Nanoplatelets (GNPs) Enhanced Cements and Fracturing Fluids Contamination**

**Jupudi, H., Awejori, G. A., Massion, C., Radonjic, M**

**420 Engineering North, School of Petroleum Engineering, Oklahoma State University**

**ABSTRACT**

Geothermal energy is identified as one of the best alternatives to fossil fuels in global climate crisis and the effective efforts for net-zero emissions by 2050. The potential of geothermal heat is yet to be unlatched thus requiring a novel approach in all aspects of wellbore technology including cementing. Understanding the characteristics of the system is important to develop a cementing technology for such expensive and risky wells. Materials used require stability at high temperatures and be chemically resilient to geofluids that attack ordinary Portland cement (OPC) causing loss in mechanical strength. Recent studies have shown that adding graphene nanoplatelets (GNPs) to cement can improve properties and reduce risks from mechanical failures. GNPs effect on overall cement properties has been studied and experimental results show promising outcomes at very low concentrations (<1% bwoc), significantly impacting strength and stiffness of the cement. But the mechanism in adding low quantities of GNPs to cement is unclear as it can increase the cement strength and resistance to fracturing, even under high temperatures and high pressures (HTHP) conditions. The Class-H cement is hydrated with and without, liquid and powdered GNPs at 0.008% and 0.1% concentrations each and cured in approximately pH 13 Ca(OH)2 solution to examine the influence on cement hydration. Also, the hydration of Portland cement-based slurry prepared with 10-30% of mixing water replaced by formation brines is being investigated. Cement cores are cured in hydraulic fracturing fluids and approximately pH 13 Ca(OH)2 solution. All the samples are subjected to cyclic temperature loading between 20 oC and 110 oC following an 8-hour cycle for 7 and 28 days in an environmental chamber. These temperature cycles help us evaluate close to the realistic conditions where enhanced geothermal systems undergo changes over tens of thousands of times. The cement paste samples are examined to investigate graphene’s mechanism during hydration, mechanical and microstructural properties for samples prepared by formation brines using micro-indentation, scanning electron microscopy (SEM) and micro computed tomography (CT) for the microstructure of the cement while energy dispersive x-ray spectroscopy (EDS) X-Ray diffraction (XRD), and Raman spectroscopy for chemical analysis and phase identification, permeability (Nano-Permeameter) and porosity (Helium-Porosimeter) measurements for petrophysical analysis. For the 7-day period analysis, we have, Information from this study will thus help to understand how potentially newly formed phases in hydrated cement will impact field performance. Geothermal wells are yet to be utilized in complete potential thus preparing a better design of the barrier material that withstand cyclic temperature loads that is environmentally safe for energy production and storage, cost efficient, and finally to make and test it is the objective our work. This will be a used on a large scale for all the upcoming projects on drilling of geothermal wells.