Crude oil is still the most readily exploitable source of energy available to humankind and the main source of feed-stocks in many industries and products upon which our present civilization relies (Kanickly, et al., 2001). The process starts by identifying a geological structure with potential oil accumulation (oil reservoir), followed by drilling to tap and produce oil, then processing the crude oil into various types of fuels and industrial feed-stocks. In each of these stages, it is hard to avoid a process that involves colloidal and interfacial phenomena, or think of a technology that can benefit from the electrokinetic phenomena inevitably occurring in the process, or can be induced to improve the processes involved. For example, oil reservoir characterization can benefit from functional colloidal and nanoparticles that can enhance seismic imaging or be used to “sense” the quality and quantity of crude oil in the reservoir. Drilling fluids (muds), drill tip performance, and well integrity all involve colloidal and interfacial systems and phenomena that take place during well drilling and completion. Primary, secondary, and tertiary oil recovery processes rely intricately on the electrokinetic properties of the system and the electrokinetic phenomena taking place during fluid movement in the reservoir. The list can go on and on to cover processing of crude oil and reducing the environmental impacts of its use as a source of energy and feed-stocks. What all of these processes have in common is that they rely on the interfacial phenomena arising from the colloid-rock-brine-oil interactions.

Since it is almost impossible to capture all the processes in a single article or presentation, I will in this talk consider the simple, yet daunting example –when crude oil is displaced by high-salinity (> 1M) complex fluids at elevated temperatures (> 100 °C) in a heterogeneous porous or fractured rock. How much oil do we leave behind due to the lack of sufficient understanding of the underlying colloidal and interfacial phenomena? What colloidal and interfacial phenomena are encountered or can be induced to improve the overall performance of an oil reservoir? How can we adequately characterize the electrokinetic properties of our system components under relevant conditions? How can we stabilize and transport colloidal particles in such high salinity aqueous environments? How can we deliver engineered nanoparticles to hard-to-reach zones in the reservoir? How do naturally-occurring physical and chemical potentials influence the mobility of suspended particles and the oil phase, and how can these be utilized to drive nanoparticles and oil in the reservoir? How can we utilize colloidal materials to control the reservoir conformance or automatically shut and open flow pathways? ....

In this seminar, the role that colloid and interface science plays in crude oil recovery will be emphasized and the opportunities it can bring to current practices will be elaborated. Two examples of Aramco in-house technologies and research results will be presented: In-situ Sensing and Intervention and Smart Water Flooding.