**Date:** October 10th

**Time:** 11:00 AM

**Location:** Ames 234

**Speaker:** Dr. Igor Beresnev
Iowa State University

**Title:** "Capillary-physics mechanism of elastic-wave mobilization of residual oil"

## Abstract

Much attention has been given over the last decade or so to the possibility of vibratory mobilization of residual oil. The common features of the ensuing applications have nonetheless been inconsistency in the results of field tests and the lack of understanding of an underlying physical mechanism that would explain variable experiences. Such a mechanism can be found in the physics of capillary trapping of oil ganglia.

Entrapment of ganglia occurs due to the excess capillary pressure building on the inner side of the downstream meniscus entering a narrow pore throat. The resulting internal-pressure imbalance acts against the external pressure gradient, and the ganglion becomes immobilized. The external gradient needs to exceed a certain "unplugging threshold" to carry the ganglion through. The two-phase flow with the ganglia thus exhibits the properties of the Bingham (yield-stress) flow, not the conventional Darcy flow.

The application of external vibrations is physically equivalent to the addition of an oscillatory forcing to the constant pressure gradient. When this extra forcing acts along the gradient and the vibration amplitude is sufficiently large, instant "unplugging" occurs, while, when the vibration reverses direction, the flow is plugged. This asymmetry results in an average non-zero flow over one period of vibration, which explains the mobilization effect. When the vibration amplitude exceeds a certain "saturation" level, the flow returns to the Darcy regime.

The criterion of the mobilization of a particular ganglion involves the parameters of both the medium (pore geometry, interfacial and wetting properties for the phases, and fluid viscosity) and the oscillatory field (amplitude and frequency). The medium parameters vary widely under natural conditions. It follows that an elastic wave with a given amplitude and frequency will always mobilize a certain subpopulation of ganglia, leaving the others intact; in this sense, the vibratory field will always produce a certain mobilization effect. The exact macroscopic effect is hard to predict, because, for a realistic porous space, it will represent a cumulative response of the populations of ganglia with unknown parameter distributions. The variability of responses to vibratory stimulation, following from the capillary mechanism, should thus be expected.