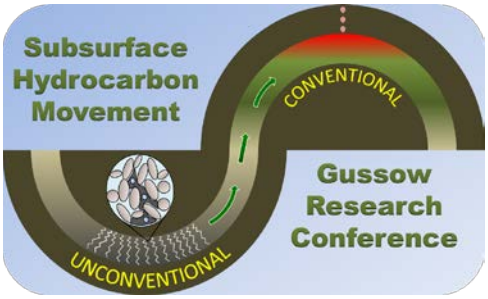

Interpretation of Surface Hydrocarbon Expressions Using the Vertical Migration Model

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Summary

Petroleum geochemical exploration is the science of using geochemical measurements to assess information about petroleum traps and accumulations before drilling. The process depends upon a reliable connection between subsurface petroleum accumulations and the surface. Vertical migration provides this geochemical connection.

Prior to the development of a good theoretical foundation, the mysterious mass transport mechanism called vertical migration was quite controversial. That changed approximately 20 years ago when the industry developed a buoyancy mechanism. Below the water table light hydrocarbons migrate vertically in a gas phase, with buoyancy providing a mechanism for predominantly vertical migration. The buoyancy model explains the gradients and data contrasts observed in many surface geochemical features. An extension of this vertical migration model calculates vertical migration rates that are consistent with field measurements. In fact, almost all field observations can be explained by the buoyancy migration model.

When the vertical migration model was extended to petroleum liquids, we found that liquid hydrocarbons migrated similarly to gases, but more slowly and through larger fractures and faults. Whereas petroleum liquids appeared to migrate up faults, gases migrate up faults and also between faults. Most gas migration is through fractures too small to be visible on a seismic section.

The vertical migration model predicts gas migration occurs in most places over a petroleum accumulation. Therefore, surface expressions can be used to map reservoir areal extent and shape. Also as predicted, petroleum liquids migrate vertically and appear along surface expressions of faults and large fractures. These complementary surface expressions of two migrating phases form the basis of modern surface geochemical exploration.

In addition to indicating the presence of petroleum and providing limited structural information, each phase (gas or liquid) provides information about hydrocarbon composition -- such as gas or oil, light or heavy oil, etc. That is a lot of information at relatively low cost.

But can surface geochemical exploration technology be used to map surface expressions of hydrocarbon migration? That possibility exists, but will require refinements to sensitivity and resolution. Surface hydrocarbon expressions from both accumulations and migration pathways can be better interpreted using the vertical migration model.

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