Reservoir Shale as Oil Source in California

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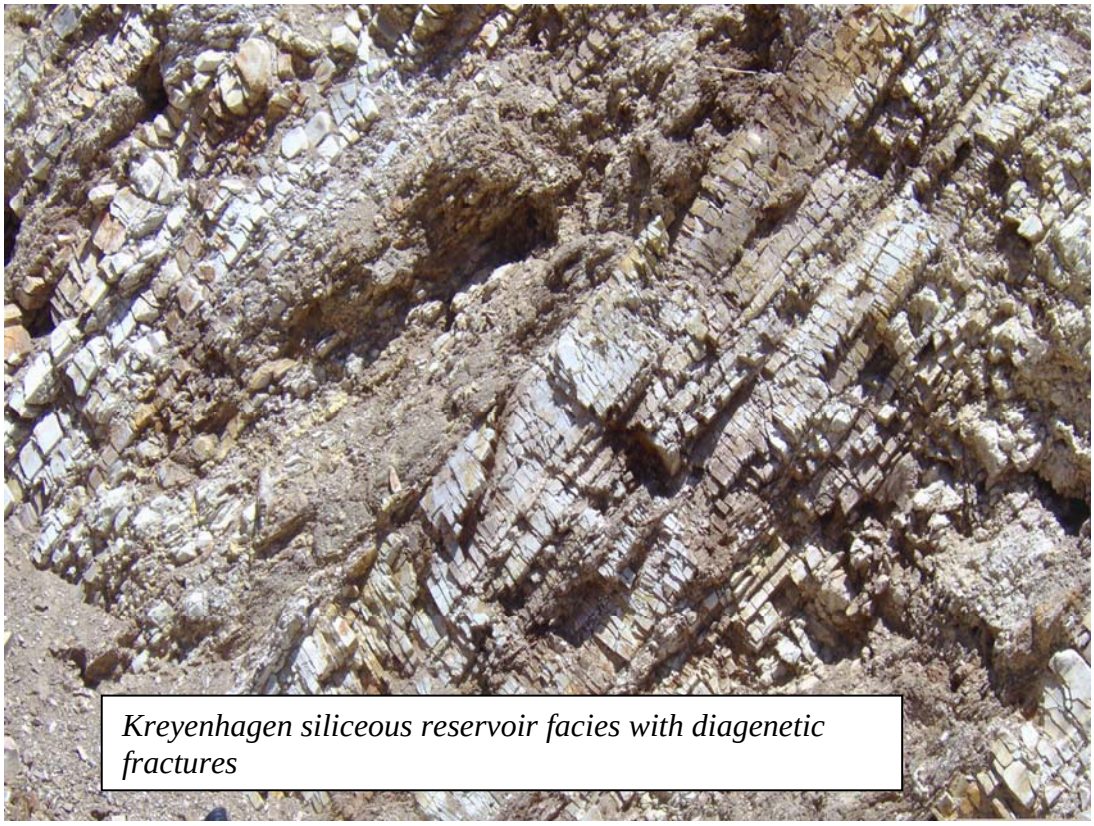
The Eocene Kreyenhagen Shale located in the subsurface and outcrops in the northwest San Joaquin Valley of Central California is a significant oil source – reservoir shale that is virtually unmentioned in the "resource shale" literature. The Kreyenhagen sub-basin in the northwest San Joaquin represents a significant natural laboratory for resource oil shale evaluation, allowing a close proximity tie of the producing shale reservoir to outcrops, including oil saturation and active seeps. The producing wells at depths between 10,500' and 12,000'are less than eight miles from the outcrop sections. The shale completions in the nearby oil field have produced significant volumes of oil and gas with continuous production since 1956. Completions have generally flowed to the surface without stimulation, with tests including the entire shale interval (1,300'-1,500' thick) of limited zones of 20 to 50 feet of the shale.

The outcropping oil source-reservoir shale offers what amounts to a continuous suite of samples for laboratory and research evaluation. INNEX is defining the extent of the saturation and the hydrodynamic parameters controlling the oil and water seepage from the outcrop sections.

The Kreyenhagen shale is geochemically immature for oil generation in outcrops so the oil seeps and saturation represent migrated oils as opposed to in situ generated hydrocarbons. This provides a unique opportunity for defining migration mechanisms, oil saturation percentages, and water saturation in an oil prone resource shale. The reservoir shale can be studied in detail, providing an opportunity to evaluate the relationship between source facies, migration, storage, and reservoir parameters of a "producing" shale oil reservoir.

In the nearby sub-surface, this shale has excellent oil source capacity with TAI from 2 to 7%, HI from 300 to 600, and 90% Type II oil-prone kerogen. Tmax, TAI, and Ro data indicate the producing shale section on the crest of the anticline is at "early mature to early peak" maturation. Basin deeps flanking the anticline have burial to 20,000'-25,000' depths with condensate/gas generation maturity. The section produces 37-40° API oil and associated gas, which is a more mature hydrocarbon than the host shale maturity, indicating that this hydrocarbon is a migrated product of more mature deeper buried shale, not an in situ generated hydrocarbon. INNEX has initiated a reservoir simulation to explain the timing and mechanisms for effective migration into this reservoir and, conversely, the effects and drainage areas of production from the shale. Migration pathways and production is enhanced by bedding plane fractures, tectonic fractures, and diagenetic fractures, as well as interbedded siltstones and turbidite sandstone beds with primary porosity and permeability.

Kreyenhagen Shale in Outcrop



Kreyenhagen siliceous reservoir facies with diagenetic fractures

Kreyenhagen shale with Tectonic fractures