

ABSTRACTS – 2018 INTERNATIONAL SYMPOSIUM, SALT LAKE CITY, UTAH

ately to immense improvement in the economics for drilling and ultimately the establishment of the Society for Economic Paleontology and Mineralogy (SEPM).

World War II created new opportunities again for women to enter the geologic workforce and they did in droves. With the onset of electric logs and seismic, women could venture into exploration using the newest technology. But again, careers were discouraged after the war, both when women married and also because a new social order was developing...a powerful social dynamic of putting the “little ladies” back in the home “free of the burden of working”—the June Cleaver era. For the next thirty years it was a struggle for a woman to get an exploration job...and if they did, it always came bundled with menial tasks and inferior pay.

In the early 1970s, the EEOC threatened oil companies with denying them federal leases if they did not have a “diversity” plan for hiring women and other minorities. An immediate response resulted in the hiring of great numbers of women. Affirmative Action actually worked and had lasting effects. Within a very few years women thought they were only hired for their brains! And by then, they probably were. But, the world had long forgotten the smart and enduring women who were the *real pioneers*.

RANK WILDCAT TERRITORY - NORTH DAKOTA’S DISCOVERY PERIOD

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Post discovery North Dakota was anything, but an oil boom. Amerada first, the communities of Bismarck, Ray, Tioga, and Williston second, and the state’s burgeoning petroleum industry third, had several complex issues to deal with once oil was discovered in commercial quantities. Amerada had discovered oil in rank wildcat territory. The communities surrounding the discovery well were initially incapable of providing support to the industry due to a lack of infrastructure. This reality was made worse by the fact that there was no immediate guarantee enough petroleum could be produced from this or additional wells for the market. More importantly there was no current market, i.e. refineries, for that petroleum where it would be produced. The complexities of the petroleum market and North Dakota’s infrastructure would also contribute to the delay in development until such a time as production induced the necessary capital investment, not just for additional exploration, but for development of the industry including service companies, housing, and infrastructure. Despite the American Petroleum Institute’s claim that North Dakota would be devel-

oped methodically by the industry these complex factors, addressed by industry, community, and state leaders determined the slow development of the Williston Basin; booming only when these issues had been satisfactorily resolved.

THE UNCONVENTIONAL REVOLUTION IN EXPLORATION GEOPHYSICS

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During the last 25 years, 3-D seismic imaging has revolutionized hydrocarbon exploration by delivering an accurate 3-dimensional picture of the subsurface (Fig.1). The image is capable of detecting fluids within the reservoir and has significantly reduced the risk of locating and developing hydrocarbon deposits.

In the late 1990s, deregulation of natural gas prices allowed long-recognized deposits of natural gas locked in tight rocks to be economic. It sparked factory drilling (repeatable high-density evenly spaced) wells and hydraulic fracturing that would help unlock the reservoirs. All that was needed was a geologist to determine depths and limits of the reservoir and engineers to drill and complete the wells. If 3-D seismic data was available, it might have been used to define both the limits of the field and drilling hazards. Generally, the cost and time required to process and interpret 3D Seismic was considered too high to affect the perceived geologic risk of the Factory approach.

Completion costs in unconventional reservoirs account for over 50% of the well costs. It is therefore critical to understand the geometry of how the rock is fracturing and determine optimum well spacing to balance the cost of development with the value of the gas or oil being produced. By extending AVO (Amplitude Versus Offset) to the pre-stack domain, it’s possible to simultaneously invert for V_p (pressure-wave velocity), V_s (shear-wave velocity), and density. Armed with these three fundamental rock properties that dictate elastic and inelastic rock response, researchers were able to combine those properties to tie directly to how well a rock will respond to hydraulic fracturing, or which rocks contain a higher Total Organic Carbon (TOC), or other rock properties that control how a rock responds to seismic waves or hydraulic fracturing. Combining these results allows interpreters to map areas of higher productivity and identify bypassed reserves.