

Part 11: Meandering Through the Oil Industry - EXPLORATION: To Boldly Go...

By Brian Rohrbach

This technical article is in a series characterizing the process that the oil industry follows to bring us one of our favorite commodities, the gasoline that powers our Classics. Finding oil started out easy, got harder, tech makes it easier again, repeat.

" Engineering materials used in the exploration have improved."

Sorry for splitting an infinitive (Star Trek made me do it!). As mentioned in the last installment in this series, the oil lies underground, usually miles beneath the surface of the Earth. So, it is not just an issue of extracting the oil from places far below, there is also that little issue of figuring out if the oil is there in the first place. So, how do we find it?

In the early history of oil exploration, basically all we did was look for seeps. Much like water runs downhill, oil does the reverse and runs uphill within the confines of different layers of ground strata. We find the seep, look at the lay of the land, and then guess at where a reservoir is located. We would confirm by drilling a set of wells to see the extent of the reserve. The drilling approach to recover the oil was pretty crude too, mostly encapsulated by easily relocated wooden structures where all you could do was to drill straight down, never really certain how far down you should go.

But the days of seep prospecting are long gone....

Next up was to play the analogy game: Well, we found oil when the land looked like this before... Geologists stepped up to form a fundamental understanding of where petroleum comes from and used that knowledge to focus on areas that were most promising. What is needed is a source of the organic matter that will be heated and squeezed to both form the oil and make it migrate. We then need a



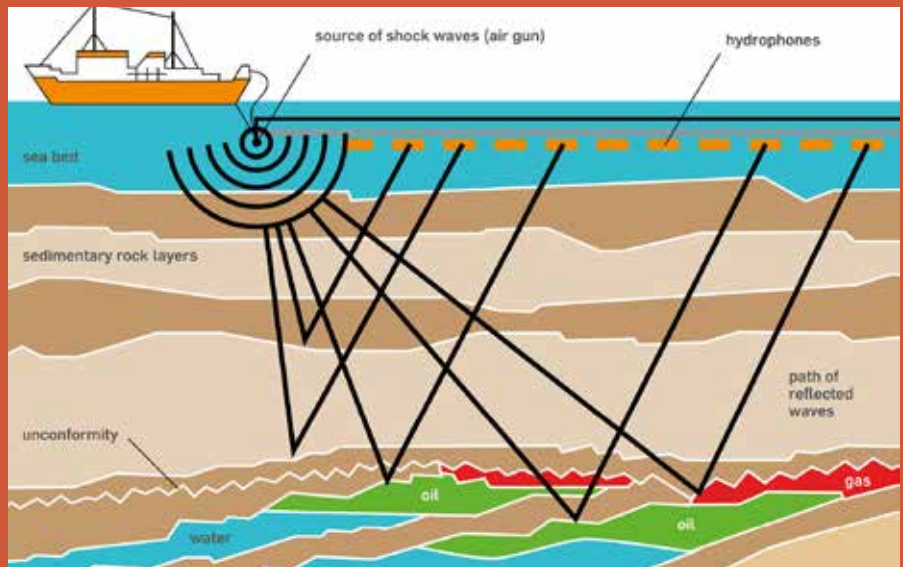
trap to capture the crude before it disappears into the surface environment. Two scientific fields came into being: geochemistry – looking to make sure

the oil has a source, and geophysics – looking for structures that can hold oil. We will look at geophysics and leave geochemistry for another day (about 3 months from now).

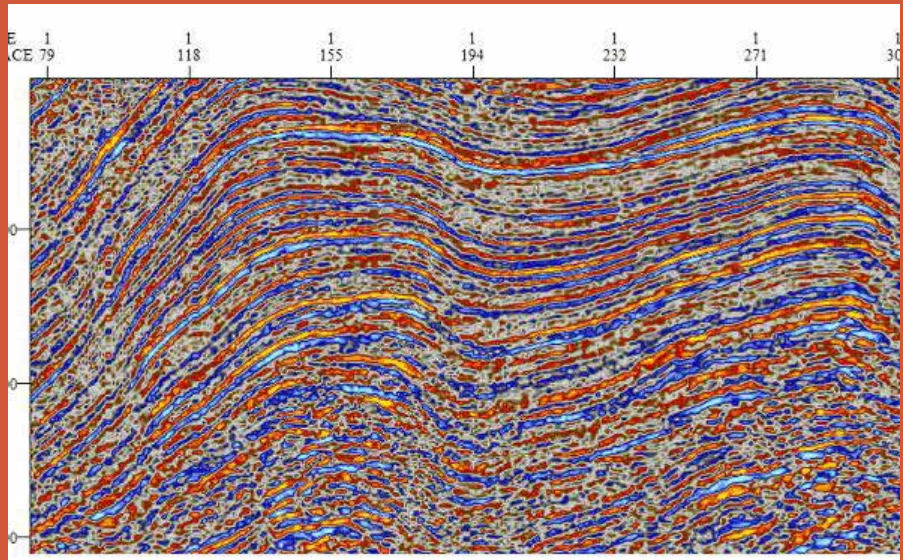
The era of geophysics transformed exploration about 70 years ago (show of hands here: who doesn't like a good explosion?). We use either an air gun or small explosive charges to generate a wave, then monitor using a series of acoustic sensors. Sensitive microphones or vibration detectors detect the reflections of the shock waves - hydrophones over water, seismometers over land. Applying a bit of physics allows these surveys to detect features of the sub-surface geology. The time it takes for reflected sound waves to travel through rock of different densities creates a profile of the substructure.

The shock waves are sent off in a sequence and the whole jumbled mess is pieced together by computer to form an image of the strata. We use the image, of course, to estimate reservoir structure and depth, but we also try to interpret porosity (how much oil we might find) and permeability (how easy will it be to squeeze the oil out). The images generated from this wave harvesting looks like the following picture, presented so you can try your hand at doing the interpretation.

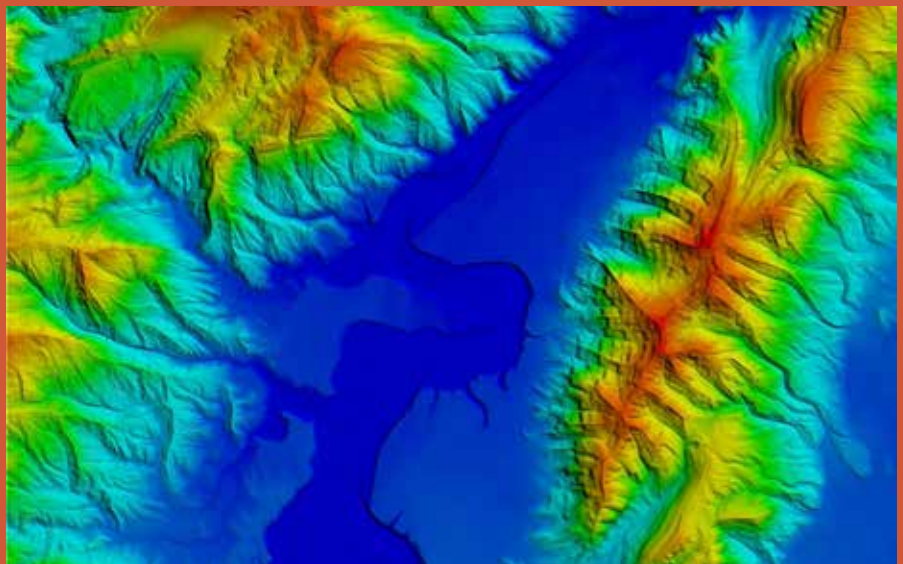
Oil exploration has even gone into space to try to find areas where the subsurface geology can be inferred from the structures observed from afar.



Doing the wave.



Wave images (Just like an ultrasound at a doctor's office.)



Enhanced false-color imaging (And, into space we boldly go.)