The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

How big an apple, Sir Isaac?

Posted by Heading Out on December 11, 2005 - 12:39am
Topic: Geology/Exploration
Tags: aramco, gravimetric, magnetic, saudi arabia, surveying, tech talk [list all tags]

Be it known that I have seen the place where a bored young Isaac Newton carved his name into the wood during class, long before he went on to develop those ideas that rendered a similar mental state to many thousands, if not millions of children, as well as enlightenment of an entire global scientific community. And it was that and his apple that led into today's topic.

Our story begins

> Back in 1934 when two young pilots named Dick Kerr and Charley Rocheville escorted a Fairchild 71 single engine by sea from New York to Alexandria, Egypt, and then daringly "hopped" it to Saudi Arabia under its own power by way of Cairo, Gaza, Baghdad, Basrah and Jubail where the first exploration parties were waiting desperately for an "aerial eye". Their flight was really the start of Aramco's airline.
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> The early days of flying in Arabia have given birth, of course, to numerous legends. One tells of the time when a hive of bees broke loose from their crate on a flight to the al-Kharj experimental farm. Then there's the story of the 60 screeching prize hunting falcons which were flown tied to a burlap-covered plank for a local amir. There was also the old Bedouin who tried to cook his dinner on an open fire in the cabin.

From which you might gather that it is a weekend and we are back talking about technical stuff. This is a short technical review of some aspects of the oil business, and today I will explain a little bit about how we find areas that will justify a seismic survey, and then a drilling investigation. These are the gravimetric and aerial magnetic surveys that are the initial large areal reviews of what the ground looks like, underneath the surface.

Most of the surveys are now carried out by magnetic techniques, since this is easier to use in an aircraft, but for historical reasons we should include gravimetric, since this was the tool that discovered Ghawar, back in 1948.

What we initially want to find is some indication that potential oil traps exist that can retain oil underground. What the instruments initially look for are very subtle changes in the earth's gravity field, or magnetic field, since these are, in turn, an indication of changes in the rock layers being looked at.

The rocks that underlie everything else are called the basement rock (we are a creative bunch in some of these names). They are dense, heavy and don't (cultish views non-withstanding) have

any oil in them. The rocks above them, however, are lighter, and this is particularly true of rocks that have holes (pores) in them, into which fluid can flow. Fluids are, typically, less than half the density of the surrounding rock. Further some of the rocks that can trap the oil and gas, such as salt domes are also lighter than the surrounding rock. The most common trap is what is known as an anticline, which can be simply thought of as an underground hill, or range of hills, such as I mentioned last week.

Thus when a survey crew travels along, measuring the level of the Earth's gravity they can plot relative levels of the gravity field, from which they can derive, through computer analysis, what the underlying shape of the rock structures are.

In the same way, many of the rocks in the Earth's crust are to some degree magnetic. Those associated with oil reservoirs often are less so, if they are located around, for example, a salt dome. On the other hand some reefs will have a higher than normal reading. So the analyst will, initially, be looking for variations in the reading from the average for the region.

Because these instruments are small, and can be carried in a plane they can quite rapidly give an overview of the geology under the surface. The main benefit of this is pointing out where it is not worth looking, and in identifying where the survey crews should be sent in to do the more detailed seismic work that will give a more accurate picture of the structure, and which will be required before the absolute evaluation, achieved through the drilling bit. It is that final evaluation that is needed to finally classify the oil as a proven reserve, and without it companies can get into trouble since while a rock structure can be in place, there is, as yet, no tool as good as a rock bit for finally telling a company what is really there.

Saudi Arabia has been a leader in developing a wide variety of information of this type, given then difficulties in access through much of the desert, and the critical need for information, even in the Empty Quarter. The country has been thoroughly surveyed, and analyzed. Incidentally you might note that I have quoted extensively this week from Aramco World. There is a wealth of information here, for those after an informal but entertaining review of the company history and other information.

This is part of an ongoing weekend series on technical aspects of oilwell (and natural gas) drilling. Previous posts can be found at::
the drill

using mud

the derrick

the casing

pressure control

completing the well

flow to the well

working with carbonates

spacing your well

directional drilling 1

directional drilling 2

types of offshore drilling rigs

coalbed methane

workover rigs

Hydrofracing a well

well logging

seismic surveying

As ever, if this is not clear, or if there is disagreement then please feel free to post, and I will try and respond.