

DO WE STILL NEED MAGNETICS TO FIND OIL?

It appears to me that there is a growing pessimism among petroleum explorationists about usefulness of magnetic method in their hunt for petroleum resources. What is even more disappointing for the magnetic expert that petroleum geologist often is not aware of what magnetic methods can add to the table. I am writing this essay trying to answer the question stated in the title: Do we still need magnetics to find oil? Is anything new happened to the method and exploration that makes magnetic useful still? What questions it can answer? All this I do with a hope that some petroleum explorationist would see these thoughts and something would catch his interest, or as we would say magnetize him.

Time changes things and needs. Some of them become out-dated and obsolete. Some retain their positions. Some emerge expectedly or not. Two main aspects of the exploration are changing with time. They are technological developments and need to explore new geological targets.

Improvement of the instruments and survey techniques has led to acquiring of the high-resolution data in timely manner. Within last decade powerful computers have drastically increased speed of time-consuming calculations. In that it has stimulated development of multi-functional processing and interpretation software programs and (what is even more important) created environment for invention and testing new mathematical algorithms. Unfortunately for many geophysical exploration methods, similar developments in seismic have overshadowed them, but they have developed during this time as well. I am going to mention just a couple of examples of these recent techniques: Euler Deconvolution for depth to basement estimate (Thompson, 1982, Reid

et al., 1982) and Calculation of the effective magnetization in sedimentary cover (Goryachev, 1987, 1993). There are more out there, and I am sure there are more to come.

Oil fields have been extensively developed over last 100 years. Some of them have fulfilled their mission and became a history. New discoveries are needed to replace them. However, it gets tougher and tougher to find new fields. Emerging geological targets are much more complex and challenging than 30 years ago. Both onshore and offshore exploration targets deeper petroleum prospects. Offshore it moves from the shelf to deep-water. Exploration becomes worldwide integrated. At present time petroleum geologist often works all around the world going from one geological area to another. Where is magnetic method in this changing world of petroleum exploration?

Historically it has played a major role for understanding of regional geology and tectonic history of the large prospective areas. At this stage magnetic data are used to differentiate crustal types, estimate depth to basement, determine major tectonic discontinuities, and to outline sedimentary basins (Logachev, 1962, Heiland, 1963, Dobrin, 1976). Magnetic method provides an explorationist with quick, informative, and often critical framework. For instance, if an explorationist is familiar with magnetic characterization of West Africa and may relate it to geology, the magnetic anomaly map of Brazil may tell him a big deal of its regional geology as well. It certainly will make his geological transition easier, if he moves from one place to another.

The deeper target are often troublesome for seismic. One of the reasons is that due to compaction the elastic properties of the layers often become undistinguishable with depth. On the other hand, the magnetic properties of the layers are retained. That makes

magnetic method extremely useful for basement and deep sedimentary structures mapping. The magnetic and interpretation techniques, some of which have been mentioned, become more and more sophisticated in solving these problems.

It is often possible with current magnetic methodology to delineate faults and fractures that may control reservoir. The fault modeling programs utilizing 3-D seismic data are widely used, but magnetic method can be used in similar fashion for the same problem. Certainly, it does not have seismic resolution, but it may answer many questions. It may show main faults as well as predominant fracture orientation. And if this magnetic-based fault modeling is done prior to 3-D seismic acquisition, it will most-likely lead to optimization of the seismic survey or to the critical and costly decision on purchasing seismic data for the prospect evaluation.

The Table 1 is a brief summary of the magnetic method applications. It is not planned to be a complete reference, but rather an illustration of the general problems, for which magnetic method can and cannot be applied. Some of the aspects listed in the table have been discussed in this short review some have not. I hope that those mentioned in the review will provoke a reader to learn more about magnetic method and explore its capabilities.

... I bet, at times every explorationist gets puzzled looking at seismic section trying to figure out what this or that reflection means. Does it really mean anything? And where the ... is a basement? I am sure that in these moments he thinks that it would be nice to have some fast and inexpensive way to get some answers. That's right! Magnetic is not only an informative, but inexpensive method compared to seismic. Look! The magnetic data may be even acquired along with your seismic. Maybe it is time to look at them?

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Application/Target	Works			
	Doesn't work	In some cases	In most cases	Always
Crustal Types				●
Depth to Basement Estimate				●
Basement Relief			●	
Major Tectonic Discontinuities				●
Crustal Age		●		
Extrusive/Intrusive Bodies in Sedimentary Section				●
Sedimentary Structures controlled by Basement Relief			●	
Sedimentary Structures not controlled by Basement Relief		●		
Faults			●	
Direct Hydrocarbon Indicator (DHI)		●		
Fractures		●		
Porosity	●			
Permeability	●			

Table 1. Applications/Targets of the magnetic method in petroleum exploration. What it can do for you?