

## **Characteristics of electrical exploration technology used by Siberian Geophysical Research Development Company LLC**

“Siberian Geophysical Research Development Company” carries out electrical exploration in hydrocarbon material prospective field regions. It also conducts investigations aimed at upgrading of efficiency and geological informativeness of geophysical survey.

DNME (Differentially-Normalized Method of Electro-prospecting) is the prime “tool” used by the company for search and delimitation of hydrocarbon accumulations. DNME is a new and effective tool for solution of petroleum geophysics’ problems. At present the following has been developed: method theory, equipment and software. Numerous works of large-scale were carried out during the last few years in Russia and abroad. As the result of these works the company accumulated huge dataset that has been generalized in the form of reports, projects, dissertations, scientific statements and publications. All of these data allow to form a clear picture of DNME method and its potential.

DNME considers the fact that in time domain development of eddy and polarization currents proceeds differently. This leads to space-time structure diversity of electromagnetic fields, which are created by IP effects and eddy currents. This allows to separate – due to relevant geometry of generating-receiving array – IP and inductive transient effects at the stage of transient signals measurement. Besides, company specialists developed the new approach that allows to “get rid of” induction effects and find 3D distribution of polarizability. This approach showed itself as highly efficient. The basis for this is unconventional processing algorithm of measured signals.

DNME (in the modification known by the review authors) combines advantages of non-stationary electromagnetic soundings and IP method. This allows mapping distribution in plan and through depth of both electrical conductivity and polarizability, as well as other polarization parameters (time constant and Cole-Cole formula exponent).

These parameters are connected with geochemical conditions within near-surface section, which are controlled by hydrocarbons vertical migration. That is why DNME is an effective tool for hydrocarbons prospecting. The basis for DNME is mathematical theory describing transient electromagnetic fields in the presence of conductive and polarizable mediums.

On the basis of this theory algorithms for 1D forward and inverse DNME modeling were developed and implemented. The software for 3D modeling is at the final stage of development. Another important component of DNME success is that special attention is paid to the issues of

technology and technique of transient signals measuring, as well as their processing for increasing signal-to-noise ratio.

Company members have made considerable progress in this area. This allows to carry out measurements in heavy conditions – when level of natural and industrial noise ten times higher than the level of useful signal. It is important to note the effort that company specialists put into development of physical-geological models relating hydrocarbon accumulations to overlapping polarizable rocks (supposedly having sulphide mineralization).

This is a unique and second to none investigation. It is conducted in association with St. Petersburg mining institute. Ph.D. thesis on this issue is in the final stage of development. Though DNME helped the company to hold a firm place in geophysical services market, its members use and develop other methods of pulse electrical exploration. Thus in recent years Siberian Geophysical Research Development Company carried out works in the areas where galvanic groundings are difficult if not impossible to realize and potential hydrocarbon accumulations overlapped by high-resistivity layers.

For work in these very conditions the unique technology of inductive excitation logging (ungrounded horizontal loop) and galvanic (by line) field recording was developed and is used. Works are carried out in 3D variant, besides for measurements several receiving lines are used for every transmitter coil. In the result the dataset is obtained. The analysis of data uses special technique and allows to separate effects produced by medium deviation from 1D model from induced polarization.

The company is oriented to the most progressive technologies and collaborates with many scientific and production companies, as well as with individual specialists. As an example, let's mention offshore DNME investigations. When these works were carried out the whole complex of difficult scientific-and-real-world problems arose, many of which were solved only due to cooperation with other organizations.

We also need to mention that Siberian Geophysical Research Development Company includes geological department with high-grade specialists and the electrical survey data inversion is carried out with consideration of ground geology data, boring and other geophysical methods, primarily seismic exploration. Those company reports that we made reviews of particularly consider results of geoelectric survey interpretation. This provides high validity of conclusions and recommendations including deep-wells location recommendations.

Among the members of Siberian Geophysical Research Development Company are Candidates of Science, the company executive is Doctor of Science. The Theses for science-degrees are directly connected to the development of DNME. This points huge scientific

potential of the Company's team. Some of the young specialists work on doctorate theses applied to DNME or related areas.

Over a period of years the Company works closely with INGG of Siberian branch of Russian Academy of Sciences (RAS) in a field of development of theory, technology, algorithms and software for polarizable medium EM sounding. Specialists of INGG of Siberian branch of RAS and the Company exchange ideas, computer programs and actual data. Post-graduates and candidates for a degree that work in the Company regularly participate in scientific and technical conferences held by INGG of Siberian branch of RAS, discuss scientific data with laboratory workers of ground geoelectrics. From its side the Company makes opportunity for INGG members to participate in acquisition tests and productive works, carry out joint field and laboratory experiments using material and technical foundation of the Company.

Post-graduates of INGG of Siberian branch of RAS, Irkutsk Technical University and St. Petersburg Mining Institute take part in the solving scientific tasks. Company arranged original digital telemetering electromagnetic prospecting systems and software for recording, processing and inversion of EM sounding data. Mechanical and cross-country transport, space communications and navigation allow carrying out geophysical works in practically any physiographic conditions. Excellent material rate in conjunction with scientific potential of the specialists with positive field experience suggest that Siberian Geophysical Research Development Company ranked among leaders of geophysical services market in Russia and abroad.

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