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Change connections in the loop

Until recently, processing stages have functioned in a self-contained manner. Now companies are connecting the dots.

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In the oil and gas field, data volume grows exponentially every year in an ongoing global effort to best determine subsurface opportunities for drilling and production. At the same time, a significant evolution continues in how the pieces of the "data puzzle" fit together to produce a coherent and accurate description of the subsurface. The puzzle pieces include acquisition data, seismic data, well logs, cores, petrophysical data and more. Data interaction is the key to success, while data compartmentalization may well lead to failure.

Historically, as soon as data entered a firm such as an independent, integrated reservoir services company, it followed a linear progression of processing steps, more like a factory assembly line, where it was preprocessed, analyzed, imaged and interpreted. As a functional system, that worked well enough to propel the oil industry for decades, with no real changes made until recently when "data integration" became a buzzword. Since no company wants to drill a dry hole, anything that helps reduce risk matters.

Connections increase productivity

Essentially, what is now occurring is that certain aspects of the process which were not connected previously now are. In addition, parts that were not considered relevant at a particular juncture now are brought in at an earlier stage, i.e., connecting pieces that typically had been disconnected. In other words, a feedback loop that never existed before, for practical purposes, now affects new incoming data and plays a more prominent role in making better decisions along the way than continuing to utilize the silo approach to data processing and analysis (Figure 1).

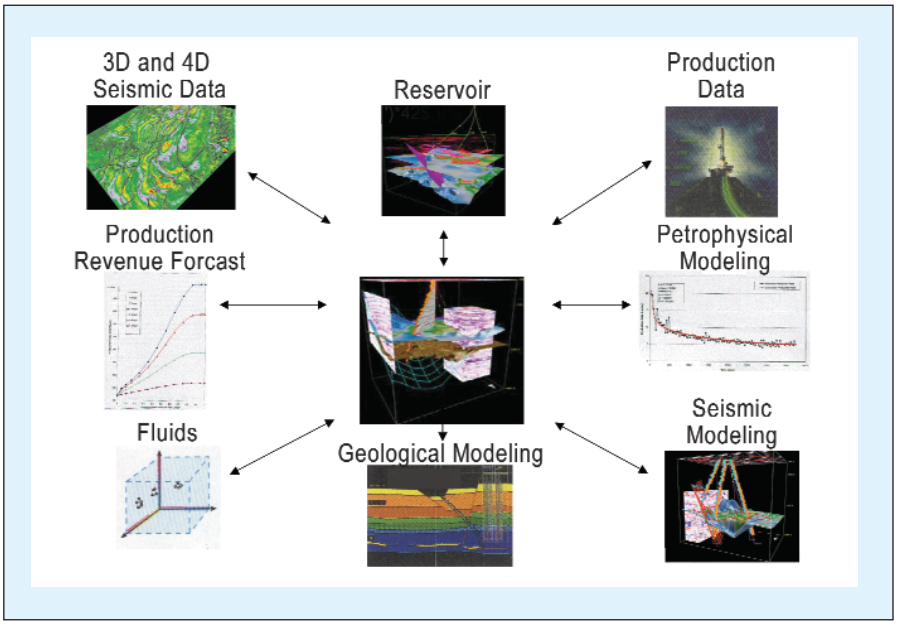

Figure 1. This figure illustrates the interconnectivity of modern data integration. (Figures courtesy of Geotrace)

For instance, the pre-processing was an independent step whose purpose was preparing data for the next stages such as imaging and velocity model building. These were independent, disconnected data processing stages to produce (1) the structural image of the earth and (2) offset or angle gathers that petrophysicists could use to extract attributes and rock properties, fluid properties, reservoir descriptions, traps, and other similar data. Very little feedback took place between these processing steps.

That is where the concept of data integration comes in. Data integration involves two major challenges: one, the technical aspect of having all the data accessible to all applications and users regardless of format, type or origin and two, having personnel capable of processing and analyzing these data. A simple example comes from trying to design a proper deconvolution operator by looking at the well log data and generating synthetic seismograms. This kind of data interaction is relatively new and only possible because of the integration concept. From velocity model building to depth migration, processing stages had all virtually functioned in a self-contained manner until companies began realizing the power of "connecting the dots."

As result, geologists, geophysicists and petrophysicists have found themselves forced to become as one, to tie together disparate information or data ranging from well logs to depositional environment and petrophysics to tell team members whether a velocity model being built actually makes sense. Some have called this an ongoing collaborative effort, although it actually goes beyond that by raising the bar on what an explorationist needs to know and how to get that information. That is because when work is being performed on velocity model building, for instance, all applicable well data can be readily accessed and utilized.

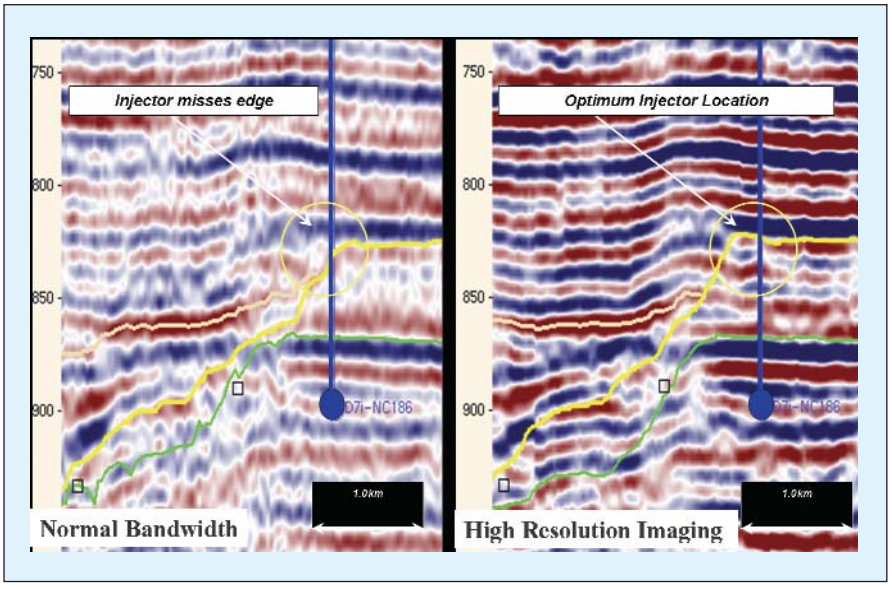

Figure 2. Seismic examples from a well in Nigeria. Enhanced processing techniques led to better stratigraphic understanding.

The power of data integration

What is simply accepted now that was quite difficult before is the requirement that information be obtained from petrophysicists who have the logs on different systems on different computers. Even then, petrophysicists had to be asked the right questions in order to provide the appropriate answers. Today, when someone wants to see a log, it resides in the same systems utilized to process the data, so accessing it is straightforward. All the data is contained within a project identifiable by a project name.

Therefore, just by knowing the project name, a wealth of data/information can be elicited such as where the wells are located, type of depositional environment (e.g., in deep Gulf of Mexico, on the shelf), what's nearby, what other discoveries have been made, etc. Data is all being integrated because it is connected in a much more complex way than ever before. The challenge now is how to use this new information or new interconnections to get answers to wide-ranging questions about structural traps, stratigraphy, lithology, fluids, seals, etc. extending to reservoir simulation and production issues.

Data integration proved crucial in the development and delineation of a reservoir in the onshore **Block NC186**, Murzuq Basin, Libya. After a successful oil exploration program was in place for several years, the desire to enhance production motivated the new study. New forms of data and processing techniques, previously unavailable, now made the possibility of enhanced recovery a reality. The producing reservoir is in the middle of the Ordovician Hawaz formation. The structure is a high created during the post-erosional event

The regional seal is the Silurian shales of the Tanezzuft formation. The Hawaz depositional environment is characterized by a gently dipping shelf covered by shallow (epicontinental) seas with an extensive coastal plain area dissected by tidal channels.

The application of special processing on the seismic data, together with well, geological and production data, allowed the successful stratigraphic delineation that resulted in a new location of producing and water injector wells (Figure 2).

Blurring the boundaries

An important objective of leading-edge geophysical service companies is to blur the boundaries of data location, origin or format. The desired result is to make information easily accessible and usable by any member of a processing team. Within that interactivity, care needs to be given to data security and confidentiality issues to avoid conflicts between processing teams working on different projects for different clients. These information access and analysis capabilities have critically expanded not just the exploration and production (E&P) efforts, but also the processing and analyses of data.

A good example of this integration comes from the depth migration world, where improved knowledge of the geology together with well logs can easily change the velocity model derived, for example, by alerting the team to the presence of anisotropy or pressure changing regimes. Furthermore, petrophysical, fluid information and rock physics can change the migration parameters so as to highlight certain data characteristics and help guide the interpretation. Integration also includes access to previous processing and interpretation steps performed by different teams at different times. Feedback from this information ensures appropriate progress of the project and acts as a compass to a successful result. The important point is that the information is part of the system and the knowledge transfer does not rely on somebody telling (or not telling) something to somebody else. The data and information become part of a knowledge matrix accessible by all.

Key to successful exploration

In the ongoing enhancement of "connecting the dots," clearly data integration is critical to the success of exploratory efforts, with two aspects being most important. One is to bring in more generalists trained in a variety of disciplines including geology, geophysics and petrophysics, to see the connections between the different data sets. Second, it is vital to more effectively build the machinery to handle the data integration. One example is prestack depth migration and velocity model-building, where integration has had a profound and measurable effect on the exploration and production cycle time. Data integration is changing the face of data processing as well as E&P.

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