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Improving Storage and Workflow of Pressure-Related Information—Don't Lose Your Expert Community

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Abstract

The next ten years are critical for managing manpower in the upstream petroleum industry. As experienced technical resources retire at an ever-increasing rate, companies are waking up to the reality that years of work and millions of dollars worth of knowledge and expertise is walking out the door.

In many companies, one person or a small community of experts are the only resource focusing on a particular discipline, such as pore pressure analysis or geomechanical modeling. Companies that have not developed or implemented solutions to combat the retirement challenge will be at a growing competitive disadvantage.

Factors surrounding data workflows and storage of pressure-related information within operating teams have been examined and show that data inaccessibility and inefficient data workflows have cultivated an environment where technical resources are unable to fully capitalize on available data. The current work environment does not allow past work to benefit current efforts and these factors are all at play in an industry that demands data sharing, collaboration and cross discipline cooperation.

By using existing technology and improved workflows it is possible to protect and benefit from the efforts of the retiring technical resources while improving the flow of information to the end user.

These storage and workflow challenges are reviewed for the pore pressure and geomechanical disciplines to demonstrate how better storage and data management translates into improved workflows and greater efficiencies among engineering and geological teams.

Introduction

To overcome the large-scale replacement of experienced knowledge workers with technical neophytes, the E&P industry will become increasingly dependent on efficiency gains provided by computer-aided geoscience and engineering tools. E&P companies and their suppliers have, for years, researched and developed a broad range of such applications. These applications can be viewed as "channels" in the workflow where access to prior know-how and experience becomes embedded in the work process. This is no substitute for a lifetime of practical experience, but it may become the next best alternative in the coming decade.

Many of these applications require reliable access to large volumes of data. In some areas, notably seismic data management, the E&P industry is at the cutting edge of information technology. However, this willingness to invest in storage solutions is not universal. In many E&P companies, retention and access to some key technical datasets are managed by a single employee. Such practices magnify the retirement challenge, and companies that have not developed or implemented solutions will be at a growing competitive disadvantage.

A typical characteristic of such "curator-managed" databases is that one person, or a small community of experts, are the only resources focusing on a particular discipline or domain of related technologies. One such domain is pore pressure analysis and geomechanical modeling.

Pore Pressure Information Overview

An examination of data workflows and storage of pressure-related information within operating teams shows that data inaccessibility and inefficient data workflows have cultivated an environment where technical resources are unable to fully capitalize on available data. In many firms, this inhibits access to prior technical learning. This is an important consideration when adjusting to a changing workforce: less experienced engineers and geoscienstists can benefit greatly from examining and/or emulating past work. In this sense, the work being done by today's experienced professionals will become valuable source material for future problem solving. Another rationale for improved workflows is to facilitate data sharing, collaboration and cross-disciplinary cooperation. This not only generates better solutions, but also is an effective strategy to supplement the knowledge of newer employees.

By using existing technology and improved workflows it is possible to protect and benefit from the efforts of the retiring technical resources while improving the flow of information to the end user.

Pore Pressure Analysis Example

The management of pore pressure information offers a good example of the problem and how it is being successfully addressed.

Drilling operations today target increasingly difficult reservoirs. Pore pressure data is an important aspect of reducing risk and enhancing drilling performance many of the most difficult conditions, such as deepwater, subsalt and HTHP wells. It is a critical input into well design. Drillers rely on the data to maintain a safe margin between a) fracturing the formation, or b) allowing unwanted fluids to enter the wellbore, both serious and expensive hazards.

But the data is diverse, often of varying quality and compiled from multiple sources **(Fig. 1)**. As is stated in a Joint Industry Project conducted under the auspices of the Drilling Engineering Association[1]: “Usually one of the most time consuming and difficult tasks in making a geopressure prediction is to pull together all the required data. A good prediction requires a combination of geophysical, petrophysical, geologic and drilling data. The prediction process requires judgment and flexibility to be able to work with the data available to make a prediction. In companies where each of these disciplines is represented by a separate department, there are sometimes organizational issues that make this process cumbersome.”

As a result, extracting more value from data is difficult. This situation is compounded by an increased work load and a leaner work force, which heightens the need for real-time decision making coupled with data sharing, collaboration and cross-disciplinary cooperation.

As E&P companies address these issues, there are many common questions they are asking themselves:

- Where has all of the data gone? We should be looking for oil and gas, not data.
- How do we capitalize on our expert’s efforts?
- Do we have the most efficient work flow for data search in place today?
- How is the analysis delivered to the decision makers, the drilling engineers, and can it be improved?
- How do we ensure that our efforts during drilling fully benefit from the planning expertise?
- How do we close the loop and take the lessons learned to the next well in the series?
- How can I ensure that my people are using the right data?

Data/Information Management and Access

The majority of pore pressure analysis in most companies is assigned to a very small community of experts. By default, these experts are also in charge of data storage and data in/out workflow.

There is no standard practice among operating companies for the storage of pore pressure data. The end product consists of a “project” containing the pore pressure analysis along with extracts of the key datasets used. Typically, projects are stored locally on PC hard drives and are often backed up to a private area on the company’s network. A completed project may also be available to other users through a shared network drive. Because projects can be copied between users at different points, this distributed data structure creates a situation in which projects, wells and datasets may be duplicated many times on various personal and network drives.

Managing this data—years of pore pressure data, well logs and analyses in a variety of formats on corporate networks, individual hard drives, stacks of CDs and on paper—is a difficult task. It is a practice that virtually guarantees wasted effort, lost data and high error rates. Based on the author’s experience and industry commentary, at least 40% of an analyst’s time is spent searching for the appropriate data and another 20% is spent qualifying the data.

This is problematic for pore pressure experts. Further, with no defined workflow and no established data management policies or tools, data and analyses are commonly stored in a manner that suits the needs of incumbent pore pressure experts, with little regard to other critical company interests. As a result, the analyses and data available to the drilling engineer are frequently of limited value for decision making, degrading their ability to designs wells.

Like a physician making a diagnosis from a handful of transparencies while the MRI technician has a full set of digital CAT scan images, drilling engineers are not able to capitalize on all the existing information.

The unwieldy process often results in $30 to $100 million dollar wells being planned from inefficient paper plots, .PDF files and text documents.

Addressing the Problem

For an organization to minimize the knowledge loss, strategic and tactical plans must be in place to achieve the following, key objectives:

- Both the organization and the employees are willing and able to learn
- Knowledge is recoverable from staff and contractors
- Process and practices are in place to enable knowledge retention
- Applications and databases support knowledge retention practices

For many of us, teaching and mentoring are not innate skills. Educational systems require that teachers spend hundreds of hours learning how to teach; we should not expect the process of knowledge transfer in a corporate setting to just happen spontaneously. There are many theories of learning, but there is general agreement that in experts, multiple cognitive processes are at work. This makes it difficult for technical experts to share the knowledge with novices.

In the context of the aging workforce **(Fig. 2)**, it will likely be a challenge for a person of the baby-boomer generation to relate their expertise in language suited for “generation X” students. It is also likely that there will be a shift the origin of geoscientists and petroleum engineers. In many disciplines the future workforce will be less dominated by North Americans and Western Europeans. The net effect will be that interpersonal communication will be impeded, and a less effective means of achieving understanding.

Since many E&P technical applications are software-based, one obvious approach is to embed knowledge capture and transfer capabilities in those applications. For this approach to be effective, gaining knowledge through applications and their associated databases must be straightforward and intuitive. This implies higher levels of usability and accessibility.

Applying these concepts to the domain of pore pressure analysis and geomechanical modeling requires a review of specific workflows to identify opportunities for improved knowledge capture.

Pore Pressure Analysis Workflow

In the process of well planning a drilling program must be designed. An important and integral part of any drilling program is the prediction of the amount of pressure that will be encountered while drilling through each sub-surface rock layer. This is necessary for safe and efficient drilling and is normally required as part of the drilling-permitting policy for most regulatory bodies.

In order to do a quantitative analysis for pore pressure prediction, it is common practice to first look for pore pressure analysis results from nearby wells, generally referred to as analogue wells. This clearly provides an opportunity to exploit prior knowledge creation **(Fig. 3)**.

In one major oil company studied, all pore pressure analysis is done by a single expert within the company. The expert would store results from previous analyses on common computer disks, which were then stored in a desk drawer or on the floor of his office. When asked how he determined if there was an analysis already performed on one of the analogue wells of interest to help plan the well currently being planned, he stated, “If I remember I did one I look through the CD’s. If I don’t remember, I just do a new analysis.” This example is not atypical of industry practices. It not only leads to duplicate work, it is wholly unsuitable for knowledge assimilation by a future workforce.

While it is clearly beneficial to search for and download prior pore pressure calculations performed on a nearby wells, often that information alone is not sufficient. Who did the analyses? When were the analyses performed? What data/information was used to conduct the analyses? Answers to these and similar questions are frequently required to determine if a new analysis is needed. Proper knowledge capture should make this information readily available.

Most major oil companies have similar workflows for pore pressure prediction. First, a pore pressure calculation is performed on a well using a software application. The results are then moved from the pore pressure application into a database used by the company’s mapping software. The pore pressure results are then mapped across a geographical region of interest over a subsurface horizon of interest.

When we look at this workflow in more detail we can see other opportunities for increasing efficiency and improving workflows–ensuring the right information gets to the right person at the right time. The pore pressure application requires multiple data inputs, invariably specifies types of well log data. Thus, from the outset, the pore pressure analyist must find the correct well log traces, e.g. a gamma ray trace, to use in the analysis. This process is not trivial–it is essential that the trace’s attributes be fully understood. For example, is the trace based on measured depth or true vertical depth? What are the subsea depths? Has it been corrected for environmental factors? Has it been depth adjusted? Was it acquired by wireline or LWD?

Once the pore pressure analysis is completed, it should be captured in a searchable database, along with the necessary metadata: information that enables future users to incorporate the analysis properly into their work.

How was the pore pressure calculated? What input data were used in the calculation? What calculation method was used? What parameters were used in the calculation? Who did the analysis? When was the analysis performed? Is this the most recent analysis? Are there other analyses on this well? This information is necessary to ensure that the appropriate results are loaded into the mapping application for future well planning and prospect generation. Unfortunately, metadata, in today’s source systems, is infrequently captured upon creation, especially when the process is under acute time constraints.

Similar difficulties are faced when seismic velocity data is used in the analysis. Among the finding in the DEA119 report[2]: “It is dangerous to assume that data is accurate without questioning the way it was obtained and processed. This is particularly true with seismic velocity data, which is often the only indicator of porosity/compaction/geopressure in the area where a new exploration well is planned. This data can be problematic both from the standpoint that velocity data processing is typically driven by exploration requirements that are focused on locating reservoirs in deep depths and not within the more shallow sections where pressure transition zones and other problems occur.”

To enable realization of future knowledge transfer opportunities, companies must establish and enforce processes for capturing the appropriate information and knowledge at each point in the workflow. The application itself should facilitate such policies: software and databases must be optimized, integrated and implemented to induce the capture without creating an undue burden on the user.

Additionally, tools should be available to support the search and retrieval of data based on knowledge queries which can be easily constructed by users who are oblivious to database structures or storage locations. Once the data are retrieved, it must be easy for the user to display the retrieved data in a way that is meaningful to the user in his area of expertise. These advances are achievable with properly designed and integrated software and databases using available technology.

A proven methodology in addressing these issues is the development of specialized workflows and processes that take full advantage of computing technology such as task-driven relational databases, Internet communications and standardized communication/data protocols, like WITSML.

Conclusion

The demographic profile of the E&P industry is an inescapable fact. We should recognize that this isn't just a workforce, these are the men and women who *created* the modern E&P industry. They did not have to contend with the problem of inheriting a predecessor's digitized work products. They relied on paper charts and reports, or nothing at all. With very few exceptions, the modern work processes they developed were designed with little or no regard for knowledge retention and transfer. That wasn't their problem.

However, the impact of the exodus of experts can be mitigated with a proactive, strategic plan that facilitates the capture of knowledge and information for future use, without disruption to current work processes.

Like it or not, many of the professionals working today will leave with most of their knowledge. Their legacy to the industry will be the work they performed. If poorly managed, their work products will be hard to find, expensive to reconstruct and subject to misinterpretation and misuse. Tomorrow's professionals will try to use that work to solve their problems and find a liability, not a legacy. Properly managed, that work can be a technological advantage that may differentiate winners and losers in the coming race among operators and their suppliers to extract value from available talent pool.

References

1. Saleh, S., Shaker, S.: "Best Practice Procedures for Predicting Pre-Drill Geopressures in Deep Water Gulf of Mexico," *DEA Project 119 Manual*, (2001), 11

2. Saleh, S., Shaker, S.: op.cit., p. 11

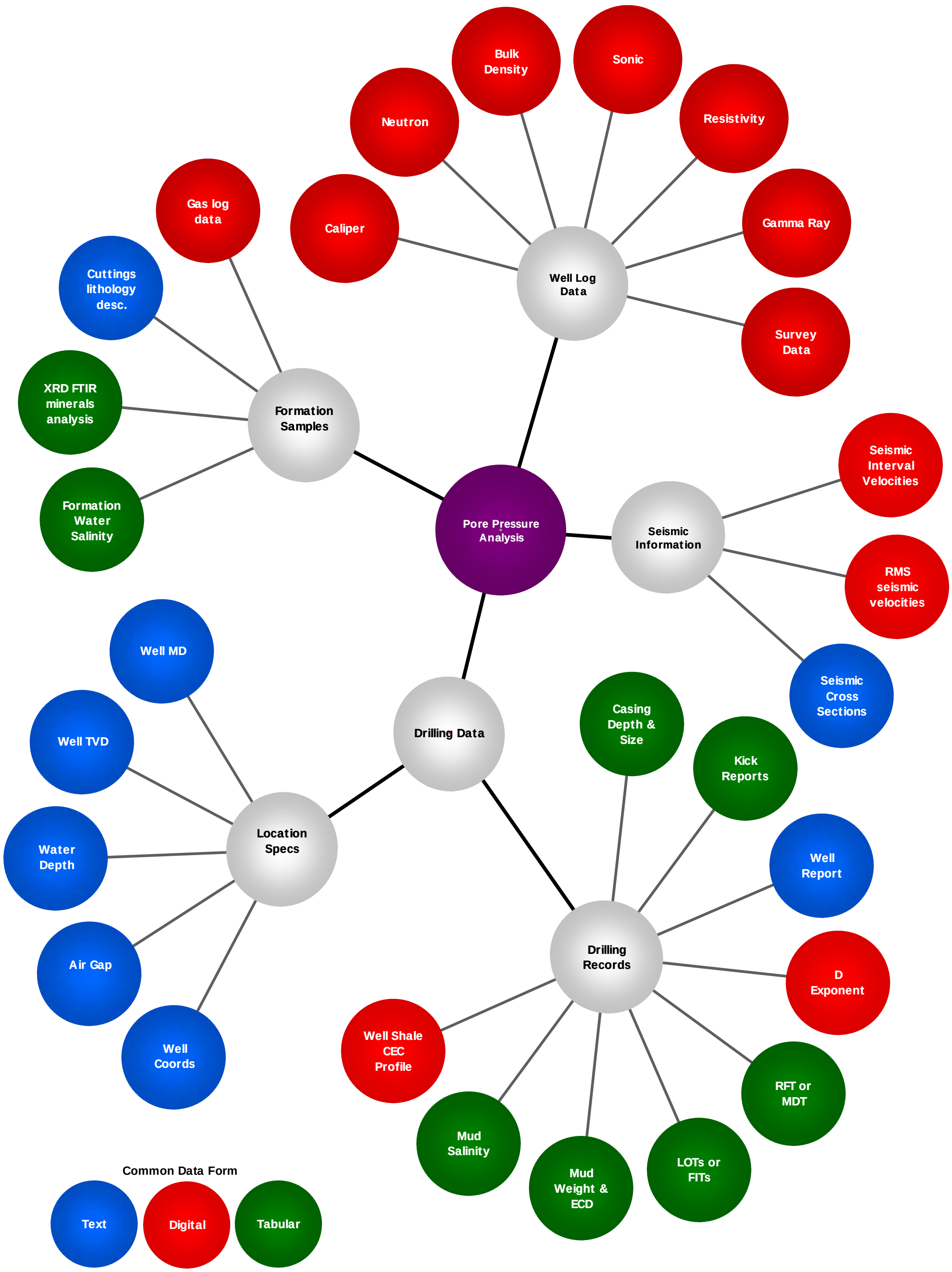

Figure 2 Pore pressure estimates are based on a wide range of inputs from various sources, making future reconstruction of the analysis a difficult task. This diversity of inputs also creates a need for documentation of data sources

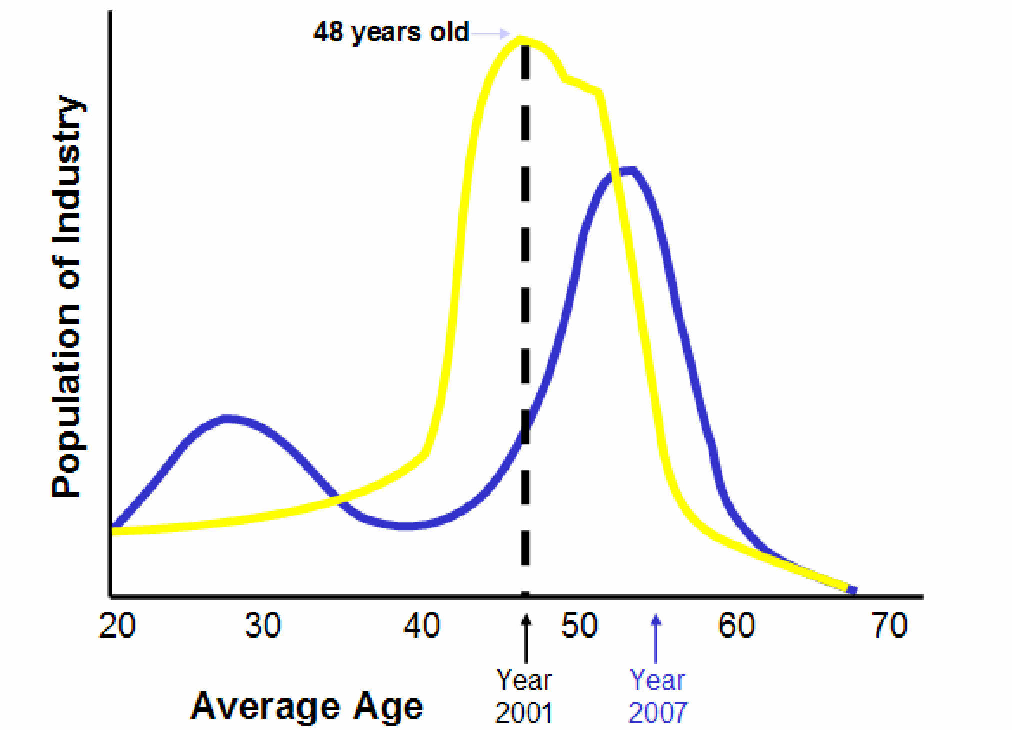

Figure 2 In 2001 the average of the E&P technical community was 48. It has been projected that by 2007 there will be a bimodal population and the aging experts will be at retirement age.

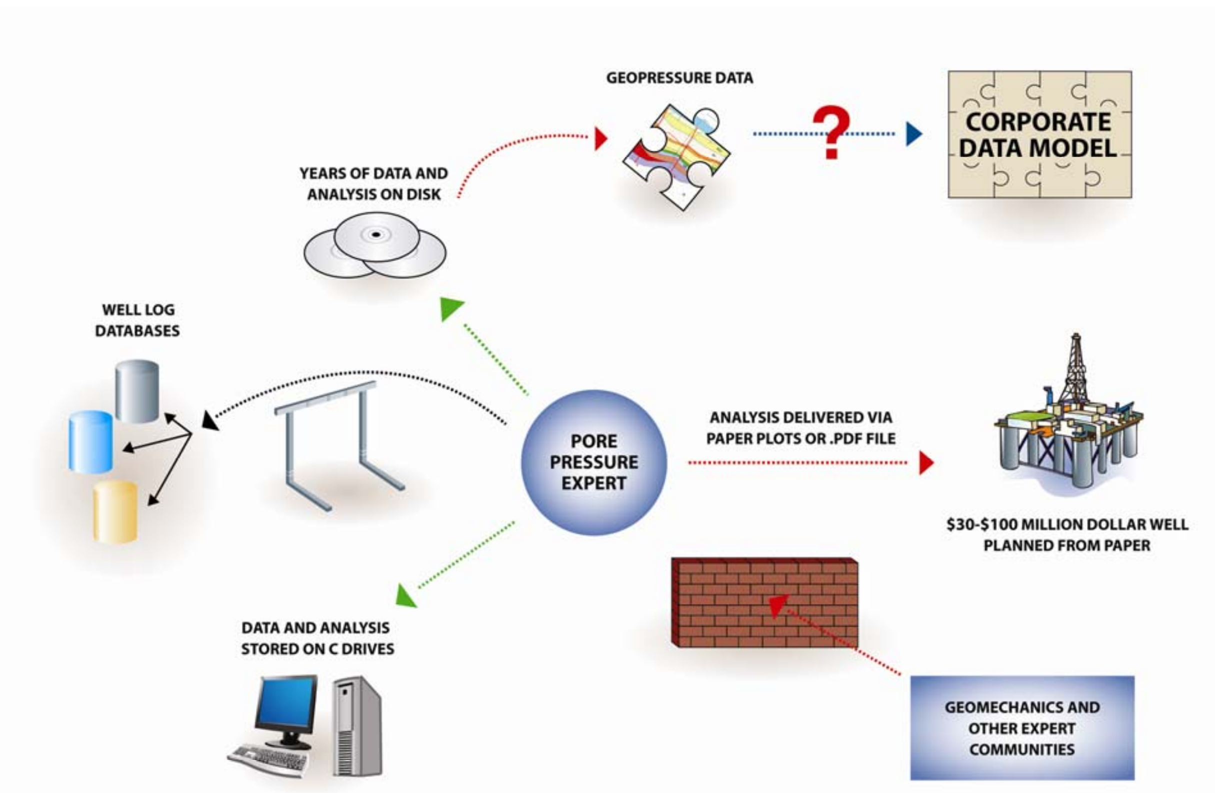

Figure 3 Industry standard databases simply do not provide a place for f specialized knowledge, information and data. This results in decreased security and little to no access to the information by other expert communities. A better system must be developed to streamline the workflow, protect the data and provide the engineer with a robust tool to better facilitate his or her needs