An integrated geoscience approach to digital transformation for the energy companies of the future

Philip Hargreaves[1*] and Alex Kurobasa[1] discuss how digitization is helping the geoscience profession to widen its scope in the search for cleaner sources of energy.

The most successful digital transformation strategies within the energy sector must closely align with the needs of the businesses that they support, both in the short and long terms. The geoscience element of this strategy should be an integral, fundamental even, component of this as geoscience observations drive many of the future policy decisions of energy companies. Hosting large raw data volumes in cloud-based infrastructure helps to facilitate the journey but does not itself answer any business problems. It is the intelligence and insights derived from the data that can truly influence business decisions and generate the maximum value from vast data assets.

Geoscience insights do not stand alone when discussed at the board level; successful digital deployments must allow for rule-based coupling with other business data categories: financial, environmental, market Intelligence and many others. As energy company portfolios diversify, or at least as companies consider diversification options in the wind, solar, geothermal, CCS and other markets, the geoscience resources drawn upon will also expand. In the future, energy companies will not focus solely on geoscience resources beneath our feet but on every component of the Earth's system. Approaching geoscience data with this mindset at the earliest opportunity will allow energy companies to better meet the demands of a more diverse, evolving business environment.

The business strategy takes centre stage

Whether your company's digital transformation is well advanced or in its infancy, there is no doubt that the market events over the past 18 months will have asked questions of its long-term business strategy. Did exploration focus shift? Has production been affected? Have net-zero pledges been mandated? Will diversification into new energy sources influence Capex? Each of these elements will require data-driven insights from geoscience to de-risk investment decisions. Clear visibility on these strategies should steer the priorities and content of any digital transformation. Mapping out the largest value decisions that might need to be made and itemising the geoscience inputs that control these decisions will help to ensure that the most valuable insights are part of a transformation work plan. Are these data inputs already available to digital platforms or currently siloed? Are insights derived from the data easily available to decision makers? Do they need to be procured or sourced? These types of questions should help to prioritise the digital transformation approach. Strategies will continue to evolve, so flexibility and regular reappraisal of data content is essential.

Maximizing the value of every geoscience data point in your organisation — the TGS approach

The value proposition for adopting digital transformation processes is clear – more accessible, better-structured data to provide

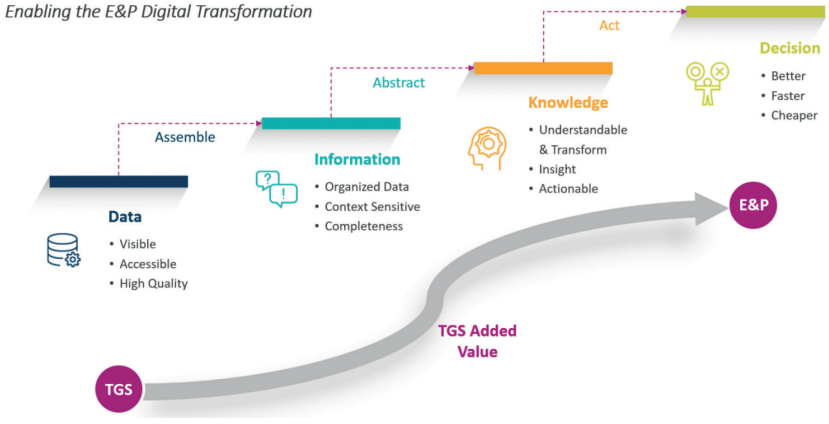

Figure 1 Enabling the E&P data digital transformation – the TGS approach.

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swifter insights. It has maximized the value of existing datasets that specialist acquisition and processing teams have meticulously built over decades. Digital transformation projects carried out with these datasets over the last three years have resulted in a huge cloud-based resource on which to build new insights. This solid base translates into an efficient workflow for further growth of an already comprehensive data lake into new energy transition-facing topics. Some key elements of this workflow are detailed below.

The assemble stage — creating a data model based on high quality data

Visibility and swift accessibility are often what is thought of as the main outcomes of 'loading data into the cloud'. Significant elements these will be, but certainly not the end of the journey, more an enabler of the value elements of the transformation.

A rigorous and clear data model is the foundation to any cloud-based data solution, providing the foundation on which swiftly accessible data is built upon. This was a key consideration during the design phase of the TGS Data Lake, a platform that now encompasses more than 6PB of analytics-ready geoscience data, 6 million well logs, 74 million pages of well documentation and 500 metadata categories and now incorporates energy transition themes such as numerical weather simulations, wind measurement data, offshore wind market intelligence and remote sensing.

Carefully designed metadata formats, using industry standards where relevant, allow for simpler queries against the data. Consistency across different data categories is key, ie, is the 'country' field consistent across all geoscience types? What about finance and market intelligence data too? If these elements influence an investment decision, they must be available in the same environment as geoscience outcomes for their meanings to be fully contextualised. This homogeneity doesn't just make it easier to write complex scripts on top of these datasets, it also can significantly improve the speed of metadata extraction, search and cataloguing. Queries can also be recycled and targeted at different datasets, improving consistency of answers. With increases in consistency come reductions in risks.

With a well-defined data model in place, a data lake can grow and incorporate new categories of geoscience data more smoothly.

Case study: Facies map browser

For more than 20 years, TGS has continued to deliver large volumes of geologically consistent well and map data to the industry through its Facies Map Browser (FMB) product, providing geoscientists with a robust geological framework with which to assess hydrocarbon and carbon storage opportunities at a variety of scales. Over this period, improvements in data management standards and the evolving needs of the industry have led to the

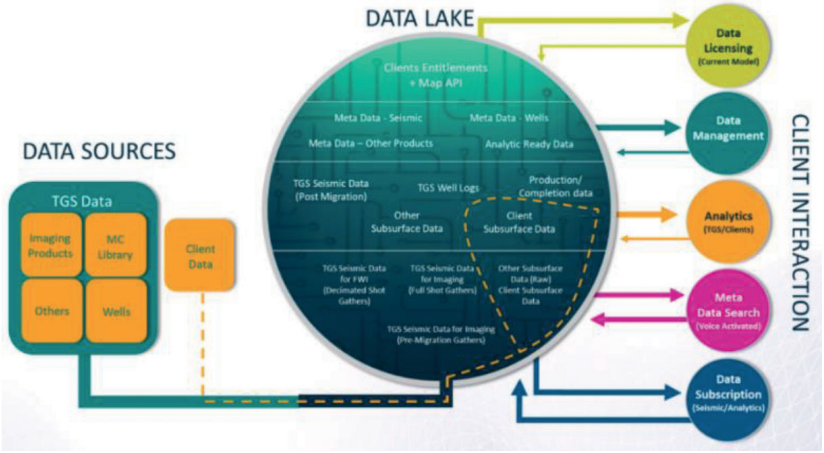


Figure 2 The TGS data lake structure.

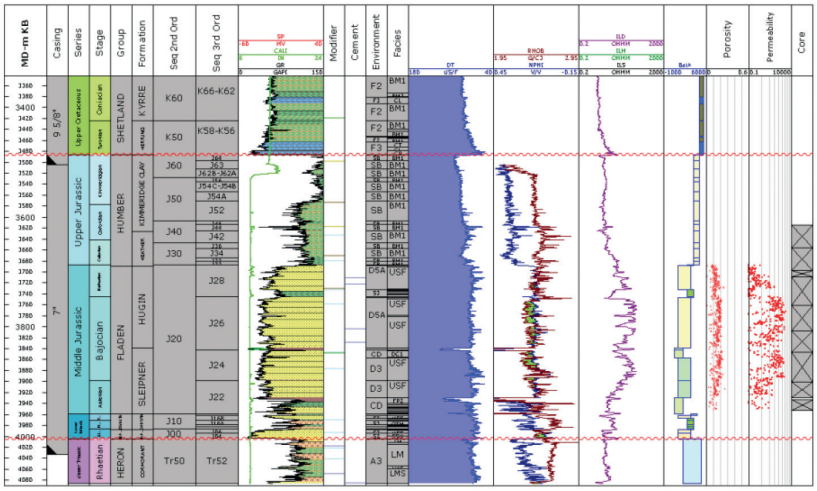


Figure 3 Facies Map Browser sequence stratigraphic database.

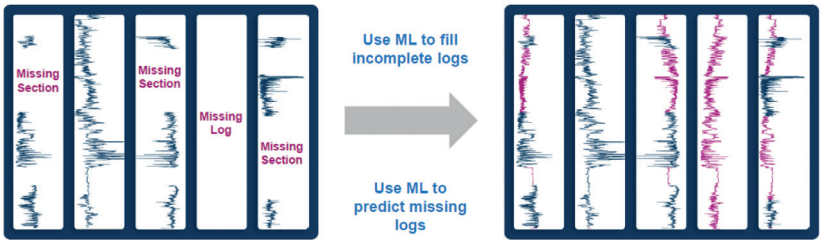


Figure 4 Using machine learning to predict missing data from incomplete well logs.

evolution from local database models to the widespread adoption of scalable cloud-based databases and technologies at an enterprise level. In 2021, TGS set about reimagining its FMB well and map database, which contains large volumes of contextualized well and map data, describing the subsurface of some of the world's most prolific hydrocarbon basins; including the North Sea, Mexican Gulf of Mexico, offshore East Canada, Brazil and NW Australia. The consistency of the data within the FMB is one of its key strengths, allowing end-users to quickly visualize and derive insights from a vast well library.

A growing trend in digital transformation initiatives is the liberation of data from siloed applications, its integration into a single modular ecosystem where data, services, assets, and competencies can be combined, leveraged and capitalized on. Integration of the FMB data into TGS' cloud-based data lake provides significant improvements in the accessibility of data (and metadata) for the geoscience community. When combined with flexible customer-facing APIs that deliver on-demand subsurface insight, end-users can efficiently search and integrate the latest well and map data across their workflows, optimizing productivity and access to up-to-date data for decision making and technical evaluation.

The Abstract Stage — turning data into knowledge and insights

As data is progressed through the assembly stage, a wide range of solutions that connect to the data resources become available. Delivery to multiple users in flexible formats, on-demand access, web interfaces and input into AI/ML workflows can be enabled. Reference again to the most significant value business decisions at this stage is a valuable driver to selecting and prioritizing the construction of these solutions. Those with the greatest impact will answer these decisions more confidently, faster or more cost-effectively than existing workflows. A broad range of use cases can point to the same data: ML workflows benefit from connections to raw data, but web dashboards may require a simplified view to deliver the clearest insight.

Case study: ARLAS

TGS' unique ARLAS (Analytics Ready LAS) solution demonstrates the power of solutions that can connect to large volumes of consistent data. TGS has digitized nearly 2 million wellbores in North America: the world's largest digital well log library. Yet not every curve for every well log is complete. Sections, or entire curves, can sometimes be missing, and some areas may have a sparser distribution of wells. A basin-scale machine learning pipeline has been developed to solve these problems by predicting density, gamma ray, neutron porosity, deep resistivity, and compressional sonic. For each target curve, separate models are trained from different combinations of available curves. The power of 2 million wells on which to base machine learning algorithms results in a remarkably high accuracy rate: typically more than 90%.

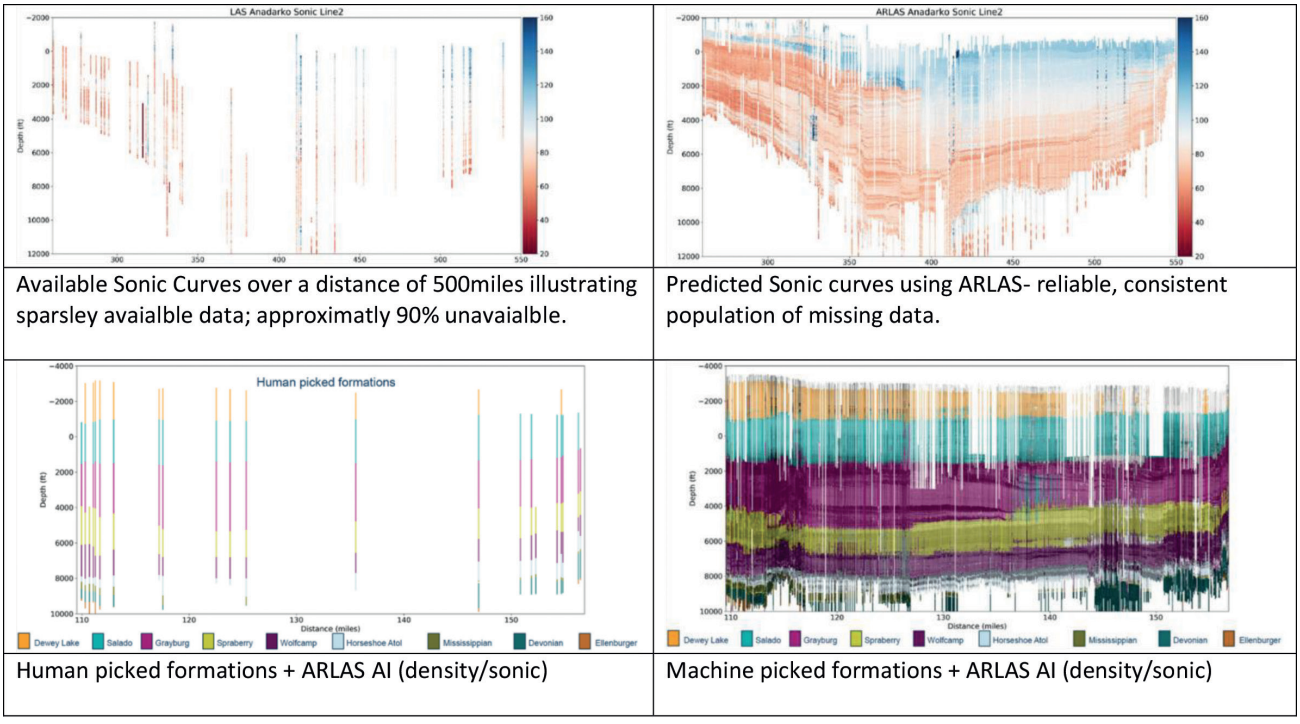
At the level of a single well this provides useful data to infill segments of missing data. On a basin level, this can be extremely powerful, allowing new insights to be rapidly generated and contribute to business decisions. Missing data can be assimilated over hundreds of miles, increasing basin-wide understanding and local interpretation of single wells. With data gaps resolved further automation of formation interpretation can be successfully attempted to allow human interpretation of well logs to be propagated over large distances. This technique can significantly reduce interpretation timelines, an important factor when time-pressured decisions require geoscience input.

Competitive advantage for approaching the energy transition

The presence of a pre-existing data lake resource provides an advantage when bringing tools like ARLAS and FMB to market. Predefined workflows and data models make integrating new data quicker, and drawing on large pools of consistent data makes machine learning outcomes more reliable. These advantages are still relevant as new categories of data may be required to fulfil the energy transition demands. Some topics, such as CCS and Geothermal, draw on similar geoscience data resources that are familiar to oil and gas companies and are indeed already components of the TGS data lake. ARLAS, for example, is a technology that can provide insights for geothermal prospecting, and FMB's sequence stratigraphy database can provide a commentary on carbon storage potential; singling out properties similar to that of the storage hub concepts currently under development in UK and Norway.

Many metadata categories are relevant to multiple data types, so significant components of existing data models can be preserved. Security and authentication protocols can be leveraged. Data science/ML expertise can be redirected with new guidance from subject matter leaders. The approach remains consistent, centring on the largest value business decisions and providing data and insights that support them.

Wind and solar are rapidly growing, competitive markets with margins that can be finely balanced. Therefore, data that supports key business decisions can have a critical commentary on the overall viability of a project. Having the best available data to draw from quickly will provide wind farm operators with a solid competitive advantage, a trait shared with oil and gas exploration. Companies such as TGS, who recently introduced a New Energy Solutions (NES) team, recognize this and set out to incorporate these additional data categories – wind, solar, CCS, and geothermal – into their existing data lakes. TGS calls this its NES Ecosystem.



Available Sonic Curves over a distance of 500miles illustrating sparsley avaialble data; approximatly 90% unavaialble.

Predicted Sonic curves using ARLAS- reliable, consistent population of missing data.

Human picked formations + ARLAS AI (density/sonic)

Machine picked formations + ARLAS AI (density/sonic)

Figure 5 Using ARLAS to predict missing well data at a basin scale.

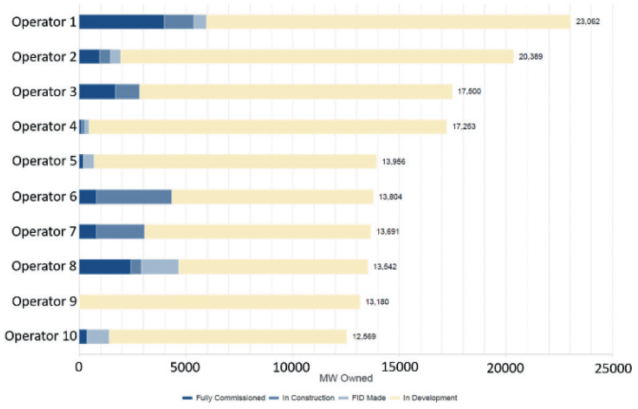


Figure 6 Extract from 4C Offshore's ForeSEE application showing the development pipelines of the 10 largest wind operators in the world.

In offshore wind, identifying market entry opportunities or growth opportunities, understanding forward-looking trends and unit supply issues are vital components that strongly influence the most significant decisions that impact windfarm project plans. This is especially true of those associated with forward strategies as existing players plan their growth focus and new companies consider their entry.

These are the business decisions that market intelligence providers 4C Offshore set out to support. As the world's leading provider of market intelligence data to the offshore wind market, 4C Offshore provides clear insights relating to the components that influence the most significant decisions in offshore wind.

Centring analysis around the ForeSEE web application and data services, 4C Offshore presents superior intelligence for all offshore wind farm projects (installed or in development), project owners, stakeholders, and service providers and carefully organizes these data points into analytics-ready data resources and top-level summary reporting. Digital transformation strategies often talk of the importance of 'contextualized data' – the ForeSEE database provides the true meaning of this for all data resources relevant to the offshore wind industry. It is a resource to place all other data points in context with the business environment in which they relate – a fundamental goal when delivering data to support business strategy decisions. In May 2021 TGS acquired 4C Offshore.

Another theme of data influencing key business decisions in offshore wind is Wind Resource Assessment – the process of estimating the power of the wind in a given location. The data requirements, processing and validation procedures of weather research and forecasting models and wind measurement data share many similarities with subsurface geoscience techniques. Recognizing this, TGS has begun to integrate a range of datasets from this theme into its NES Ecosystem, using existing infrastructure and analytics techniques to fast-track the process and reduce the time required to generate valuable insights from the data.

Using the principles set in place by a data lake platform built over several years, TGS can rapidly incorporate geoscience and supporting data to answer business-critical decisions relating to oil and gas exploration; and now also themes facing the energy transition. This reduces the time required to reach relevant data and increases the value of the insights derived from that data value passed on to decision-makers.

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