



Using GIS to Manage Precious Natural Resources

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By: [Amielle Lake](#), [Jim Farley](#)

Our world's most precious natural resources are in shorter supply than ever before. As such, geologists and software engineers are currently rethinking how geospatial technologies can lead to better asset management. The Oil & Gas sector has decided to focus on the management of coordinate reference system (CRS) metadata to augment the sector's ability to capture data related to the management and exploration of oil. Like many things geospatial, interoperability is playing a key role in these solutions.

[Galdos Systems, Inc.](#), [Shell International Exploration and Production](#), and the [International Association of Oil & Gas Producers](#) (OGP) have joined forces to harness the power of open location technologies to develop a geodetic registry — a Web registry of geodetic parameters consisting of CRS definitions and definitions of transformations between these CRSs.

Getting Coordinated

"Location, Location, Location" is the key to resource management as much as it is to real estate. Drill a pilot well in the wrong place, and you could be looking at tens of millions of dollars (USD) in investment with little or no chance to recover costs.



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Given its importance, how is location appropriately determined and recorded? How do we ensure that the diversity of measurements used in locating the drilling rig all make sense relative to one another? The answer lies in understanding and relating all of the different CRSs that are used to document position.

In the age of GPS, many believe that only latitude, longitude, and elevation are needed, and that it isn't necessary to give thought to how those numbers are obtained. In reality, however, these values are not unique; they depend on which CRS, or earth model, is used to calculate them. In addition to GPS (which relies on the World Geodetic System (WGS) 84), a large number of other CRSs are being used in many different countries and regions. The variety reflects historical, legal, and technical influences, as well as specific requirements for accuracy. Thousands of datasets have been created and are routinely maintained in formats and CRSs that reflect this diversity.

Now, consider drilling an exploration hole below the surface of the sea based on knowledge of the subsurface rock structures obtained from seismic data. The intent is to 'explore' for oil or gas deposit by drilling into a rock formation several kilometers below the seabed, which may itself be some 500 meters below the drilling rig. The location of the drilling rig is likely determined using GPS, but GPS relies on a ground-based reference station (for example, DGPS) to improve the accuracy of the position measurement. The location of the GPS antenna on board the rig must then be referenced to a point on the drill shaft at the height of the work floor of the rig. From there, the drill bit needs to be steered to its subsurface target. The entire well trajectory, or borehole, is ultimately determined relative to the surface position of the drilling rig.

The observations of well-logging equipment are also related to positions along the borehole.

Typical well logs report information on rock type, porosity, permeability, and fluid-bearing characteristics of the rock material as a function of distance along the borehole. For some purposes, knowledge of this information relative to the hole is sufficient, but if other wells exist nearby and are penetrating the same reservoir, the relative positions of those wells with respect to the seismic data is important. Understanding this information permits geologists to build a continuous model of the rock layers by integrating seismic and well data. The absolute positions of the wells, seismic data, and other relevant geoinformation are all paramount to accurate location determination.

Data Integration is Key

Most GIS systems and other geospatial software incorporate internal CRS definitions, which are wrapped in the actual GIS software code. In other words, it is a very tightly coupled system. The problem is, the reference system definitions themselves are largely based on proprietary data. As a result, there are often conflicts — and even errors — that arise when comparing one GIS database to another.

In June 1994, the European Petroleum Survey Group (EPSG), a professional communication forum composed of the survey departments of the major oil companies, published a list of CRSs that are used in the oil industry around the world in order to share standard CRS definitions and related information. This dataset is now offered in the form of a Microsoft Access database. In 2005, the EPSG was absorbed by OGP and now includes all major oil & gas companies worldwide. However, the dataset has retained 'EPSG' as its brand name.

Today, OGP is in the process of replacing the Microsoft Access database with an online dictionary of CRSs based on the Indicio Web registry supplied by Galdos Systems. This project is part of OGP's application to the International Standards Organization (ISO) to obtain ISO accreditation for the EPSG dataset. To address the requirements for this effort, Shell International Exploration and Production B.V (located in the Netherlands) worked with Galdos Systems' Professional Engineering Services department to develop a geodetic registry for both freely accessible and private geodetic parameters, based on the Galdos Indicio Web Registry Service (WRS).

The purpose of these efforts is to create single access points for public and private CRS definitions and related geodetic information. The public geodetic registry allows oil & gas companies and many other organizations to freely access useful CRS definitions. The private geodetic registry can provide companies such as Shell with a system to better manage their private data. Given the value of oil these days, it's not hard to imagine how important it is to ensure that such data be kept secure and accurate.

Galdos management and the fourteen international oil companies that actively support this project believe that an interoperable geodetic registry will help facilitate better decision making in the oil & gas industry. Perhaps this infrastructure will even make the difference between finding oil and sinking an expensive dry well.

The Role of Oasis eBRIM, OGC Catalogue Specification

The geodetic registry being deployed by Shell and the OGP is based on the Galdos Indicio WRS. The WRS is a new OGC specification — actually, it's a profile of the OGC Catalogue 2.0 specification that employs the OASIS ebRIM (eBusiness Registry Information Model). In this context, ebRIM provides the foundation model for capturing geodetic information.

This includes classification schemes or taxonomies, packages, and associations.

The INdicio Geodetic Registry is machine readable and writable over the Internet. Such functionality enables users to freely develop and maintain new CRS definitions and share them immediately with their counterparts worldwide. INdicio is sophisticated and provides high-level descriptions of each CRS, with details expressed in Geography Markup Language (GML). The end result is that the registry can deliver complete GML CRS definitions for any of the hundreds of CRSs used routinely in the oil & gas industry today. In turn, users are provided with robust search capabilities, wherein they are able to search by classification, identifiers, and other parameters.

A further strength of INdicio is its ability to capture and maintain relationships (associations) between the CRS definition and other information objects. For example, one can easily associate a CRS with a drilling project, a seismic exploration dataset, or the drilling project with the company that drilled the well. Managing associations in this manner enhances the value of the CRS definition and ensures greater certainty for any of the associated data items.

INdicio also supports a number of security features, including an audit trail and support for user/organization-defined security policies that determine who has what type of access to a given data record. This enables the INdicio registry to be securely managed over the Internet.

Degree of Certainty — Data Insurance

As we have noted, oil & gas exploration involves the integration of hundreds, even thousands, of pieces of data in a variety of CRSs. Each piece of data will, in part, be expressed using a coordinate or coordinates that link the data to some reference point or reference surface. Without that link, knowledge of the coordinate value(s) alone is more or less worthless. It's not very helpful for someone to know that your house is 5 kilometers from somewhere. Therefore, the certainty of the CRS used (including the correct parameter values) is directly connected to the value of the data. INdicio greatly enhances the certainty of what is stated about the data, and this 'data insurance' is itself a valuable asset in any oil & gas exploration activity.

More than Exploration

While we've discussed the CRS registry in the context of oil & gas exploration, CRSs are of equal importance to oil & gas transportation systems and to the management of the vast physical assets required for oil & gas exploration and development. As in exploration, these activities demand the integration of diverse types of geospatial information, including equipment location, land ownership, exploration tenures and leases, shipping regulations, and a wide variety of environmental data. Much like exploration, many CRSs are used, and the ability to correctly identify and use these systems is a critical part of data integration.

Future Developments

Sharing data is as important as creating and maintaining it. To enhance data sharing, it is often necessary to transform data from one coordinate system to another and to keep track of these transformations. Specifications for such transformation services are being developed at the OGC and the ISO. Integration with Web-accessible CRS registries is a natural next step. This will greatly ease the task of automated data integration.

Appropriate management of CRSs is important to any company competing in the natural resources market. While many organizations, like OGP, offer a public dataset for their member companies, at the same time, these very companies are creating their own independent private CRSs. Such localized proliferation can contribute to complexity across any industry. Today, there is a strong market requirement for Geodetic Registries to manage this complexity — not only for the Oil & Gas sectors but also for any organization attempting to better manage their assets in a location-dependent fashion.

In summary, accurate location is critical to natural resource companies. This depends not only on accurate measurements systems, but also on the degree of certainty that the measured coordinates are referenced or understood with respect to the right CRS. Errors can mean the difference between an oil find and a dry well.