Petroleum GIS Perspectives

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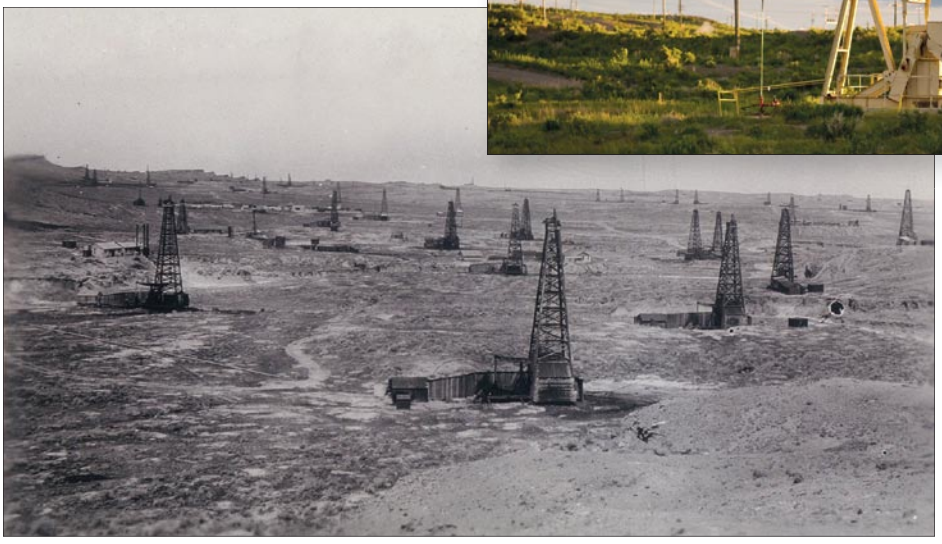
Anadarko's Oil Recovery Reuses CO_2

By Jessica Wyland, ESRI Writer

In This Issue

Carbon dioxide is not always a villain. It can actually be quite beneficial for companies like Houston-based Anadarko Petroleum Corporation, which is using the greenhouse gas for enhanced oil recovery (EOR), a process that involves injecting otherwise tapped-out wells with CO_2 to produce additional oil. CO_2 emissions that would normally be released into the atmosphere are captured, compressed, and purchased from a natural gas processing plant, then shipped via pipeline to oil fields. The CO_2 is recycled over the lifetime of these EOR projects to continue generating production from these fields.

CO_2 has breathed new life into Anadarko's Salt Creek field, a site 45 miles north of Casper, Wyoming, that invokes the kind of nostalgia associated with boomtown times in the United States. Oil was first struck at Salt Creek in the early 1900s and, at 9 miles by 5 miles, it is one of the largest oil fields in the Rocky Mountains. With more than 4,000 wells, the rich swatch of Wyoming ground has yielded about 655 million barrels of oil in its tenure. Production by conventional drilling has dwindled, but Anadarko hopes to draw at least another 150 million barrels of oil out of the field by injecting CO_2 into the ground. This pushes the oil toward predominantly previously drilled wells in the field that have been refurbished for production through EOR techniques. By using existing well bores, the company can increase production while minimizing surface disturbance.



The Salt Creek field was discovered north of Casper, Wyoming, in the early 1900s and celebrated its 100th year of production in 2008. Inset: For more than 40 years, the Salt Creek field has been producing oil through floodwater recovery technology that utilizes pumping units, or pump jacks, to pump oil out of the ground.

When Anadarko initiated its EOR program in 2003 at Salt Creek, the company built a 125-mile pipeline capable of transporting 250 cubic feet of CO_2 per day from Bairoil, Wyoming, to the Salt Creek field. Anadarko expects to sequester about 700 billion cubic feet of CO_2 over the lifetime of the Salt Creek project, reducing the state's overall CO_2 emissions.

"Our primary objective is to increase oil production from the field, which is extremely important at a time when our nation needs all forms of domestic energy resources—especially oil and natural gas, which will continue to make up the bulk of our energy supply for the foreseeable future," said Ken Michie, Anadarko's subsurface manager. "We are producing oil that's been trapped in a sandstone-type rock. As a benefit of our EOR operations, the Salt Creek field will be one of the largest CO_2 oil recovery and geologic sequestration projects of its kind in the world. We are currently using 125 million cubic feet of CO_2 per day that would otherwise be vented into the atmosphere—that's equivalent to eliminating the emissions of more than half a million cars per year."

Old Field, New Potential

While the concept of carbon sequestration for the sake of conservation is an emerging idea, the repurposing of CO_2 for enhanced oil recovery

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ESRI on the Road

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July 12–16, 2010
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www.esri.com/uc

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Alberta, Canada
www.internationalpipelineconference.com

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October 2–5, 2010
Keystone, Colorado, USA
http://seg2010.org

ESRI Electric and Gas User Group Conference
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Dearborn, Michigan, USA
www.esri.com/egugconference

GITA's GIS for Oil & Gas Conference
October 25–28, 2010
Houston, Texas, USA
http://gita.org/events/oil_gas/10/invite.asp

The Geological Society of America Annual Meeting
October 31–November 3, 2010
Denver, Colorado, USA
www.geosociety.org/meetings/2010

PETEX 2010
November 23–25, 2010
London, England
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ESRI Petroleum User Group Conference
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ESRI International User Conference Supports Petroleum and Energy

If you work in the energy industry, you should attend the ESRI International User Conference. This year, ESRI is hosting paper session tracks that target your specific challenges. Entire tracks are dedicated to GIS solutions for petroleum, electric and gas, climate change, and renewable energies.

ESRI technology experts will provide presentations and demonstrations that explain advances in analysis, cloud computing, and enterprise efficiency. Energy professionals will be available in the exhibit hall to chat with you about your specific needs.

Come join us and be inspired.
When: July 12–16, 2010
Where: San Diego Convention Center, San Diego, California, USA
Learn more and register at www.esri.com/uc.

Access to World's Geologic Data Improved with ArcGIS Server Technology

By Barbara Shields

OneGeology, a global initiative to improve the accessibility of geologic map data, will be increasing its capabilities by expanding the use of GIS technology from ESRI. The 116 nations that participate in the program will benefit from the latest ArcGIS Server Geoportal extension technology (formerly GIS Portal Toolkit) because more of their data will become available on the OneGeology geospatial portal.

OneGeology is a distributed Web service that uses national geologic data servers worldwide. The data is interoperable, and clients can easily access the data layers for free and pull them into their own projects. The program is a voluntary collaboration that is absolutely dependent on data and support from around the world.

Initiated in 2006 and launched in 2008, the OneGeology program is coordinated by the British Geological Survey (BGS), and the portal infrastructure is provided by the French Geological Survey (BRGM). Nearly every country in the world has a geologic survey, some of which are among the oldest scientific organizations in existence. Until recently, this vast amount of data has often been hard to manage, locate, and share. OneGeology now makes geologic data from across the globe available at a scale of 1:1 million, and in some countries, data at scales of 1:50,000 is becoming accessible.

Visit OneGeology at www.onegeology.com.

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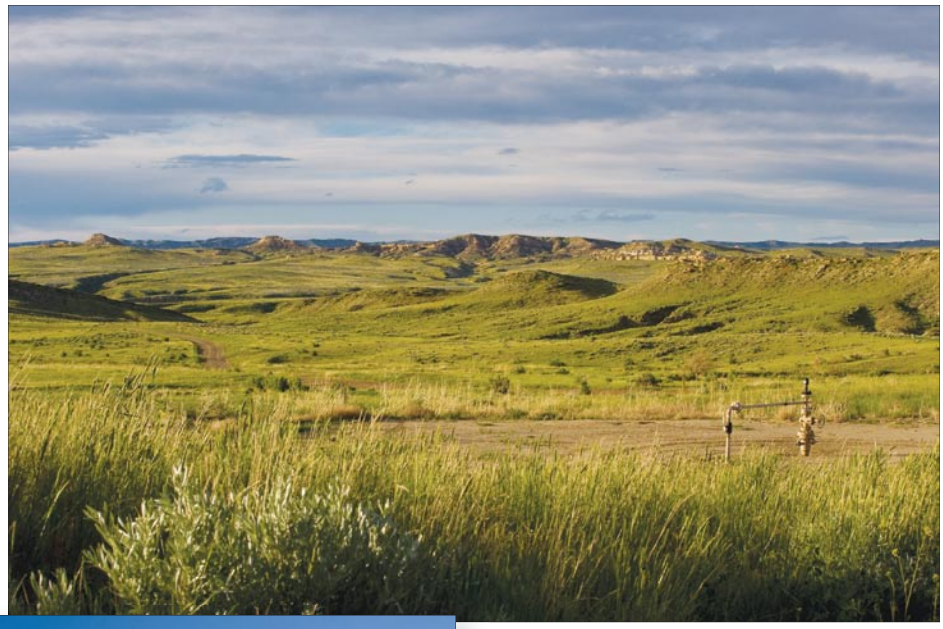
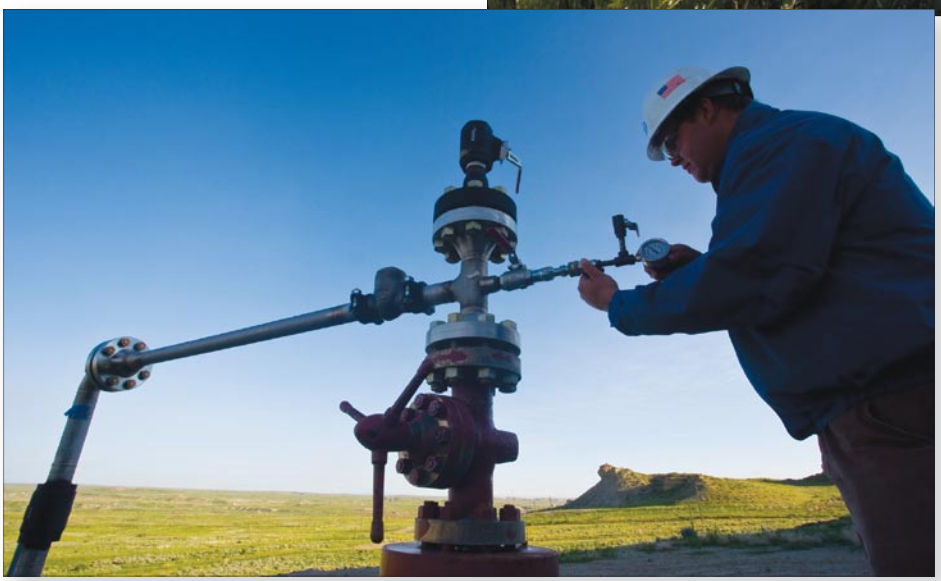
Anadarko's Oil Recovery Reuses CO_2

has been in practice by the oil and natural gas industry for 35 years. With the evolution of related science and technology, EOR has become an increasingly efficient, safe, and practical investment.

In the United States, there are more than 13,000 EOR wells and 3,500 miles of high-pressure CO_2 pipelines, according to a 2007 report by the American Petroleum Institute (API). The report estimates that, through EOR projects, 600 million tons of CO_2 have been injected into the ground to produce about 245,000 barrels of oil per day.





Low-rise wellheads replace pump jacks in the portions of the 100-year-old Salt Creek field, where Anadarko has implemented enhanced oil recovery technology that utilizes CO_2 to stimulate oil production. The CO_2 injected into the ground increases domestic oil production and prevents the greenhouse gas from being emitted into the atmosphere. As a benefit of these EOR operations, the Salt Creek field will be one of the largest CO_2 oil recovery and geologic-sequestration projects of its kind in the world.

The life cycle of a producing oil field, such as Salt Creek, includes several stages. Initially, oil flows naturally to the surface with existing reservoir pressure. As natural pressure drops, the reservoir is flooded with water to push out more oil. In the final stage, any remaining oil is recovered by CO_2 injection, miscible natural gas injection, or steam recovery.

"We expect CO_2 injection to keep Salt Creek Reservoir in oil production for at least 30 more years," Michie said.

The Technology Tool

Oil companies undertaking EOR projects look forward to considerable return after great investment. Required infrastructure includes natural gas treatment facilities for CO_2 capture, pipelines, compression equipment, transportation, distribution lines, flow lines, and wells for injection. The oil, natural gas, and pipeline industries manage infrastructure and operations as meticulously as possible by using geographic information system (GIS) technology. GIS links crucial data to physical locations. This gives operators an up-to-date picture for site and route planning, asset management, field crew deployment, and decision making.

"The ability to manage, correlate, predict, model, and share volumes of data in an interactive digital map makes GIS an essential analytic tool," said Robert Brook, pipeline and gas industry manager, ESRI.

Since 1969, ESRI has worked to advance GIS technology by developing a suite of GIS software for desktop, mobile, server, and Web applications. The California-based company has more than 1 billion users around the world, touching virtually every industry, from government and business to health and conservation.

Anadarko uses GIS from ESRI to track pipeline maintenance, view land reclamation, and keep up with revegetation of native grasses. By calling up layers on a GIS-based map, designers can look at wildlife habitat, protected species development, and archaeological sites.

"We use GIS to map every piece of infrastructure, from the flow lines and pipelines we use to move the CO_2 to our buildings and wells," Michie said. "These wells are so old, and the survey techniques have evolved so significantly, that a lot of the old locations didn't match. We've used GIS to remap those wells along with our pipes, so we know the exact locations of our pieces of infrastructure."

BP Azerbaijan Manages World-Class Pipeline with GIS

Currently celebrating its 100th year of operations, British Petroleum (BP) is one of the largest energy companies in the world, employing 92,000 people in more than 100 countries across six continents. BP's primary operations involve finding, extracting, and transporting oil and gas to create a variety of consumer products, such as gasoline and home heating oil.

One of those countries is Azerbaijan. Nestled east of Turkey, south of Georgia, north of Iran, and west of the landlocked Caspian Sea, Azerbaijan straddles the border between eastern Europe and Eurasia. Though it is a relatively small nation, its extensive and strategically located oil reserves led BP to quickly establish operations in Azerbaijan following the dissolution of the Soviet Union in the early 1990s.

With production levels at 3.8 million barrels of oil per day, BP Azerbaijan relies on pipelines and a fleet of tankers to transport the oil worldwide. Given its landlocked geography, BP Azerbaijan makes extensive use of pipelines and manages four of them, including the Baku-Tbilisi-Ceyhan (BTC) pipeline.

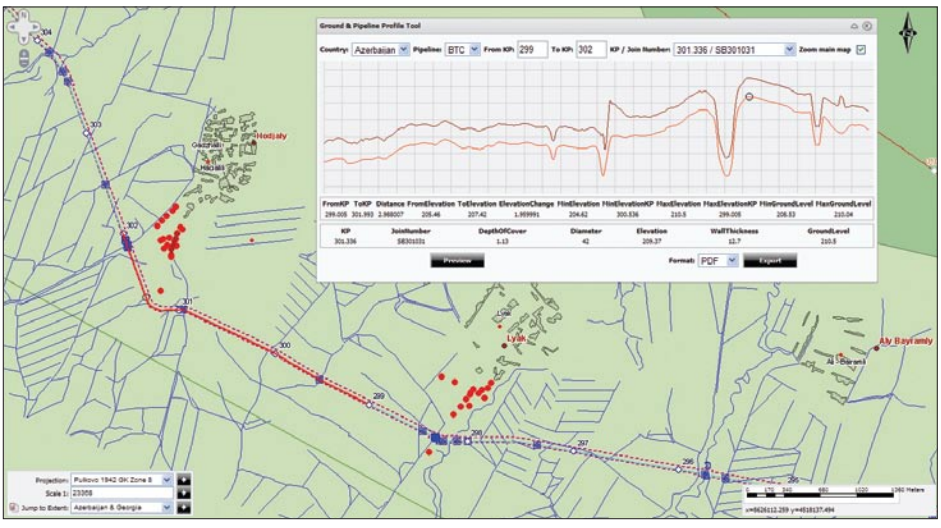
After years of route planning and construction to address political, geographic, and environmental considerations associated with opening the flow of Caspian region oil to western markets, the BTC pipeline began moving crude oil in 2005. Spanning 1,099 miles (1,768 km) of often challenging terrain—including several mountain ranges and 1,500 watercourses—the BTC pipeline is the second longest in the world. Bypassing the congested sea-lanes of the Bosphorus Strait, it transports over a million barrels of crude oil per day from a marine terminal near Azerbaijan's capital city of Baku, through Georgia, to the Mediterranean coast of Turkey, where it is transferred to tankers for shipping to Europe.

Historical Perspective

To help manage the complex planning and construction of the BTC pipeline, the GIS team of BP Azerbaijan used both an internal ArcGIS Desktop application and an external, Web-based ArcIMS application for sharing data with the engineers responsible for routing the pipeline. This publicly accessible Web mapping application also supported external agencies responsible for making complex and important decisions concerning land management, transportation, and environmental assessment.

"As the project progressed, we started identifying newer and more powerful uses for GIS," explains GIS team leader Emin Hamidov. For example, the GIS team used polygons on the pipeline's map to represent the progress of each of the nine steps involved in laying pipe: grading, trenching, pipe stringing, welding, nondestructive testing, joint coating, lowering, backfilling, and reinstatement. Working concurrently on different steps kept the work on schedule, but all effort had to be carefully balanced against sequencing constraints, like the safety standards that limited the length of trench that could be dug before the previous section was backfilled. By updating the polygons daily with the data coming in from the field, the team members were able to see the point to which each step had been completed. From this, they determined how to optimize progress and prevent equipment from sitting idle.

By the time oil started flowing through the pipeline in 2005, the GIS team members were already contemplating how to refocus their Web-based GIS efforts to meet changing stakeholder requirements. While the existing ArcIMS system was designed to manage pipeline planning and construction, the team's custom applications had never been intended to provide the functionality BP Azerbaijan needed for managing operations on an ongoing basis once pipeline construction had been completed.



Every weld in the 1,768-kilometer-long Baku-Tbilisi-Ceyhan pipeline is registered in BP Azerbaijan's GIS. The easiest way for a pipeline engineer to locate a weld is by using its x,y,z coordinates.

BP Azerbaijan operates four pipelines that transport crude oil from the Caspian Sea to the Mediterranean and Black seas. Pipeline engineers use satellite imagery to help monitor changes to the landscape over time.

Full-Powered GIS via the Web

For example, one feature the team was keen to introduce to the Web was a pipeline profile tool that would show the depth of ground cover along the full length of the pipeline. "If you need to do some excavation work, this is very important," explains Hamidov. "It's one thing to click on a point to see the data and quite another to look at the profile. You can very quickly see where the thin bits are."

Another feature Hamidov and his team desired was a swipe tool that could be used to slide a layer aside. "Every year we order satellite imagery. The swipe tool is a hands-on tool for the engineers that helps identify changes. You can swipe one image on top of another and quickly pick up the changes in a particular area," he says.

Rather than reengineer BP Azerbaijan's existing ArcIMS Web GIS application, it appeared sensible to leverage ESRI's new ArcGIS Server technology to meet its next-generation requirements; ArcIMS had been an excellent mapping engine, but ArcGIS Server provides access to the full power of ESRI GIS via the Web.

A core aspect of BP Azerbaijan's strategy for the future was to minimize custom code while ensuring a solution that would evolve over time with core ESRI technology. The GIS team also believed that an off-the-shelf solution used in conjunction with ArcGIS Server was key to ensuring the new system's extensibility and longevity in a way that no custom solution could. The search for solutions that provided additional out-of-the-box functionality for ArcGIS Server led the team to Geocortex Essentials, an add-on product developed by ESRI partner Latitude Geographics Group Ltd. of Victoria, British Columbia, Canada, to deliver extensive features and development options for ArcGIS Server.

Although Geocortex Essentials offered much of the required functionality out of the box, BP Azerbaijan sought a number of supplemental features to be incorporated into the core product. This shifted the long-term responsibility for maintaining such features to Latitude Geographics and prevented the support challenges BP Azerbaijan had faced with custom-coded features built for its previous system. "By the time the project was complete," observes Hamidov, "we had about 95 percent of the functions we required through core Geocortex Essentials. This was very important to us."

Seven new applications powered by ArcGIS Server, deployed by BP Azerbaijan, provide secure, targeted user access to hundreds of data layers that assist informed decision making. In addition to Web-based pipeline profiling tools and layer swipe tools that provide enhanced visualization, the applications also offer custom map reference grids for large-format, template-based printing; reprojection of map data according to custom projections; uploadable and linked images to the map; and the performance of specialized coordinate-based map requests. Taken together, such features have extended BP Azerbaijan's ability to couple the power of GIS with everyday workflows for nonspecialist users.

To support the ArcGIS Server implementation, the GIS team also uses Geocortex Optimizer, another add-on product developed by Latitude Geographics, designed to track site usage, improve application usability, and support the creation of monthly management reports to empirically demonstrate system-wide return on investment.

With the production system well received by users, BP Azerbaijan project manager Govsiya Maniyeva notes, "The outcome of this project has been a system that provides not only what BP Azerbaijan needs now but also the technology foundation to meet the long-term requirements of our organization."

More Information

For more information, contact Govsiya Maniyeva, project manager, BP Azerbaijan (e-mail: maniyegr@bp.com), or Tom Kasmer, project manager, Latitude Geographics (tkasmer@latitudegeo.com).

Complis—Just Ask for the Required Information

by Boris Kowalewski, viasecure Deutschland GmbH

For most companies, a typical process for data management is to collect and record data day by day in different spreadsheets, databases, applications, technical drawings, and overview plans.

Without a digital system for organizing information, companies typically lose data when they make corporate changes. They may lose relevant knowledge and vital information stored in analog formats and even as CAD drawings.

Companies manage lots of data and information including work or processes. Frequently, required information is stored only in the heads of employees who know, for instance, that by combining data in a certain spreadsheet with a CAD plan, you can get the information you need. In reality, this information is not in the hands of the company. Another problem is that isolated databases and inconsistent data quality make an information system inefficient. Efficient information systems are integral to driving business intelligence. Another key component of a successful system is the means to address the where factor. Most information is attached to location—geography.

The complis solutions manage business processes and provide the flow of information in the context of industrial plants. The heart of this solution is a modern GIS based on ESRI technology. In contrast to CAD systems used for drawing technical plans, GIS technology provides a central data model for all types of data. The complis solutions manage spatial as well as intelligent datasets. One decisive advantage is that users can combine spatial data directly with any other data; include it in analyses; and use automated tools to access, view, and process information.

The second important element of complis solutions is an integration engine, which integrates existing databases or applications. This is useful for building a comprehensive, efficient, company-wide plant information and management system.

The success of a software system depends on its usability by different kinds of users. Built on modern Web technology, complis solutions are easy to handle and can be used anywhere a computer with a Web browser is available.

The system can be extended quickly and easily. New operations and complex GIS models can be generated on the desktop system and released to the server. The Web services of other providers can also be incorporated into the system.

Just ask complis if you need information, from simple queries to complex analyses. The complis solutions are distributed by Swiss-based complete plant solutions GmbH. Learn more at www.cp-solutions.ch.

SynerGIS Informationssysteme

By Gernot Tutsch, SynerGIS

SynerGIS Information Systems GmbH was founded in 1973. It has been the ESRI distributor for Austria since 1987 and for the Slovak Republic since 1993.

In early 1992, SynerGIS started the development of generic GIS solutions based on ESRI's leading GIS technology for specific markets such as the municipality market in Austria. Over the years, it moved its application framework to ArcGIS and enhanced the product portfolio with desktop and server solutions for different markets.

With SynerGIS WebOffice, the company introduced a Web-based information system platform for integrating other IT enterprise systems in a geographic approach. SynerGIS WebOffice is built on ESRI ArcGIS Server technology, bringing the power of the desktop to the Web while keeping the interfaces easy to use. SynerGIS WebOffice is used in approximately 250 customer server installations. Existing integrations with SAP, different electronic document management systems (EDMSs), GEONIS Server from GEOCOM, and arbitrary customer databases are showing the power of this solution.

SynerGIS GeoOffice is the desktop application that enhances ArcGIS Desktop with user-friendly, streamlined functionality for land management, urban planning, and infrastructure management. It also provides enhanced plotting and powerful dimensioning capabilities. SynerGIS GeoOffice is used by more than 2,000 customers.

SynerGIS ePaper is intelligent reporting technology for creating combined reports including maps and arbitrary data from other databases as well as content such as images.

In addition to its standard application development, SynerGIS also has a long history of custom project implementations. Together with its customers, it has realized successful projects in many areas including electricity and gas network companies and the petroleum business. Within the petroleum business, OMV Aktiengesellschaft and Petrom are two satisfied customers that are using SynerGIS solutions in many areas. SynerGIS' main focus is providing actual planning and decision information to many users and seamlessly integrating applications such as EDMS and land management applications.

Today, SynerGIS is developing as a European company with subsidiaries in the Slovak Republic (ArcGeo) and Romania (SynerGIS S&F) as well as affiliates in Germany (AED-SynerGIS) and Switzerland (CPS). Learn more about SynerGIS Informationssysteme at www.mysynergis.com. Contact Gernot Tutsch at g.tutsch@mysynergis.com.

GIS Integration and Interoperability for Upstream Energy

Brian Boulmay, Business Partner Director, OpenSpirit Corporation

The energy industry is spatial by nature—where to explore, what target to hit, where to drill, how to get the raw materials to refining, how to get the refined materials to market, and where the market is. It is all decided by location. And now that the experts say the easy oil is gone, finding accurate locations is more critical than ever, and the environments in which petroleum companies operate are exponentially more complex. Companies are drilling deeper wells with smaller targets and in more challenging areas than ever imagined. All of this requires leveraging information from more sources, across diverse technologies and in a variety of formats, using innovative ways to decipher that information.

OpenSpirit provides the integration framework that enables you to navigate these multiple platforms, different languages, complex data types, and diverse coordinates and units over a variety of vendor solutions. OpenSpirit enables integration and interoperability across your upstream workflow. Leveraging the robust mapping ability and powerful analytics of ESRI GIS is a key part of this integration.

If you are doing regional exploration and want to see all your wells and seismic data on the map, a live link to this information is provided via the OpenSpirit ArcGIS extensions. Perhaps you are modeling or creating an interpretation in the subsurface tool of your choice and need to see surface features from your enterprise GIS for spatial context. OpenSpirit enables this with its SDE Data Connector. If you are responsible for managing the corporate data assets and making this data available to end users, ArcGIS Server and OpenSpirit Web Server enable you to serve the data and let end users load well, seismic, and interpretation data right from a browser to the geological and geophysical (G&G) desktop. If you are the exploration manager needing a simple browser tool to review your portfolio, OpenSpirit's free add-in for ArcGIS Explorer (build 1200) provides this capability with just one click of the mouse. All these workflows are possible, leveraging a single OpenSpirit infrastructure that is fully integrated with ESRI's server and desktop technologies.

Looking forward to the digital intelligent oil field, or smart oil field of the future—whatever name your company uses for the next generation of oil fields—integration of the subsurface and surface will become even more powerful. E&P companies must bring together subsurface, surface, and operational data (such as SCADA, LIMS, production, and historian systems) to complete this complex picture for making decisions. OpenSpirit, working with partners such as ESRI, provides powerful capabilities and enables critical workflows to ensure your business is using the right data at the right time for making quality decisions, right from the start.

For more information, visit www.openspirit.com.

PetrisWINDS Enterprise, PetrisWINDS OneTouch, ESRI ArcGIS Server, and Microsoft FAST: A Single Source of Information

By Jeff Pferd and Abhijeet Narvekar, Petris Technology, Inc.

Data within the energy industry is most often associated with a specific geographic location, requiring search results to be associated with geographic coordinates.

Petris has taken steps to include both structured and unstructured data records in map- and attribute-based searches. The structured data typically has geodetic references. The problem of map-based integration with that data is ensuring that the map positioning is based on the same coordinate reference system (CRS). This may require complex coordinate transformations and knowledge of the CRS and datum utilized in each data store.

You may be able to reference a well name or a platform to a specific locale, but where do you place a document or picture that is referred to as being "from Texas" or "in Canada"? These are real geographic boundaries and are polygons on maps. The document reference is best associated with the geopolitical polygon. Then, map search logic can combine point, line, and polygon logic of the registered items in the unstructured data store. Once these geographic integration challenges are met, a federated search enables companies to be more confident that all relevant sources of data can be found.

The PetrisWINDS Enterprise framework and Microsoft FAST are integrated with ESRI's ArcGIS Server. This enables map searching of data and produces a list of data records and documents. Likewise, an attribute search results set can be displayed on a map. The indexed data items are displayed against backgrounds of other GIS data stored as shapefiles, personal geodatabases, or ArcSDE feature classes by using ESRI's ArcGIS API for Microsoft Silverlight. Data items include both physical and cultural features, such as rivers, roads, and political boundaries, as well as a company's other GIS registered assets. ArcGIS Server provides rich map displays of these integrated datasets. A geodetic conversion service built using Blue Marble technology handles standardization of PetrisWINDS Enterprise Catalog data for map display. The unique combination of PetrisWINDS OneTouch, PetrisWINDS Enterprise, and Microsoft FAST, in conjunction with GIS tools, enables a company to realize material benefits through the information available.

Learn more about Petris at www.petris.com.

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