

E&P GIS: Integrating E&P Data and Applications

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Abstract

E&P, Saudi Aramco has used GIS to integrate exploration and producing (E&P) spatial and tabular information and its E&P users have applied appropriate geographic analysis tools to thoroughly analyze potential for petroleum at a location. Because data integration is one of the most powerful functions of GIS, the E&P GIS applications are much more than geographic data visualization and analysis applications. They are strongly integrated with many of the E&P databases and applications. A user can, for example, select wells on a map, and access extended attributes from a wide array of tables in the well database and simultaneously display its log and launch applications to display well cross-section information. The petroleum and facility engineers, geologists and geophysicists can now combine many pieces of information, including well profiles, surface topography, subsurface maps and other physical features, that allow them to test multiple design and selection scenarios easily and efficiently. This paper will demonstrate some of the techniques of how the E&P GIS systems have been integrated with the E&P data and its applications to optimize efficiencies and increase user productivity while continuing to discover new ways of benefitting from GIS technology.

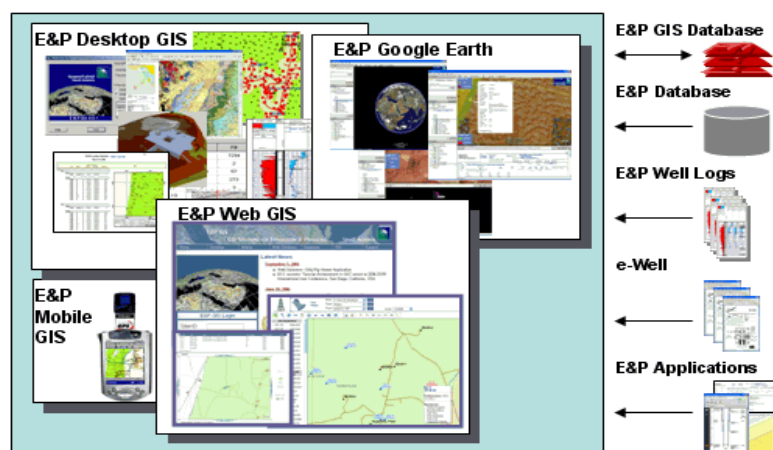
Introduction

This paper will start with an introduction to the E&P Geographic Information System (GIS) applications that integrates and represents many E&P data types in a single map view. Following the overview of E&P GIS, the paper will focus on the solutions that integrate E&P data and applications that optimize efficiencies and increase productivity for engineers to thoroughly analyze potential for petroleum at a location. The paper concludes by summarizing the effectiveness of GIS in providing an integrated environment for engineers and the GIS systems integration into the E&P workflow.

Saudi Aramco E&P GIS Systems

Saudi Aramco's E&P portfolio contains a multitude of spatial data on potential hydrocarbon accumulations. It also contains data on reserves, well locations, seismic surveys, satellite and aerial imagery, surface topography and existing infrastructure information. Major challenges in managing such a portfolio are that of ensuring data is kept up-to-date in a secure environment, a consistent evaluation with a clear audit trail is applied throughout and the data is available for integration with E&P business risk planning engines.

The GIS tools developed by the EXPEC Computer Center (ECC) of Saudi Aramco, using the ArcGIS software, support the E&P workflow from data acquisition to identification of leads that can be matured into drill ready prospects and onto facility planners that need to tie-in new well locations to existing gathering system facilities. Because data integration is one of the most powerful functions of GIS, the E&P GIS systems are much more than a geographic data visualization and analysis tool. They are strongly integrated with many of the E&P databases and applications. A user can, for example, select wells on a map, and access extended attributes from a wide array of tables in the well database and simultaneously display its log and launch applications to display well cross-section information. The petroleum and facility engineers, geologists and geophysicists can now combine many pieces of information, including well profiles, surface topography, subsurface maps and other physical features, that allow them to test multiple design and selection scenarios easily and efficiently.

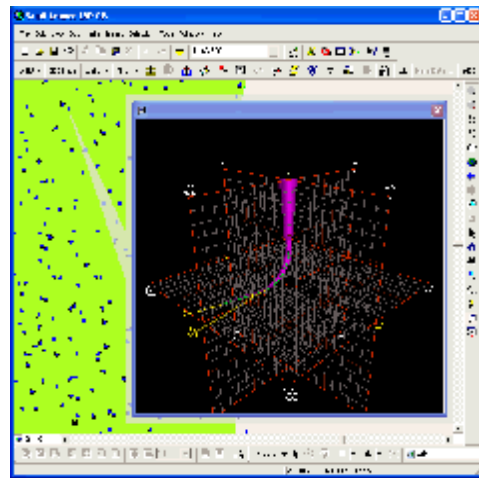


E&P Data Integration Solutions

Well Data Integration

3D Well View

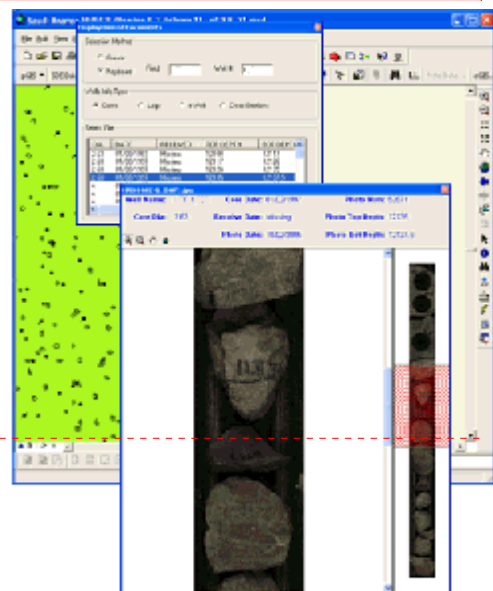
The 3D Well View hot-link tool to the E&P GIS well locations on the map provides a 3D perspective of the annotated wellbore trajectories, casing, tubing and perforation information and is surrounded by a 3D X/Y/Z distance grid for easy viewing and navigation. The 3D well perspective are created from tables in the E&P well database and are stored as X3D (VRML) files, one for each well. The X3D files are viewable by a browser plug-in and provide many viewpoints to help the user navigate to a programmed 3D scene. Additional tools help the user view the scene in stereo or as a wireframe.



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Core View

The Core View is a custom viewer that enables engineers to view and analyze core photographs that are stored in a Documentum repository and are tied to the well core descriptions stored in the E&P well database. The core description associated with each well/core-photo provides metadata information, i.e., core diameter, top-depth, bottom-depth, photo-date, etc. The core photograph is a raster image of a core along depths that are marked on the photograph. The custom viewer provides metadata information about the core and includes an overview window that allows for easy navigation for viewing the core from top to bottom in fine detail.

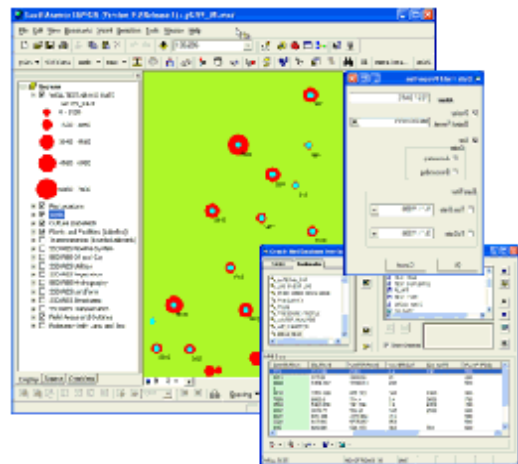
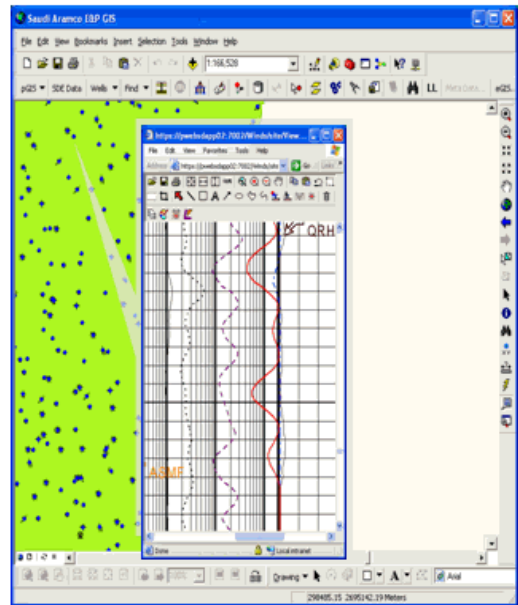


Well Logs

The Well Logs interface to the E&P GIS Well locations, displays raw and processed log images in either TIFF or CGM format. A well log data management system manages both raw and processed logs in a PetrisWinds Catalog. The geoscientific and geotechnical staff can use the map and attribute based search capabilities of E&P GIS to find appropriately located well logs with those characteristics of interest. The logs of interest are then retrieved and viewed in a CGM/TIFF browser based plug-in viewer that has redlining (markup), image rotation, EMF export, and other advanced visualization and analysis capabilities.

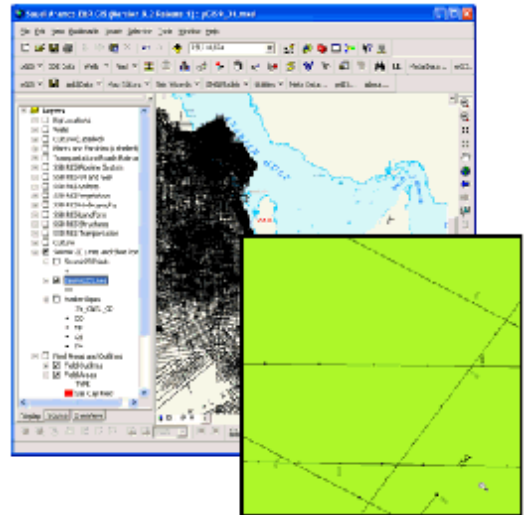
E&P Well Database

An interactive, custom, intelligent interface allows a user to define what information they would like retrieved from the E&P Well database tables for wells selected on a map. Constraints can be imposed on the relational database to provide a basis for any analysis that is to be completed in a spatial context. The constraints are designed with a syntax very similar to the natural language of the relational database, i.e., SQL, and the interface has been developed to be intuitive as possible. The retrieved data can be exported to Excel or text file format for further analysis or displayed next to the well locations on the map. In addition, one or more columns for the retrieved data can be used to create custom maps that represent quantity, with proportional symbols, when well data — retrieved from the relational database — are used as measurement values, e.g., bubble maps.



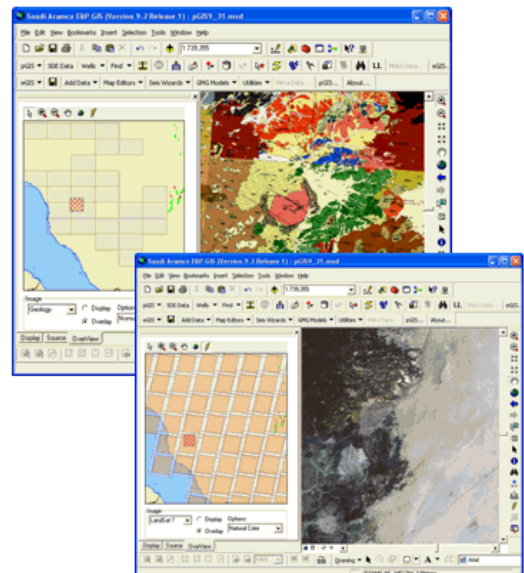
Seismic Lines/Shot-Point Mapping

The Seismic Lines and shot points are created from the E&P relational database from x,y coordinate fields and seismic line number fields. The seismic number field is used to identify the shot points belonging to a specific seismic line. The shot points GIS data contains a rotation angle field, the values of which are computed by the route event feature method in the ArcGIS software API. This software uses seismic lines as routes and shot points as point event on the seismic line. The route event API provides a function to calculate angle values perpendicular to the route event, i.e., seismic line GIS data. Hence the rotation angle field is used while displaying the labels at perpendicular to the seismic lines.



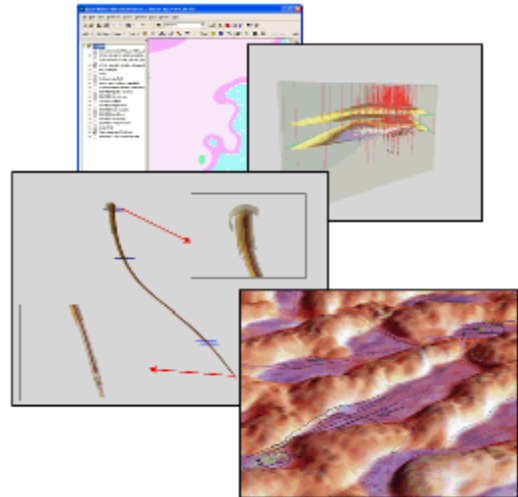
Geologic Maps & Satellite Imagery

The custom overview window of E&P GIS can display and overlay for analysis geo-referenced geologic maps and satellite imagery residing in the E&P GIS database. An index grid for the raster data shows the footprints available for display and analysis. The interactive hot-link tool allows a user to select a particular footprint and display it in a custom map viewer along with its metadata. The option to overlay the selected image on the main map window can then be used to merge the vector data for integrated analysis. Because we can only display and view satellite images using the three visible primary colors, any three of the available bands can be combined to highlight the particular features of interest.



3D GIS

The 3D GIS tools of E&P GIS enable engineers to visualize 3D wellbore trajectories and reservoir structure maps in a custom 3D viewer from data retrieved from the E&P relational database. The programs enable them to identify relationships that are difficult to envisage in a 2D mapping environment and contain analysis tools. These tools have a wellbore collision feature that shows how close wellbores are to each other so that wellbore collisions can be avoided. Facility planning tools allows engineers to first process surface contour data as a DEM (digital elevation model), overlay existing Saudi Aramco infrastructure data (pipelines, buildings, road-network, power lines, etc.) and perform 3D spatial analysis to compute new well site locations, rig-roads, and pipeline route features.



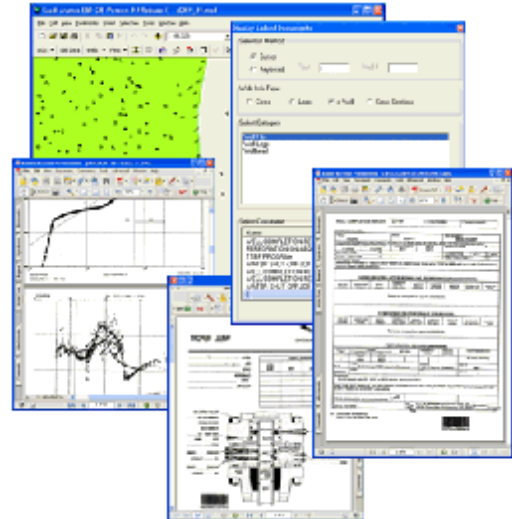
Offshore Data Integration

Offshore data was integrated with an E&P desktop GIS application that is used by drilling and workover in response to emergency situations on oil platforms, rigs and Saudi Aramco vessel locations. Saudi Aramco fire fighting vessels, security vessels, and oil pollution response vessels are tracked on the E&P GIS map display from the real time AIS (Automated Identification System) data transmitted by the vessels and stored in the corporate Marine database. In the case of an emergency, additional information on a platform and associated infrastructure connected to the platform, e.g. pipelines, is made available through easy-to-use GIS hot-link tools to the offshore data center Web site. This Web site provides detail schematics, photos, lifting gear, pipeline connection, control valve, deck elevation and additional E&P infrastructure data. This information is vital to the fire fighting crew and logistic staff that must respond to an emergency at the selected platform/rig location.



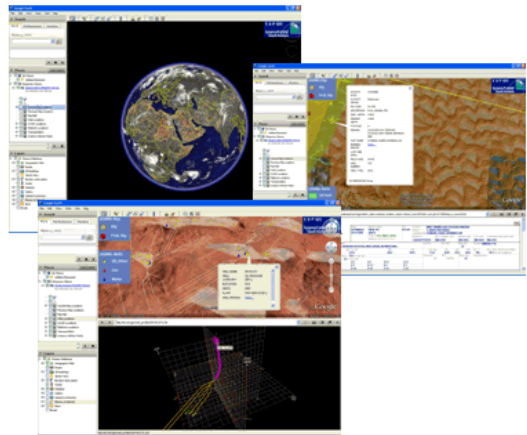
e-Well Information

A custom E&P GIS interface provides access to documents related to wells selected on a map. The business critical information for well documents, i.e., well completion, well header, build-up test results, etc., have been scanned, stored and indexed in a e-Well documentum database. The in-house developed e-Well application provides online access to all available well related reports & images. By integrating e-Well with E&P GIS, engineers are able to get to all the stored documents by either selecting a well on a map or by well name attribute query. The user credentials, the field code and the well number are passed to the application to get a list of all folders and documents that relate to the selected well. The selected documents are then retrieved and viewed using the default windows application viewer.



E&P Data Integration for Google Earth

The Google Earth (GE) Keyhole Markup Language (KML) was used to develop add-on downloads of E&P data that paints layers of well, rig, plant and field information over the GE globe. The add-ons include access to latest Saudi Aramco rig location information that is updated every hour through a GE network link place holder. Other add-ons provide access to current well and associated plant locations on GE. All layers have appropriate style templates applied to them so that GE users can distinguish between rigs that may have problems and well locations, which are distinguishable by oil, gas and water well type values. The hyperlink codes in the description field of rig and well placeholders in GE can link to the SADK morning report system and 3D-based well trajectory information, viewable in browser plug-ins, dock-able inside GE or that can be launched outside in a separate browser window.



Conclusions

The concept of data and application integration for GIS goes beyond previous IT systems. By combining data in one database with maps, photographs, and documents in other disparate databases and linking them to the other business applications, we get a synergy tool (GIS) that allows us to visualize, analyze, manage, and integrate data and systems across the organization's information highway.

By integrating Saudi Aramco E&P GIS applications with E&P data and applications, the analysis and decision making processes for E&P users is now much easier and more convenient, since all the required data and documents related to a study area can be accessed through a single unified view and environment. The cooperation between the different disciplines in E&P has ensured the tailoring and adoption of the E&P GIS applications to meet the demanding business objectives of the E&P workflow. Increasingly, end-users continue to discover new ways to benefit from this technology when one removes the complexity for data access and application integration.

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