APPLICATION OF GIS TO OIL AND GAS EXPLORATION

Introduction

Legal and Regulatory basis

Purpose of GIS application to Evidence of Reserves was to fulfill the legal requirement to submit an official declaration covering the status of reserves under exploration by the 31st of December of the current year. Since it represents a fundamental document describing the status of gas and oil reserves under exploration and includes the total research area, submittal of such a document all requirements of legal and regulatory origin are fulfilled.\(^{12}\)\(^{45}\)

Enclosures to Evidence of Reserves

In order to assist the Ministry of Economy in their preparation of the Balance of Status of mineral raw material reserves in Republic of Croatia as of the 31st of December of the previous year, the Research Department of INA d.d., Zagreb, is committed to complete the Evidence on gas, condensate and natural gas reserves under exploration in the area of active research and to submit appropriate forms containing the collected results, including the following: General data on the Company; Research area presentation, displaying the locations under exploration, as shown on the Reserves categorization overview map; Evidence of total probable oil and gas reserves in place, under exploration; Evidence of total possible oil and gas reserves in place, under exploration; Evidence of total possible oil

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\(^{1}\)The Law on Mining, Narodne novine 35195
\(^{2}\)Regulation on Oil, Condensate and Natural Gas Reserves Classification and Categorization and on their evidence keeping
\(^{3}\)Intern documents
\(^{4}\)Narodne novine 48/92
\(^{s}\)Regulation IV, on mining maps and drawings
and gas reserves in place, resulting from the research process and presenting the recently estimated total reserves of oil and gas, and Total oil and gas reserves cancelled/abandoned the previous year.

The complex base of data along with their cartographic support has been developed, not only to cover the above legal and regulatory requirements, but also to significantly influence the perception and management of oil and gas exploration.

Future development of this program would involve handling and monitoring of the following activities: geophysical survey, exploratory and development drilling as well as preparation for issue of exploration and production permits.

Preliminary records and their handling

While developing this GI system, we are closely observing the whole series of events in progress. The first Evidence on Reserves has been issued for the exploration of Pannonian area and of the area in Adriatic Sea as by the 31st of December 1980. It contained the total of elaborated locations in this regions since the year 1973, but several later annual status reports presented also the newly estimated reserves and those remaining after cancellation and/or following the poor results obtained during well testing, by reinterpretation, or gathered from other documents, such as revisions and similar papers. Along with storage of original documents, the tabular and cartographic recording of particular states has been carried out.

The first mechanical version of the tabulated section of the Evidence (status as per December 31st, 1986) has been prepared on the electronic computer machine Univac 1100/72 equipped with the application package Mapper 1100. The electronic base of alphanumeric data has been formed along with a supporting program for preparation of reports, interconnected with the personal computer containing the Lotus application package. The first mechanical version of cartographic presentation of the Evidence has been made with ARC/INFO GIS technology, for the status as per December 31st, 1989 and December 31st, 1990. The ARGIS technology has been used for edition of records dated December 31st, 1993, and December 31st, 1994. In course of 1997 a software has been incorporated into the server computer (IBM AIX BAZA DBO.WORLD) and into the user computer (PC-MS Windows NT 4.0) along with the operating version of the application named "Evidence..." with input and reporting routines handling the data organised alphanumerically and geographically in an ORACLE data base. The ORACLE 7 database, along with utilisation of the SD option and of the incorporated Intergraph Geomedia explorer permit the spatial overview/presentation of geographically organised data.

A new approach

It is important to note that owing to the SD-option all data (alphanumerical + geometrical) are situated in the same ORACLE base. This enables establishment of the client – server organization, which resulted in alteration of the concept regarding approach and general acceptance of GIS as an advanced technology.

On the user/client side the alphanumerical data are downloaded and handled by means of ORACLE forms (Developer 2000), while geometrical data are inserted by means of the Geomedia 2.0 explorer.
Storage of all alphanumerical data within a single and unified data base has an advantage in their two-directional updating, meaning that any modification of alphanumerical data becomes immediately evident also in the graphic presentation of the modified attribute and vice versa.

<table>
<thead>
<tr>
<th>Relational Base</th>
<th>User's Tools</th>
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<tbody>
<tr>
<td>Of alphanumerical &amp; geometrical data</td>
<td>Geomedia</td>
</tr>
<tr>
<td>ORACLE RDMS + SDO</td>
<td>ArcView</td>
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<td>Smallworld View...</td>
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<td>Developer 2000</td>
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Figure 1. Basis for creation of an open GI system in a client-server environment

The new technological platform corresponds to commitment of INA-Naftaplin as a corporation, regarding the field of applied information technology and it’s further development towards complete standardisation. As to the above-described application, it is in full concordance with the concept of the Company’s development, aiming to become a large basis of an integrated and open informational system.

The above-mentioned client-server organisation in present application enables an accessibility of the data not only for the employees responsible for preparation of said records, but also for the users from other Company’s departments. Recently, the client side uses the above-mentioned tools, but this kind of data organisation makes the access to those data possible via different tools or directories (per example ArcView, Smallworld View etc.).

Therefore, we are discussing today an open system incorporating all the advantages that come along with a client-server organisation.

This new GIS approach comes significantly closer to the final user, it is no longer intended only for the GIS experts but instead, owing to easy utilisation of this application situated in a familiar MS Windows environment and to appreciably decreased cost, it is now accessible to a large number of clients. As a result of this new approach, the experts from INA’s Research Department are for the first time in position to prepare full reports for the Balance sheet independently, without any assistance from GIS experts.

Informational Structure and Other Possibilities

Records, and in particular the cartographic overviews contain, along with the data required by the legislation, many additional information useful for the research process. These information and their input/output forms are summarised below: Total probable and possible reserves in place, actualised to the date of Evidence contain, along with the note on their category, also some additional information useful for their further classification per their basic exploratory locations. For the Pannonian exploration area the sub-area are shown separately, according to their former geographical designations: the river Muir valley,
Hrvatsko zagorje, the river Drave valley, the Požega basin, the river Sava valley and Srijem – Slavonian valley along with exploration area of Adriatic Sea and Dinarides. Owing to the system potentials, the spacial classification per other bases of information, such as Exploratory permits, has been solved completely.

The tables contain also a whole series of additional information, such as:
Allocation of the basic separated unit - the pay zone, to the field, to a lieu or to a drillable prospect, along with the original name of the pay zone, is it separated into blocks or some smaller sections, the reservoirs of isolated pay zones in geological/lithostratigraphic vertical, as defined by the local formations and by the members that have been conditionally placed on the same level, in the year 1986 as required by the system, with the relevant natural reservoirs (plays) for the mature Exploration area Pannonia.
For the ease of access and browsing, the total reserves are completed with the type of fluid, depth of hydrocarbons/water contact, their status as per Evidence, their designation, date and name of the assessor.

![Image](image.png)

**Figure 2.** Data input and reservoir overview form

The overview charts of Pannonian area (M 1:100,000), and of Adriatic Sea and Dinarides (M 1:200,000) contain, along with description of category and of the natural reservoir, also the character of reservoir screening/display (tectonic, lithologic ...).
As to the auxiliary elements of the Evidence, it is worth noting that the operating documentation of the database contains diverse information regarding conditionally recoverable and by its major part also singular and complex geological probabilities related to a specific reservoir.

Along with principal database, analytical purposes require close monitoring of the data connected with exploration regions, geologic and geophysical surveys and drilling operations.

Exploratory procedure evidences as feedback information the data on recoverable reservoirs, production fields, gas and oil pipelines (the upstream information). Database includes also, along with general geological features, diverse information covering the hydrographic properties, road traffic routes, populated area and geopolitical boundaries. The above data fulfil not only the present, but moreover some of the future regulatory requirements (e.g. information per concession blocks, exploratory and production permits etc.), simultaneously supplying our Company with important project and analytical values.
Feedback information handling oil and gas development and producing reservoirs have been significantly enhanced for editing purposes during preparation of Pannonian area Evidence of reserves (December 31, 1997). Out of 52 fields included into Evidence, the recent Evidence has an updated reservoir geometry and categorisation per regional reservoirs/plays for 19 most important and complex formations. Simplified summarised outlines of all represented fields have been drawn for the edition of Evidence.

Conclusion

An annual report preparation task resulted in development of a system of much greater range and possibilities, allowing therewith an access to important data to a larger number of interested users and clients.

Utilisation of above mentioned information technology standards established a scheme permitting interactive approach to a system of fully integrated alphanumeric and graphical data. Further development of this system within our Company should be marked by a serious approach in order to clearly define the rights and obligations, i.e. the authorisation granted to utilise all future data.

The described platform represents an important step in bringing the GI system technology a little closer to the final user and making it more open as a whole. Data are accessible by diverse tools to the users at different levels of decision making.

Acknowledgements

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Summary

One of the most demanding tasks in oil and gas exploration today is handling and presentation of numerous and various, but geographically defined data. In that respect, the use of GIS platform is important. Here, we have used an Oracle RDBMS on server side, with Intergraph Geomedia viewer on user side, to cover the requirements related to exploration and discovery of new subsurface energy sources.

This paper demonstrates the use of GIS, integrated with surface and subsurface geological data. This platform was used for geological analysis and covered a wide range of issues, such as Exploration and Production Permits, Geological and Geophysical Surveys, Weil Production and Feedback Data as well as Production and Upstream Data gathered in the Oil and Gas Industry. This approach enables qualitative interpretation of the whole research area, providing an optimal way to locate additional sources of energy and raw material.