Interactive visualization of well data for supporting geological reservoir modelling

Oscar Paesi da Silva*, Carla M. D. S. Freitas†, Mara Abel‡
Instituto de Informática - UFRGS
oscar.paesi@inf.ufrgs.br*, carla@inf.ufrgs.br†, marabel@inf.ufrgs.br‡,

***Abstract*—Understanding the geology of reservoirs of natural resources is crucial for evaluating the potential of prospect regions and accurately estimate the production capacity of those in the production phase. Geoscientists face the challenge of analysing vast amounts of data and interpreting them to create realistic models of the earth. In this work we propose a visualization environment based on a context view for several formats of well data, that facilitates the identification of features of interest and provide access to specialized views for detailed analysis and correlation of these features.**

***Keywords*-Information visualization; geological data visualization; reservoir visualization;**

I. Introduction

Creating realistic models of geological reservoirs is fundamental for increasing the extraction of natural resources and improve the accuracy of production estimation. Geoscientists collect data from a variety of sources, analyse and interpret them, correlating information from distinct parts of the rock in order to understand the geology of the reservoirs. This will in turn allow the formulation of mathematical models used to simulate the behaviour of reservoirs already undergoing production and provide key information to determine whether or not a prospect is indeed a viable reservoir [1]. The volume of data analysed during these studies is very large, and the specialists are always on high demand. They spend much of the time formatting data for exchange between computer tools and producing complex reports to share their results.

Recent works in expert systems have provided means of describing geological data based on domain ontologies, using shared nomenclature across different analyses and using inference algorithms to classify the samples [2]. This has greatly reduced the time that a specialist takes to conclude the analysis of samples and made it easy to share information across tools, since the information resulting from the analysis is well-structured and semantically more relevant. Furthermore the nomenclature used in the description is visually rich, representing concepts as icons that resemble the geological features. The specialists are able to recognize these features in the samples during the process of analysis, doing a mental association between the icons and the mental visualizations of geological aspects [3].

In order to improve the productivity in the modelling process we propose an interactive visualization environment that allows specialists to overview the whole data set regarding the wells in the area of interest to quickly navigate among different samples and decide where to focus the study.

II. Data sets

We take into consideration three types of data sets regarding exploration wells, the central object studied by specialists in order to build geological models:

Well logs: One-dimensional signal representing the measurement of a physical property of the rock along the extension of the well. This is the most common type of data available in a prospect. There are dozens of different registers that can be measured in each well, representing distinct rock properties.

Core description: Analysis of visual and textural aspects of the rock, obtained in cylindrical samples called *cores*. The specialist identifies and describes the attributes that distinguish one rock layer from another, the set of such attributes is known as *facies*. Well logs are also used to help the specialist interpret that data. Although the samples usually spam hundreds of meters of rock within a well, this analysis is done only in high interest areas and is much less available than well logs, due to the high cost of obtaining the samples and performing the analysis itself. This description also incorporates pictures of the whole extension of the samples.

Petrographic description: A specialist analyses thin slices of rock, taken from the well cores, under the microscope and describes the mineral composition of the rock as well as textural attributes observable only in microscopic scale, in high level of detail. This information is used to classify the rock under analysis and to provide crucial information for simulation models.

III. Visualization environment

The environment is composed of a reservoir view, for the whole dataset, and of specialized views for single wells and petrographic descriptions. It displays data using visual representations to maximize specialist comprehension.

Reservoir view: Fig. 1 shows the main component of the environment, a three-dimensional context view where the specialist is able to see the spatial distribution of the wells inside the region of interest and the data associated to them and initiate interactions to further explore the data. A well is represented by a glyph positioned at its top and a straight line running through its entire extension, working as a spine to which the well data is anchored. Selecting the well glyph in the reservoir view displays detailed well data in the single well view. A single well log is plotted aligned against the spine, so the user can compare patterns emerging from the log in several wells at once. The user can switch between different well logs to evaluate different aspects. Core descriptions are represented by boxes with colors and textures that represent the lithology of the rock. By looking at these, the user is able to quickly perceive which wells have core descriptions. Petrographic descriptions are represented by glyphs positioned at the depth from where the sample was extracted and do not display any additional information, but rather are used as selectors to trigger the visualization of the petrographic data in the proper view.

Single well view: Displays all the logs associated to the well and the facies data from the core descriptions when they are available. Distinct facies attributes are represented by specific icons and colors.

Petrography view: Since petrographic descriptions are comprised of data in different formats, each group of data is displayed using a specific visualization. The groups are laid out as a vertical list of collapsible items as shown in Fig. 2. Textural attributes are displayed by icons from the domain ontology. The mineral composition of the sample is displayed with a bar chart with values in the vertical axis meaning the proportion of that mineral that constitutes the rock. The result of methods of rock classification are displayed as ternary diagrams with subdivisions. Each subdivision has a name and the result of the classification for the sample is the name of the subdivision where the sample is plotted.

Well correlation: The well view provides an area for the specialist to create intervals within a well and assign meaning to them as the result of an interpretation. When the same interval is created for multiple wells, the reservoir view will display a volume restricted by surfaces that cross the limits of the intervals in each well and represent a single layer of sediment within the earth. The specialist can then locate and correlate portions of the wells that present similar properties and use the petrophysical data contained within the volume to determine the mathematical model for simulating the behaviour of that layer.

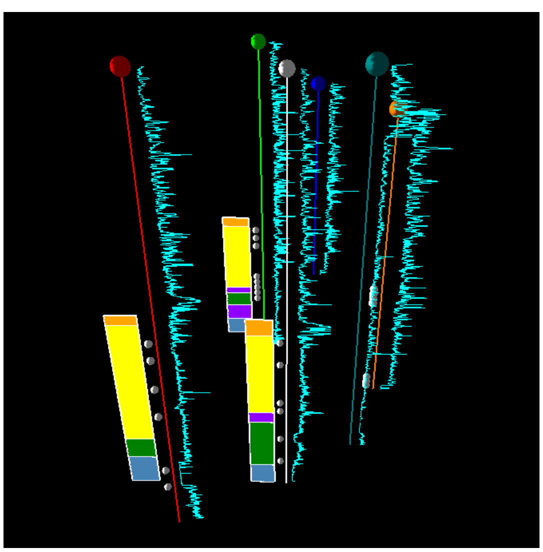

Fig. 1. Main view of the visualization environment. Each well is depicted by a particular color. To the right side of the well line a gamma ray log is rendered in cyan. To the left side of the well are the petrographic description glyphs and the representation of core description data.

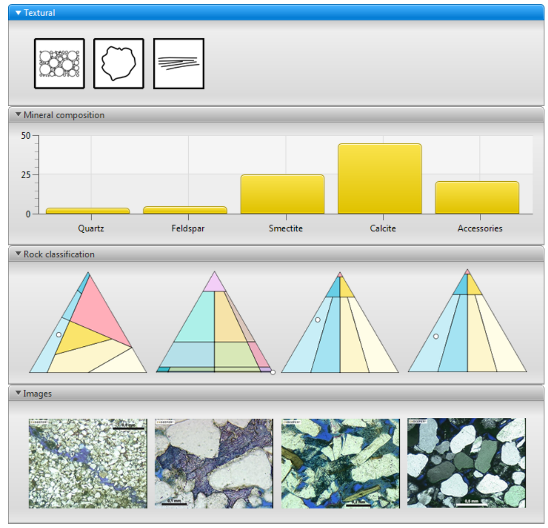

Fig. 2. Specialized view for petrographic data.

IV. Final comments

In this paper we use scientific visualization and information visualization techniques in an interactive environment for analysis and correlation of well data, aiming to reduce the complexity in handling large amounts of data that support the process of geological modelling. As future works we intend to extend the tool to include the visualization of more data types present in petrographic descriptions, and allow visualizing summarized data from multiple petrographic descriptions. Another important feature would be the visualization of results from automatic interpretation techniques. Since these methods have limitations such as reaching more than one conclusion, the user must be able to interactively refine the interpretation. We also will conduct the evaluation of the environment with specialists to validate the techniques proposed in this paper.

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