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WHAT ARE INTERPRETERS FOR? THE IMPACT OF FASTER AND MORE OBJECTIVE INTERPRETATION SYSTEMS

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ABSTRACT

Since commercial 3D seismic data became widespread there has existed a need to speed up the mechanics of the seismic interpretation process by automation. This need is now more vital as the interpreter population decreases, as seismic datasets get larger, cycle time reduction yield greater economic returns, and, most importantly, as the degree of analysis, creativity and synthesis required per project increases.

Automation has been successful in horizon interpretation where a particular identified "horizon" can be parameterised and auto tracked. This is not particularly difficult since the earth tends to be horizontally layered and reflectors are relatively continuous events. A more difficult problem has been to automate the detection and interpretation of faults and related discontinuities for use in 3D earth modelling, simulation modelling and drilling planning. This paper discusses the problems of automating the fault picking process, which can take up to 70% of man time in some interpretation projects, and is one of the more laborious of processes. It shows the flexibility and richness of results gained using a combination of technologies derived from the engineering and medical imaging communities to automatically enhance, detect and analyse seismic scale faulting in 3D seismic volumes.

Finally the potential impact on interpreter man time and creative productivity will be summarised and the impact on interpretation work flow and business practice will be briefly reviewed.

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INTRODUCTION

The primary challenge of modern seismic interpreters is to integrate quantitative predictions, features and measurements from seismic data into both static reservoir descriptions and dynamic reservoir models through 3D and 4D seismic.

Intepretation is usually defined as adding meaning to information; however, the everyday practice of *seismic* interpretation is dominated by having to extract the information from seismic data in the first place. There are good reasons for this, since seismic data are frequently noisy in an information sense and ambiguous in a meaning sense. The difficulties of dealing with noise and ambiguity have hampered the automation of various processes to date.

FAULT PICKING: TEDIOUS AND REPETITIVE EXERCISE

In a 2003 survey of over 100 seismic interpreters from over 50 separate operating companies and experienced consultants from all parts of the world including Indonesia, found that:

1) The majority of oil company interpreters spent between 60% and 40% of their time on active interpretation in front of a seismic workstation.

2) Although there was wide variation depending on the area and style of interpretation required, there was a consensus that fault picking and interpretation are judged to be both a vital interpretation task but also one that is repetitive, tedious and, as a result, was generally performed inadequately.

3) The question, "How much time do you spend in interpreting faults in a typical project?" was then posed as a follow up. Respondents replied with a range between 10% and 75% of total project time. For interpreters working the North Sea and Gulf of Mexico, the range was 30% to 60%. For interpreters building detailed 3D models of fields, the range was between 40% -70%.

   This is the kind of activity that cries out to be automated in order to release time for more value-adding and creative interpretation tasks.

Direct quotes from our respondents give an insight both into the problem and its solution:-

- "In our experience most interpreters spend over half of their picking time worrying over alternative picks, both faults and horizons. In many cases the issue is spurious precision over accuracy which the data alone cannot carry."

- "The greatest obstacle to complete interpretation appears to me to be ignorance, either of the interpreter or of his manager. Yes, fault handling maybe a roadblock on occasion, but too much mental focus on structure is a greater one. Lack of understanding of seismic resolution, confusion over seismic attributes, and over-simplification of horizon identification are others. Certainly available time is a problem; so if we can find a way of giving interpreters more time to think and perhaps seek help, great progress in information extraction will be made."

- "Fault picking is rarely completed. It is always terminated prematurely when time runs short. In some cases faults are picked only as polygons from, for example, dip maps of a surface. Surface auto pickers and general tools have improved so much that fault picking takes even longer nowadays as a percentage of the overall interpretation. "

- "Trouble is that not many managers, reservoir engineers, etc. seem interested to accept the 'reality' as we geologists see it or give us the time to work it out which is another big issue...well, not interested enough until the early high flow rates begin to drop or other things go wrong then they finally will cough up for that target specific 3D which takes ages to acquire and process by which time the damage is done....."

- "The main issue is that when time is tight some of the horizons get interpreted but the faults are either not interpreted or only the main ones interpreted very quickly (and the faults interpreted only as for e.g. polygons, or gaps in the horizons, rather than fault sticks/planes). As a geologist who often integrates the data/interpretations and builds the reservoir models I see this very frequently - it makes building the reservoir models much harder and the end product is far from ideal. The 'Holy Grail' must be 3D automated fault plane generation."

The key issues highlighted are thus

- The intrinsic structural complexity of the project area

- The seismic data quality

- The individual skill and experience of the interpreter

- The objective of the interpretation and the understanding of the task by management

- The methodology used to pick the faults and

- The time available.

PROBLEMS OF AUTOMATING FAULT INTERPRETATION

Conventional manual seismic interpretation methods on 3D data use a mixture of disparate visual clues and mental models to recognise and interpret faults, these include: direct fault plane reflections and diffractions, changes in reflector continuity, offsetting patterns in reflector shape either side of a fault and subtle amplitude and phase changes. Good quality seismic data are a major help as is interpretational experience, including a good knowledge of structural geology and tectonics. In general it is difficult to produce globally applicable rules for identifying individual faults and combining them to produce a coherent fault pattern. Developing potent algorithmic approaches to automating the fault interpretation process is not trivial.

MODERN FAULT PICKING METHODOLOGY

Innovative fault picking, namely FaultX® methodology, offers a robust software workflow which has been applied to data from a wide variety of settings and data quality with good results.

- 3D seismic reflectance data are processed to enhance the characteristic discontinuities; there are a number of methods to achieve this including 3D-DipAzimuth, Manhattan difference algorithms and combinations of single attributes to produce special meta-attributes.

- Image processing methods initially developed in medical applications are applied to isolate and detect fault-like features. The interpreter then can apply statistical filters, 3D visualisation and user controlled analysis to pass or reject potential fault candidates (Figure 1).

- Candidate fault planes can be produced and modified joined and expanded until the interpreter is satisfied and the fault model is output into a modelling system, conventional interpretation environment or visionarium (Figure 2).

RESULTS AND CONCLUSIONS

Interpreters are a scarce resource and are frequently overloaded to the point where quality of results and decisions taken using interpreted seismic data may suffer. Our poll of interpreters showed that "actual time on the job" was limited and that much of the interpretation task itself consisted of performing tedious and repetitive tasks such as fault picking and interpretation. These were both unpopular and not thought to be optimised using current interpretation methods. Our results using the FaultX® methodology show that the automated or semi - automated process is robust in the presence of noise and that this system can typically reduce the time taken for fault interpretation in a North Sea or Gulf of Mexico setting by an order of magnitude. In a typical project this can save weeks or even months of interpreter time.

In a typical oil company environment where an interpreter may spend less than 50% of their time doing interpretation, the relative saving and productivity increase created by using a methodology such as FaultX® will be far higher and the time saved can seriously impact on and improve project economics.

Other benefits are the objective and repeatable nature of the process and the quantitative nature of the results which can enable advances in understanding other spatial properties such as anisotropy and stress. Looking ahead, it is suggested that automated and semi automated methods will have a considerable impact on interpreters' work style and productivity, leading both to faster project cycle times and to optimised interpretations of the increasing numbers of smaller, more marginal, fields required to replace reserves.

ACKNOWLEDGMENTS

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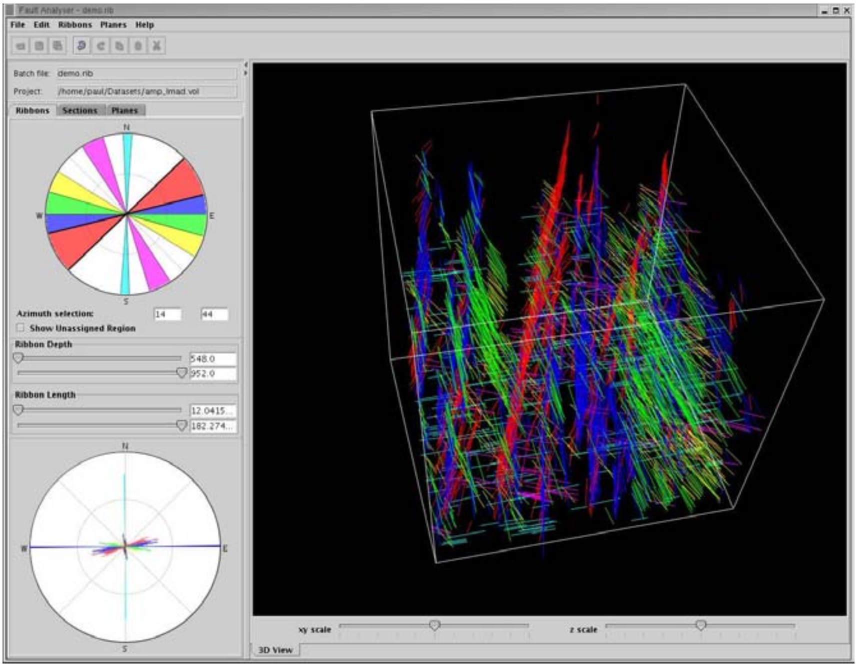

Figure 1 - Auto picked faults colour coded by azimuth

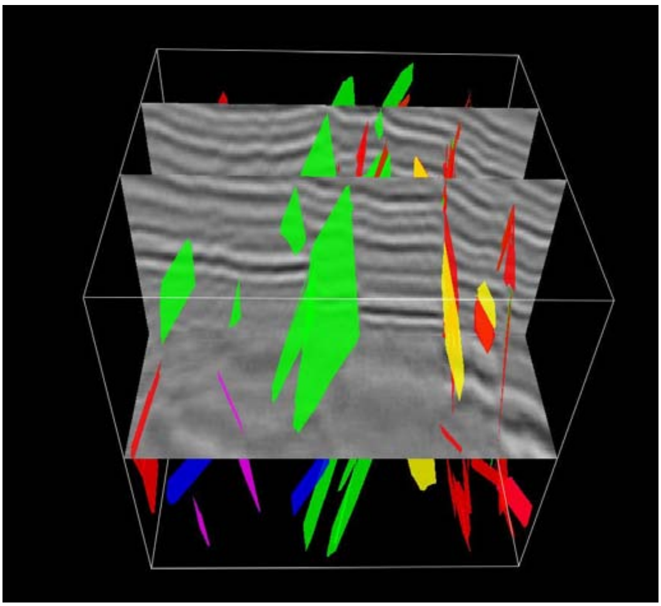

Figure 2 - Auto picked fault planes superimposed upon original reflectance data for interpreter QC.