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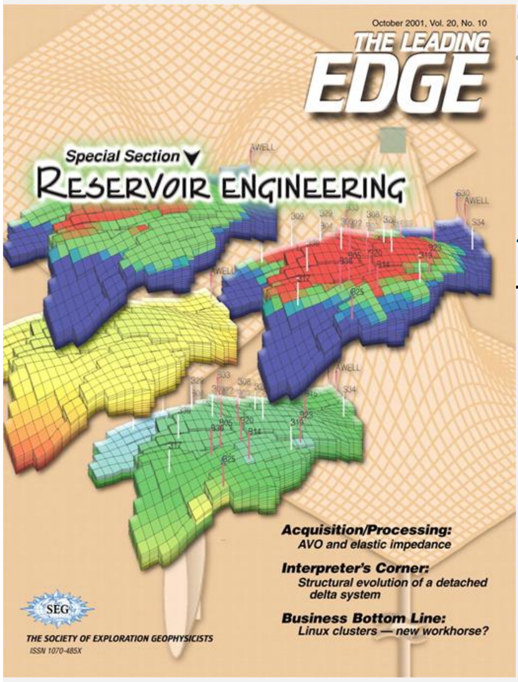

RESEARCH ARTICLE | OCTOBER 01 2001

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Peter Olden; Patrick Corbett; Robin Westerman; Jim Somerville; Brian Smart; Nick Koutsabeloulis

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Article Contents

Editor's note: A fuller version of this article can be downloaded in pdf format from the GUMPA project Web site at the following URL - http://www.pet.hw.ac.uk/research/gumpa/index.html

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The exploration and production of hydrocarbons are generally accomplished with the aid of 3-D seismic to image reservoir structure and, in some instances, reservoir properties and direct hydrocarbon indicators. Repeated seismic surveys over a period are termed *time-lapse seismic* (and sometimes *4-D seismic*). Changes observed in the seismic character with time have been attributed to impedance changes as a result of production (e.g. Gawith and Gutteridge, 1996). These changes have been used in...

First Page Preview

Modeling combined fluid and stress change effects in the seismic response of a producing hydrocarbon reservoir

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The exploration and production of hydrocarbons are generally accomplished with the aid of 3-D seismic to image reservoir structure and, in some instances, reservoir properties and direct hydrocarbon indicators. Repeated seismic surveys over a period are termed *time-lapse seismic* (and sometimes *4-D seismic*). Changes observed in the seismic character with time have been attributed to impedance changes as a result of production (e.g. Gawith and Gutteridge, 1996). These changes have been used in a few producing fields to monitor reservoir performance. Identifying observed differences in repeat 3-D surveys and relating these to either in-situ saturation or stress-state changes, or both, has been difficult because of the lack of control data. It has been noted that in some fields (Watts et al., 1995), the sensitivity to stress changes can be very much greater than the sensitivity to saturation changes. In other fields (Landrø et al., 1999), the saturation changes are thought to be more significant. To aid understanding, a need for greater integration of geophysics and reservoir engineering has been noted and was the motivation for this study (Jack, 2001).

There is a limited window of opportunity in a field's producing life when there are sufficient changes (saturation or stress) in the subsurface to show a surface seismic response. These changes have to be monitored before the field has reached significant decline for the observed changes to be exploited for reservoir management (through in-fill drilling for by-passed, compartmentalized or attic oil). Reservoir modeling is an essential tool for managing the development of and production from hydrocarbon reservoirs. Many technical issues however surround the realism and validity of the models on which management decisions are based. The maturing techniques of time-lapse geophysical seismic measurement on producing reservoirs offer the prospect of verifying and calibrating models at a field scale, by comparing the modeled response against actual field response. Hydrocarbon reservoirs are complex physical systems in which fluid saturation, pressure, temperature, and chemical effects interact. The dynamic effects of production lead to changes

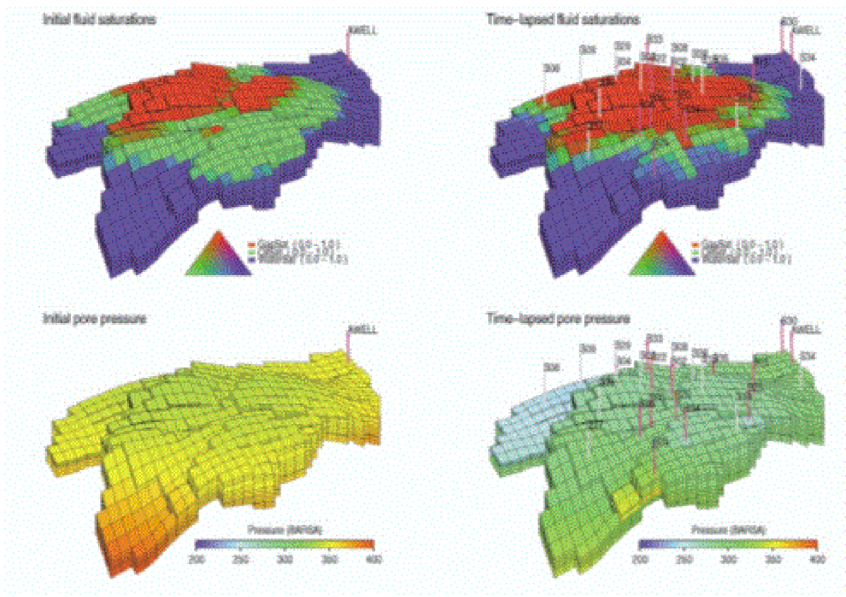

Figure 1. Example of a conventional full-field reservoir simulation showing saturation and pressure changes.

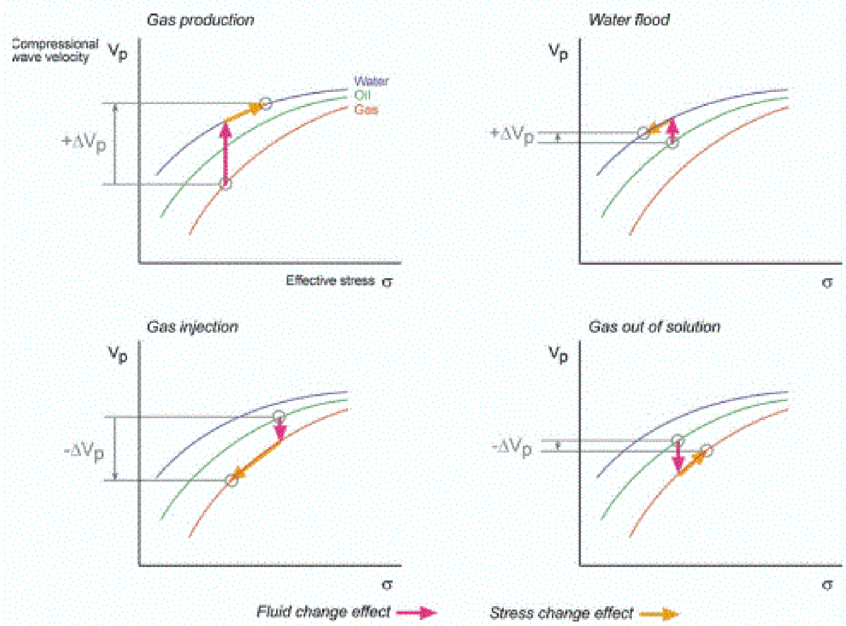

Figure 2. Schematic representation of changes in compressional-wave velocity during common hydrocarbon production processes. These models might represent changes at a single point or average changes for a field.

Index Terms/Descriptors

acoustical methods | Atlantic Ocean | behavior | body waves | connate waters | effects | elastic constants | elastic waves | Europe | faults | finite element analysis | four-dimensional models | gas injection | gas-water interface | geophysical methods | geophysical surveys | ground water | hydrocarbon indicators | mechanical properties | models | movement | natural gas | North Atlantic | North Sea | P-waves | permeability | petroleum | petroleum engineering | Poisson's ratio | reservoir properties | reservoir rocks | saturation | seismic attributes | seismic methods | seismic waves | simulation | statistical analysis | stress

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