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Discretizing Geomechanical Properties as Part of a Full Appraisal of a Mature Field in the Western Canadian Sedimentary Basin

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Summary

Measurement of geomechanical properties using seismic (shear-wave and P-wave velocities) and laboratory methods have been used in the oil and gas industry for several decades. Laboratory methods, in most cases, take only small samples from highly consolidated rocks, leaving out the softer rocks, which may not be representative of the elastic regime existing in the reservoir owing to the sample size. Also, in most cases, geomechanical studies are performed on a well-by-well basis and rely heavily on 3-D seismic to produce 3-D velocity cubes. Measurements calculated at the wellsite (e.g., pore pressure) are then used as calibration points to convert the 3-D velocity cube to a pore-pressure cube for use in the pre-drill analysis. However, the elastic properties measured are restricted to well location and cannot be interpolated across the reservoir.

Introduction

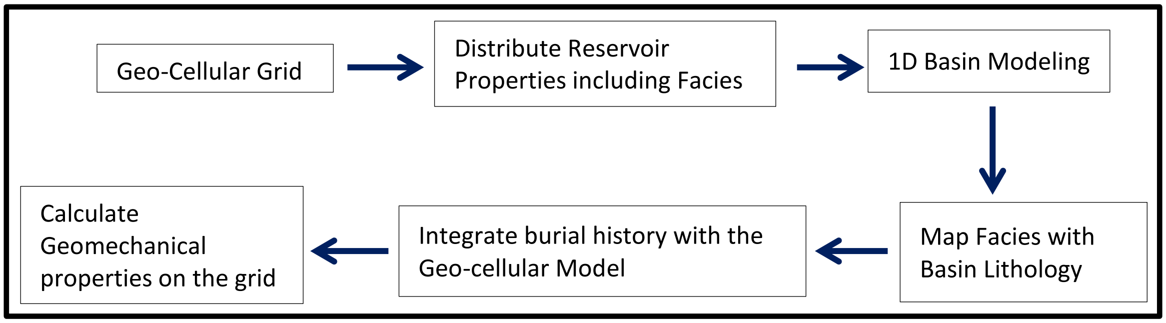
This paper describes an approach for deriving and discretizing geomechanical and other elastic properties using results from basin models. Discretizing rock elastic properties into three-dimensional grids with values assigned to each cell provides an understanding of the relationship between the various petrophysical rock properties with respect to their effects on the elasic properties or how they respond to mechanical stress at reservoir condition. This relationship is very important for defining trends in the reservoir description.

Theory and/or Method

The workflow for calculating cell-by-cell elastic properties in a reservoir can be achieved by integrating basin model parameters and 3-D geo-cellular grids. As a result, spatial representation of geomechanical properties, such as effective stress, etc., are created. The basin model reconstructs the geologic history (i.e., burial history) by back-stripping the reservoir to its original depositional thickness and incorporating faulted or eroded sections and boundary conditions. Through this reconstruction, the mechanical compaction, pore pressures, effective stress, and porosity-vs-depth relationships are established for the reservoirs in the basin.

Examples

The example presented in this paper is taken from a mature field in the western Canadian sedimentary basin. In the current workflow, cell-by-cell calculations of mechanical properties are carried out by integrating the lithotype (facies) distribution in the geomodel with the basin burial history from basin modeling studies. A schematic of the workflow used in the paper is shown below.



Conclusions

A 3-D distribution of geomechanical properties provides an improved visualization and understanding of the prevailing rock elastic properties and stress regimes that would enhance or impair productivity, thus aiding operators to effectively design their depletion strategies and also plan their wells and drilling programs with minimal drilling risks and associated costs. It also serves as input into a variety of subsurface operations, such as flow simulation, history matching, fluid typing, hydrocarbon production and flow, etc.

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References

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