

PS Fracture Systems Prediction for Exploratory Prospects, Using Multiscale Data Integration. Application in a Mesozoic Carbonated Reservoir in the Southeastern of Mexico*

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Abstract

The hydrocarbon exploration in the southeastern of Mexico has been intensified specially in fractured carbonates plays. This requires a detailed integral analysis to reduce the risk of exploratory proposals, and for better design of well trajectories. The limited information of well data and the poor seismic quality are factors that affect the prediction of the main distribution of fracture. This work shows the application of a methodology that we have developed in PEMEX to model fractured systems, integrating multiscale data. This methodology is focused in the characterization of fracture systems from the identification of fractures sets with the same diagenetic and structural origin, the calculation of fracture attributes, establishment of the stratigraphy-mechanical, images logs interpretation, seismic analysis, and 3D modeling. The main objective is to generate a fracture systems model, to reduce the risk of exploratory prospects. In addition, this study will be the base of future reservoir development. An example from the Southeastern of Mexico is presented. The main target is a sequence of carbonated Cretaceous rocks deposited in basinal facies, with porosities of matrix that varies from 2-4%. We analyzed data from eight wells near to the prospective area, 14 cores and five images logs interpretation. In addition, we performed triaxial and petrophysics tests from 14 cores. The complementary analyses consisted of petrographic description, measurement and characterization of fractures, calculation of fracture attributes, identification of geologic fracture controllers, establishment of layer-mechanical units and structural model. As a result, the intensities of all conductive fracture sets, with direction NW-SE, NE-SW and non-conductive N-S and E-W sets were modeling in the study area. In addition, a 3D visualization of potentially fractured exploratory prospects was done, and the proposals of well trajectories that can intercept open fracture sets. With these results, in addition the trajectory of an exploratory proposal was redesigned. That well is currently drilling, and it had a very good oil indication of hydrocarbons while drilling the carbonated Cretaceous sequence. In addition, the study results offers the possibility of the incorporation of reserves in the study area for this sequence, that already had been perforated by four wells which were not successful, due to do not have the correct trajectory with respect to the open fracture sets orientations.

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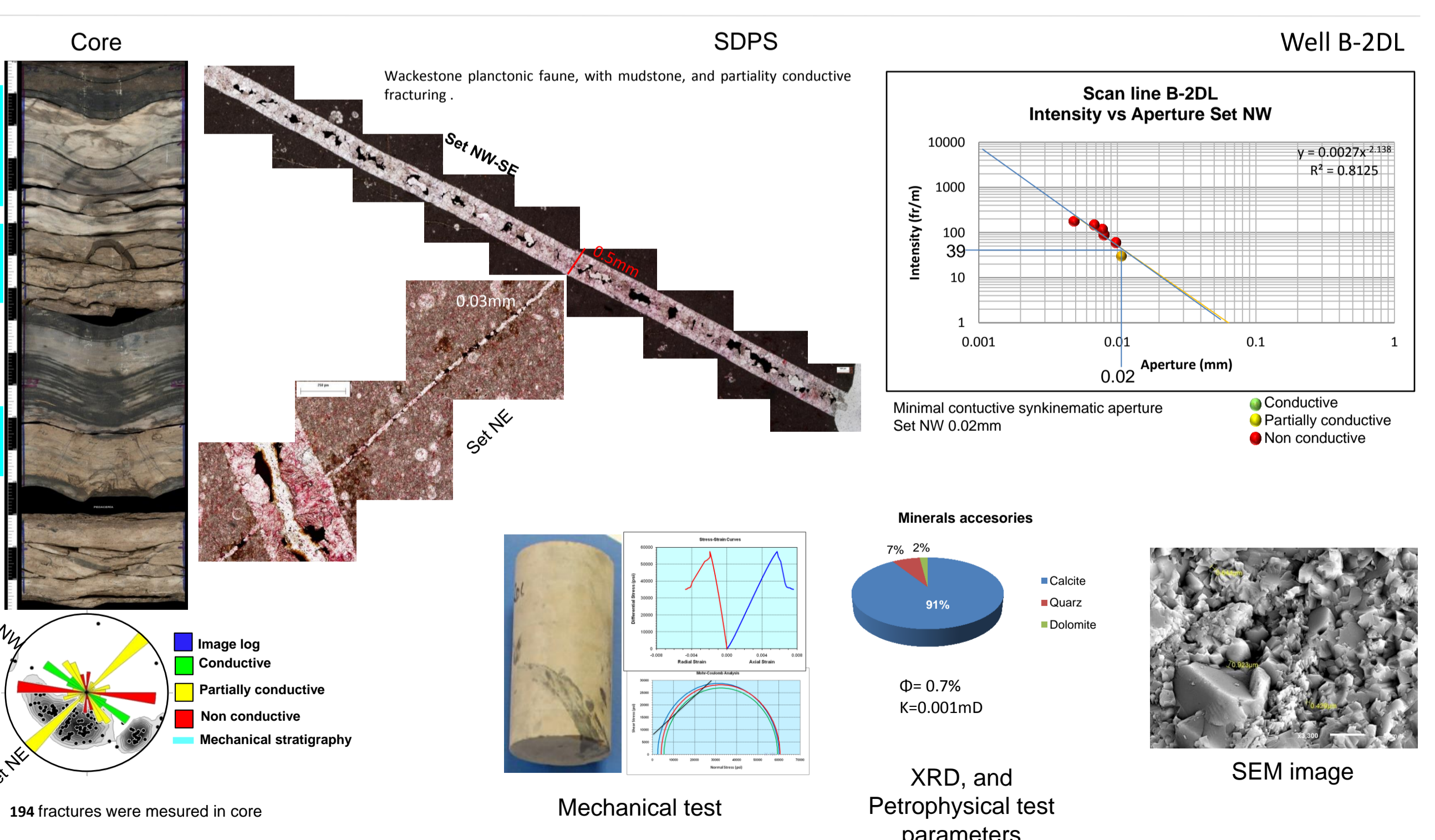
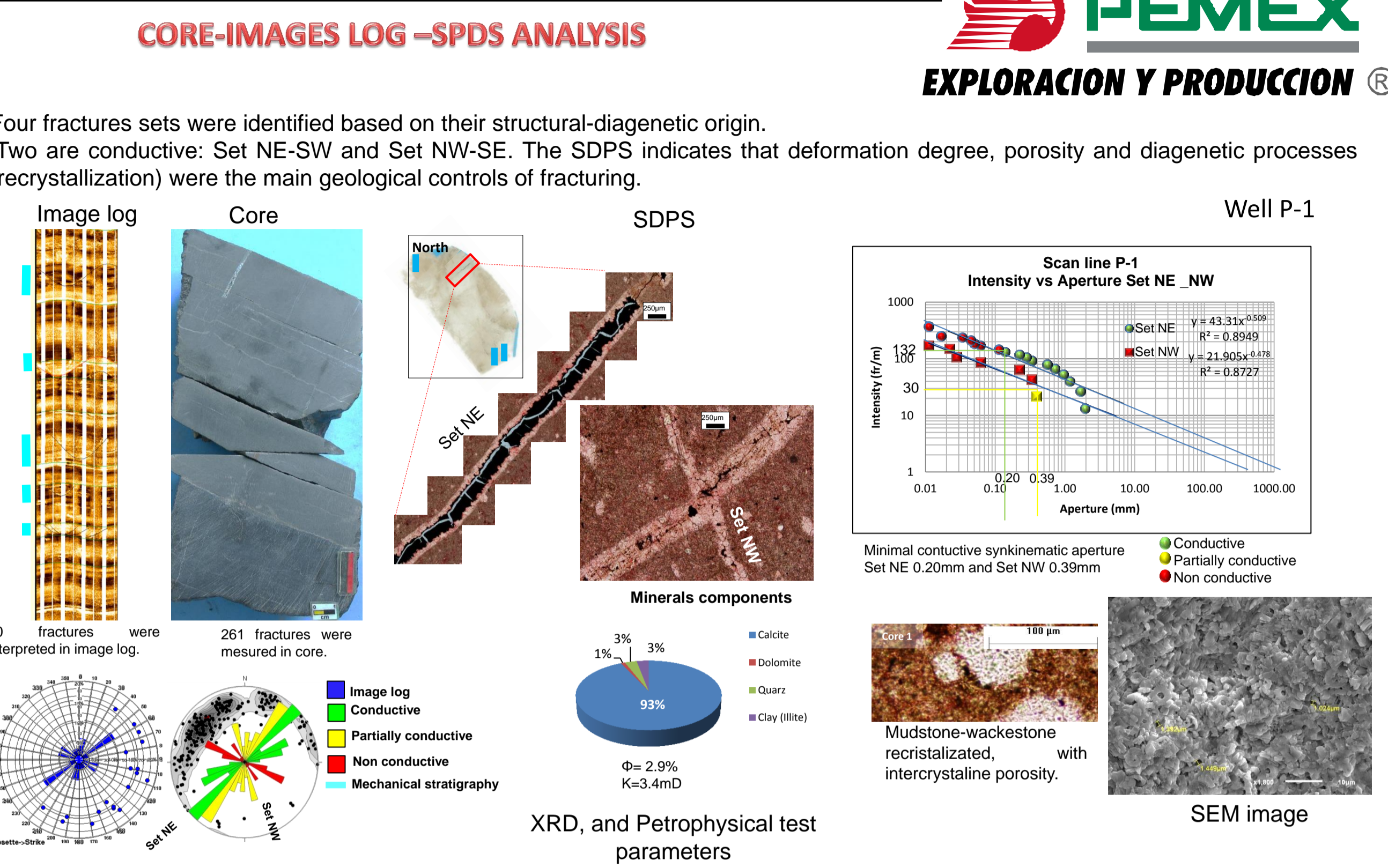
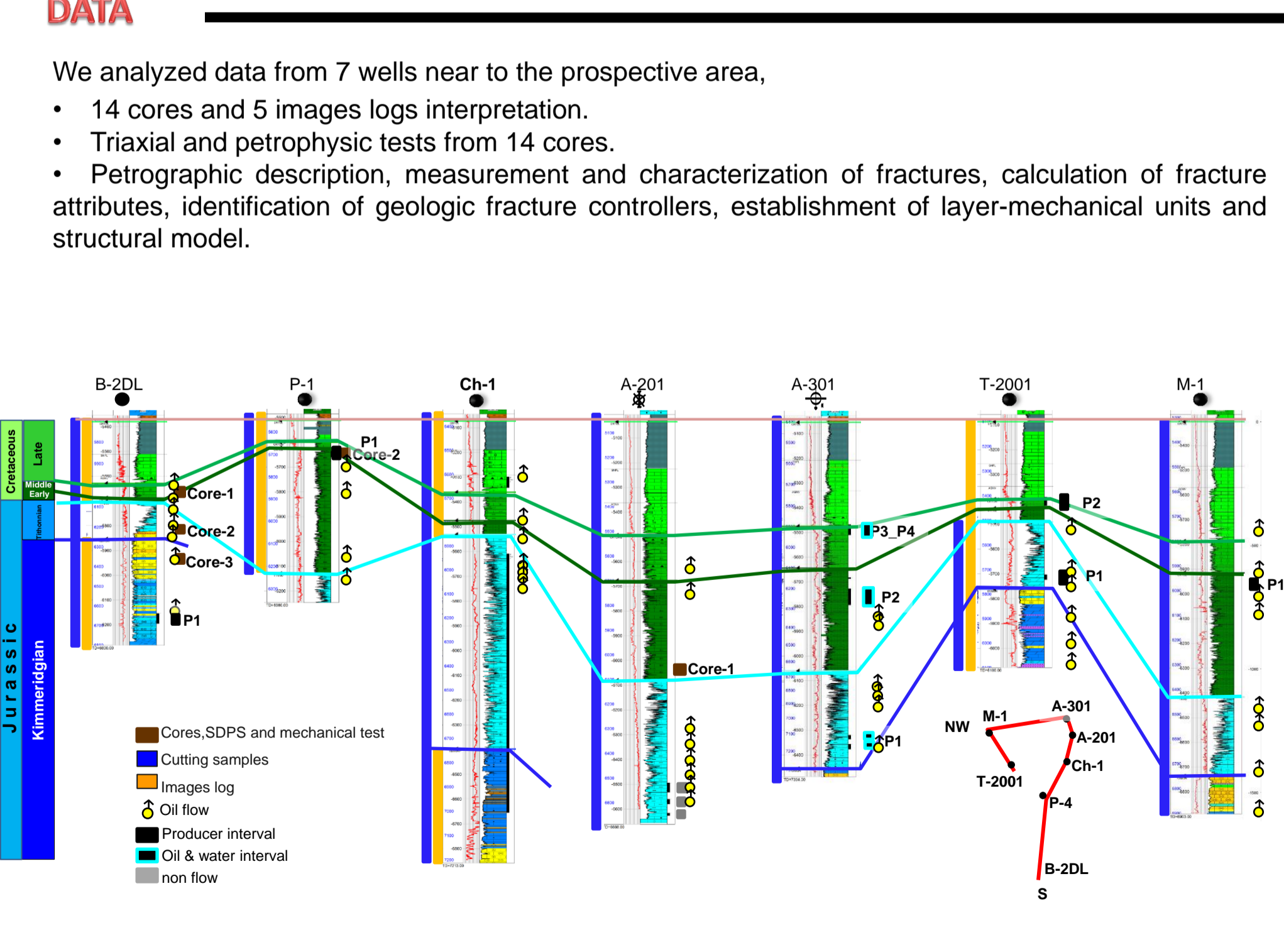
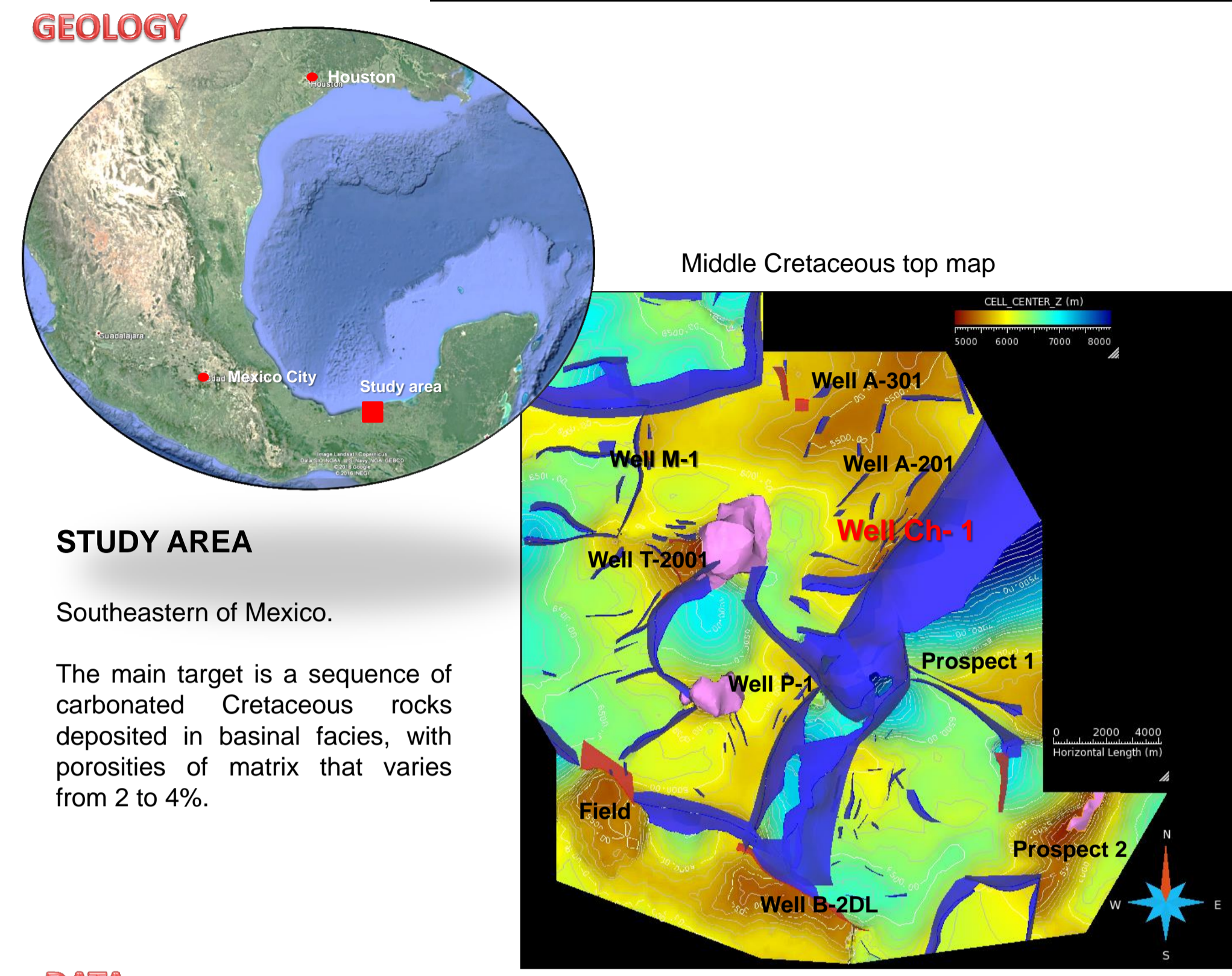
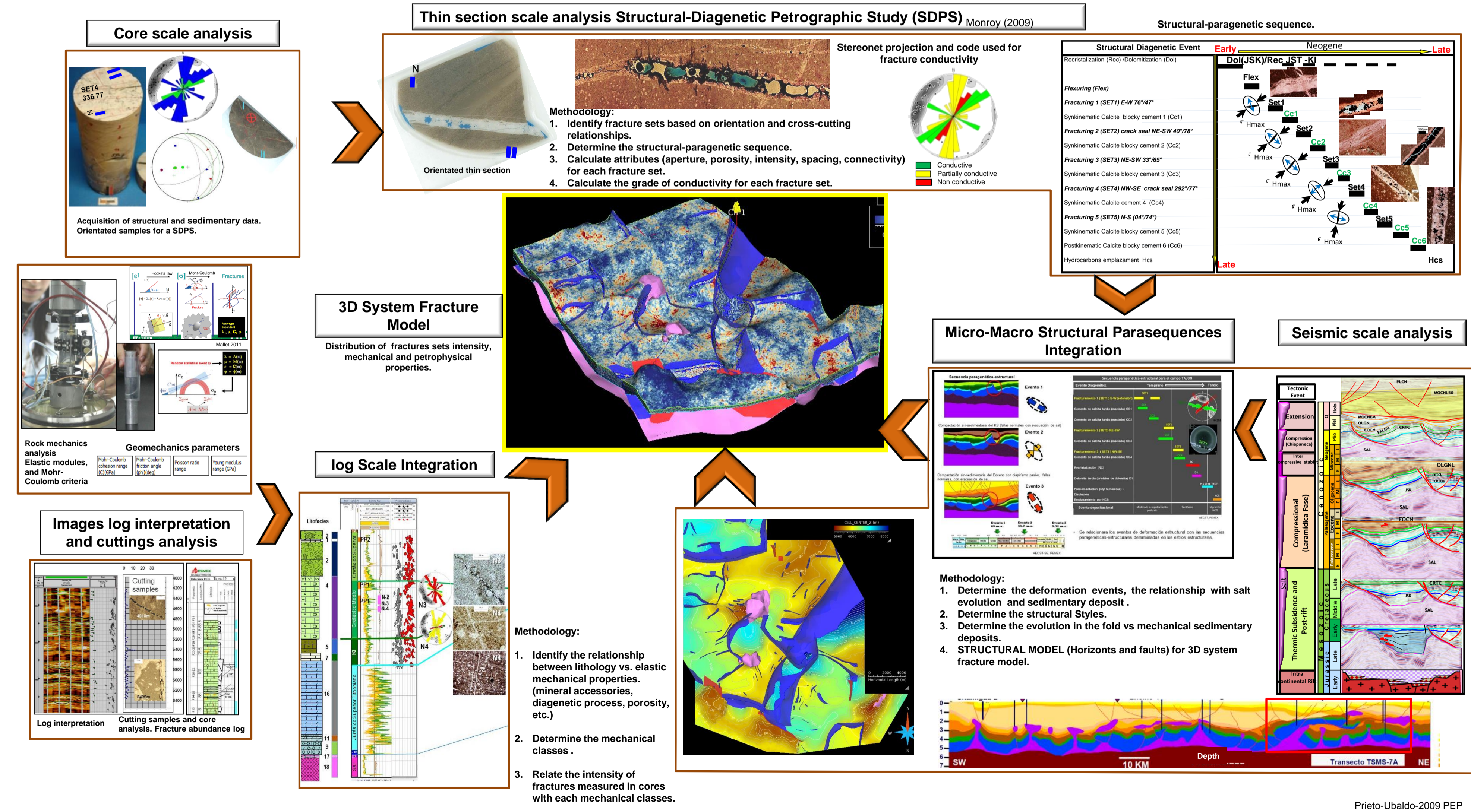
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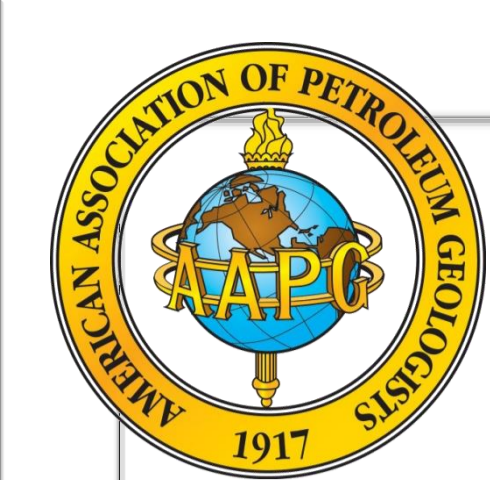
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ABSTRACT The hydrocarbon exploration in the southeastern of Mexico has been intensified specially in fractured carbonates plays. This requires a detailed integral analysis to reduce the risk of exploratory prospects, and also for better design of well trajectories. The limited information of well data and the poor seismic quality are factors that affect the prediction of the main distribution of conductive fractures.

OBJECTIVE The main objective of this project is to generate a fracture systems 3D model, to reduce the risk of exploratory prospects. In addition, this model will be the base of future reservoir development.

METHODOLOGY This work shows the application of a methodology which we have developed in PEMEX to model fracture systems, base on the integration of multiscale data, from thin sections to seismic information. This methodology is focused in the characterization of fracture systems, take in account the identification of fractures sets with the same diagenetic and structural origin, the calculation of fracture attributes, establishment of the stratigraphy-mechanical, images logs interpretation, seismic analysis, and 3D modeling. (Prieto-Ubaldo-2009),





Fracture systems prediction for exploratory prospects, using multiscale data integration.

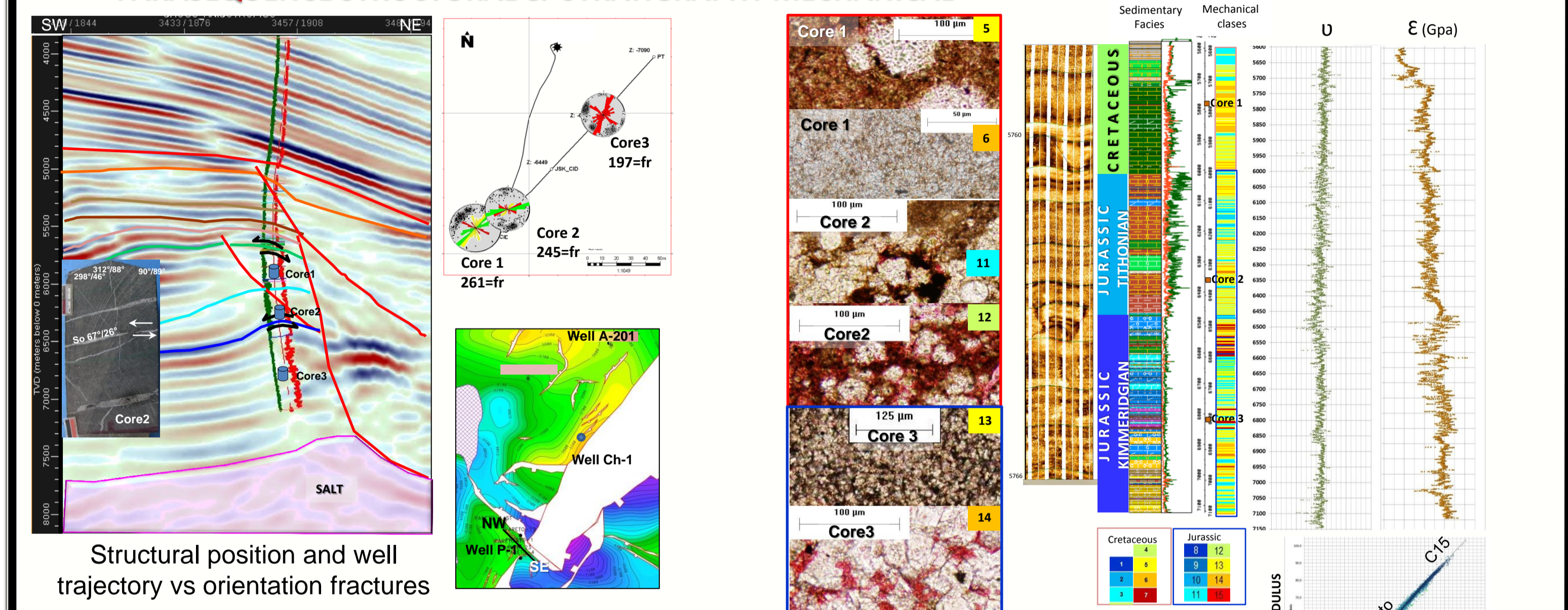


Application in a Mesozoic carbonated reservoir in the Southeastern of Mexico.

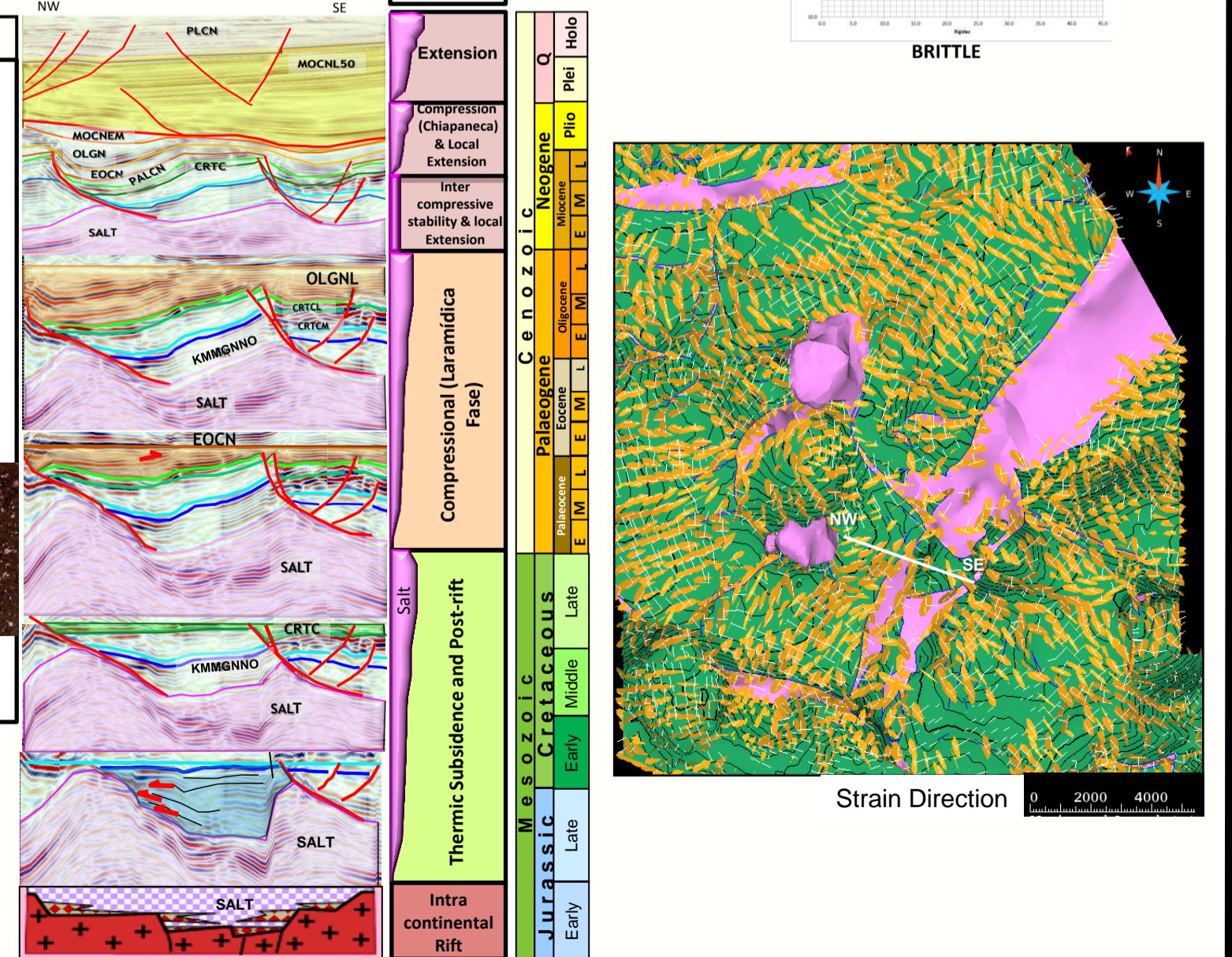
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PARASEQUENCE STRUCTURAL & STRATIGRAPHY MECHANICAL

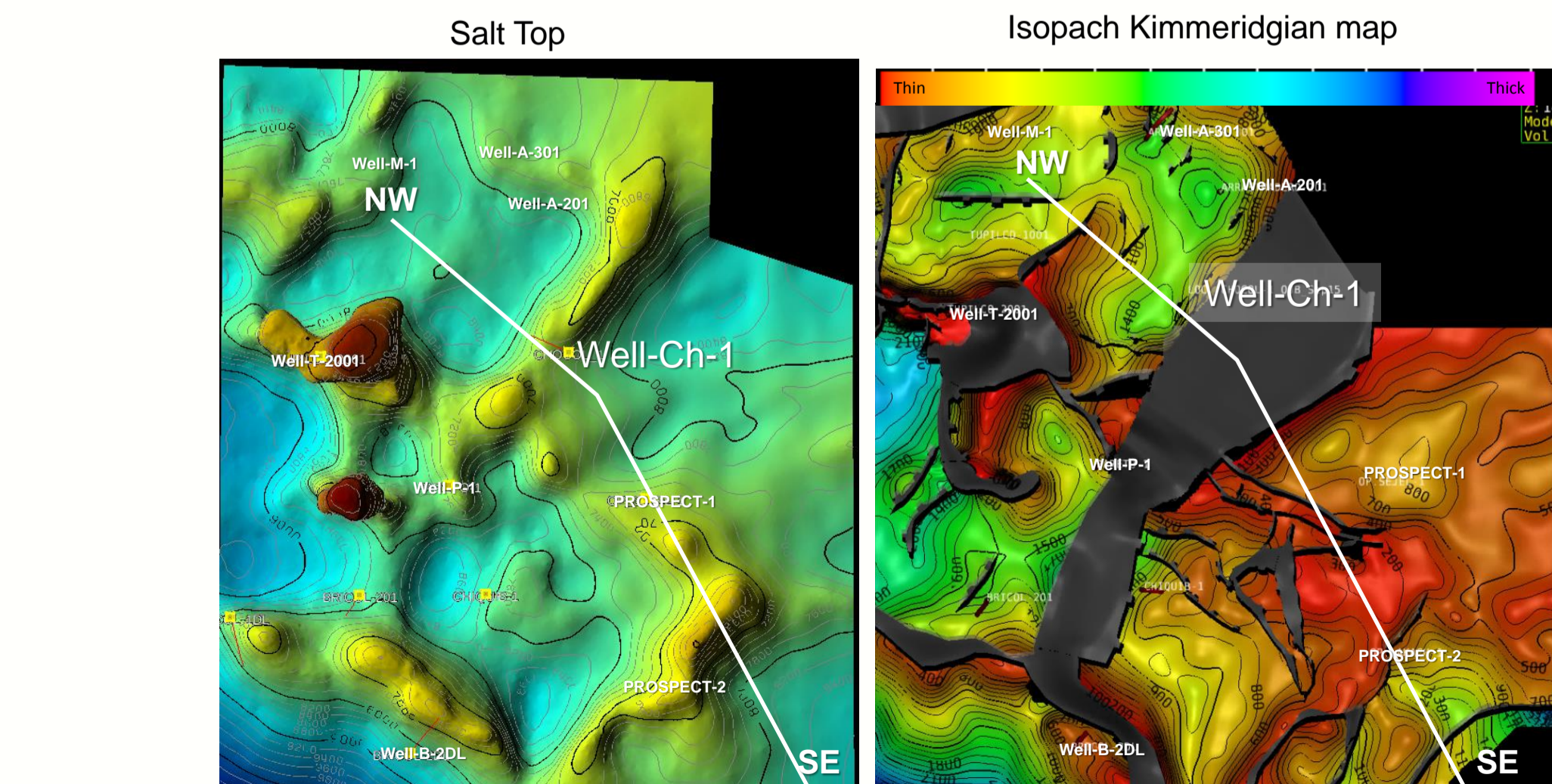
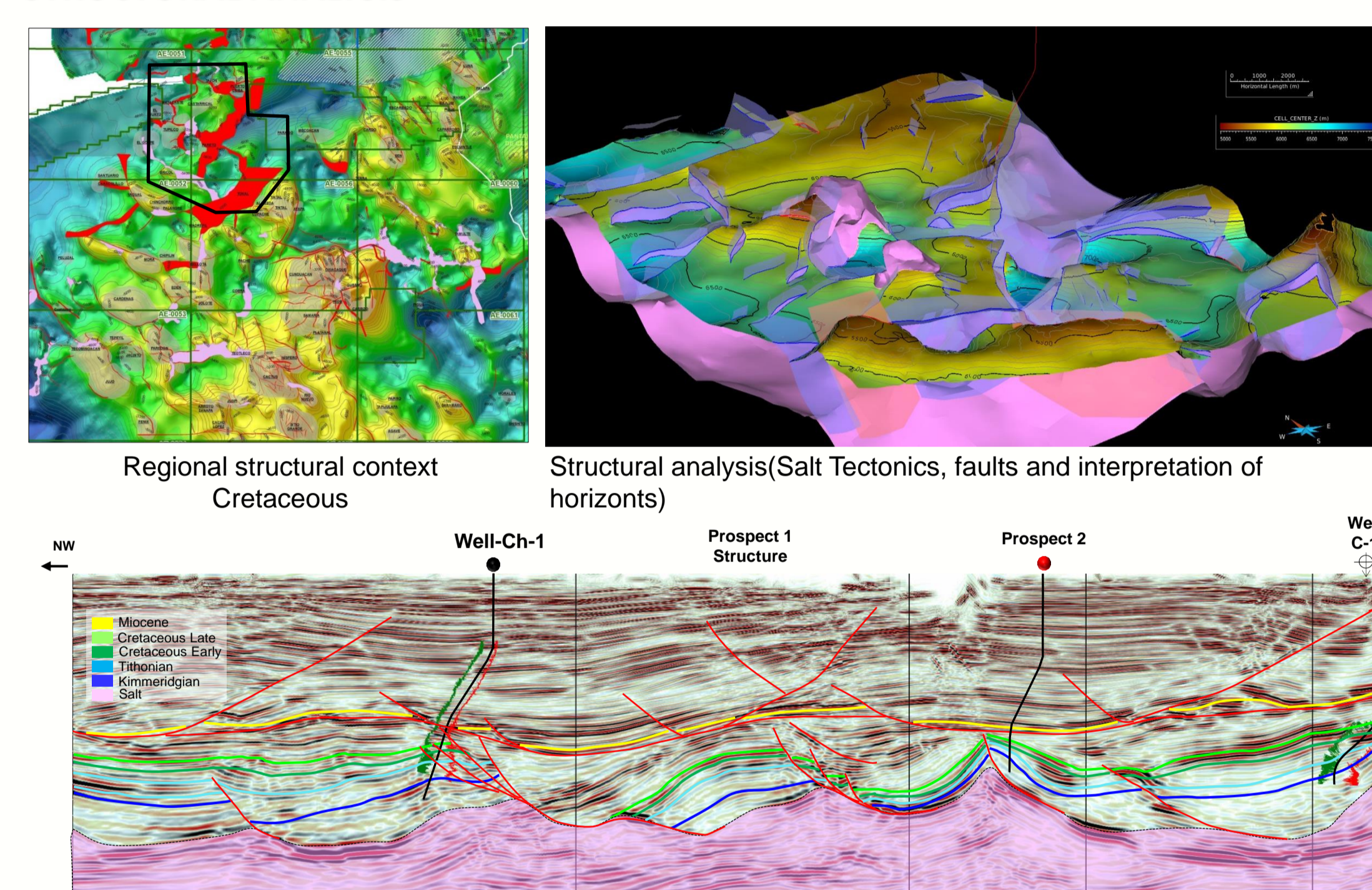


Structural Diagenetic Event	Early	Neogene	Late
Recrystallization (Rec) /Dolomitization (Dol)			
Flexuring (Flex)			
Fracturing 1 (SET1) E-W 76°/47°			
Calcite blocky cement 1 (Cc1)			
Fracturing 2 (SET2) crack seal NE-SW 40°/78°			
Calcite blocky cement 2 (Cc2)			
Fracturing 3 (SET3) NE-SW 33°/65°			
Calcite blocky cement 3 (Cc3)			
Fracturing 4 (SET4) NW-SE crack seal 292°/77°			
Calcite cement 4 (Cc4)			
Fracturing 5 (SET5) N-S (04°/74°)			
Calcite blocky cement 5 (Cc5)			
Calcite blocky cement 6 (Cc6)			
Hydrocarbons emplacement Hcs			

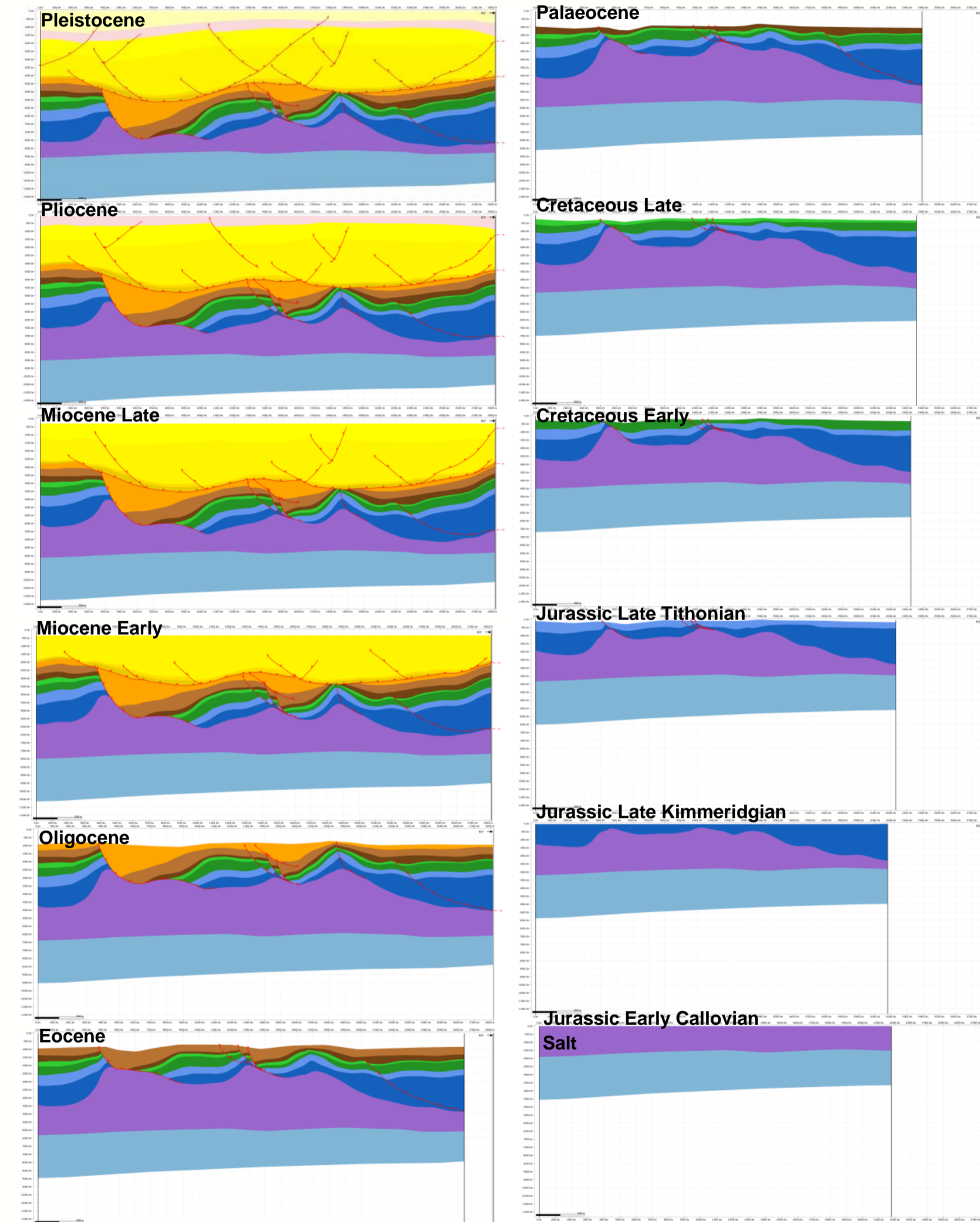


Parasequence Structural-Diagenetic Event vs Tectonic Event Relationship between micro-macro structural scales

STRUCTURAL ANALYSIS

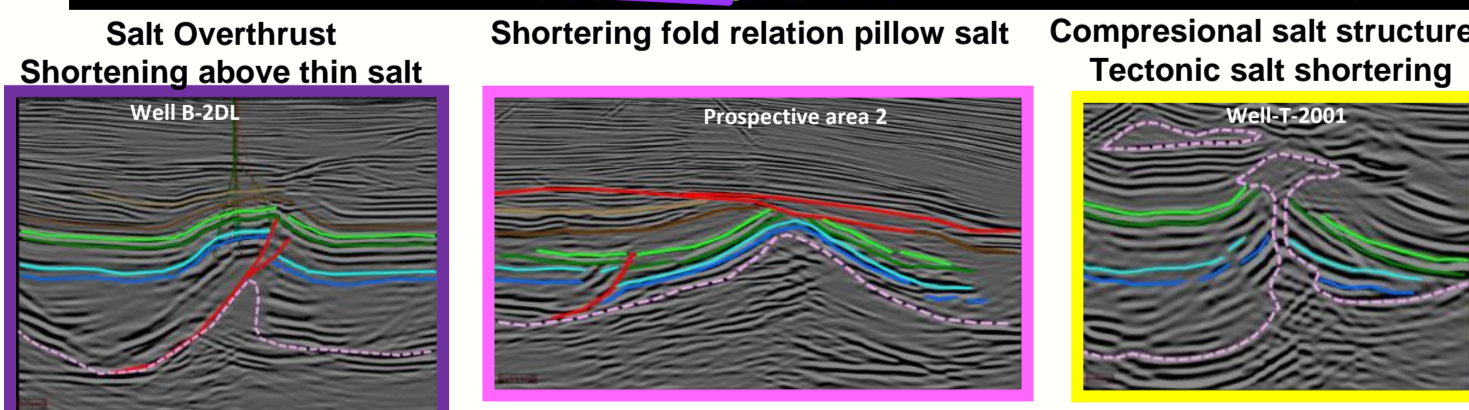
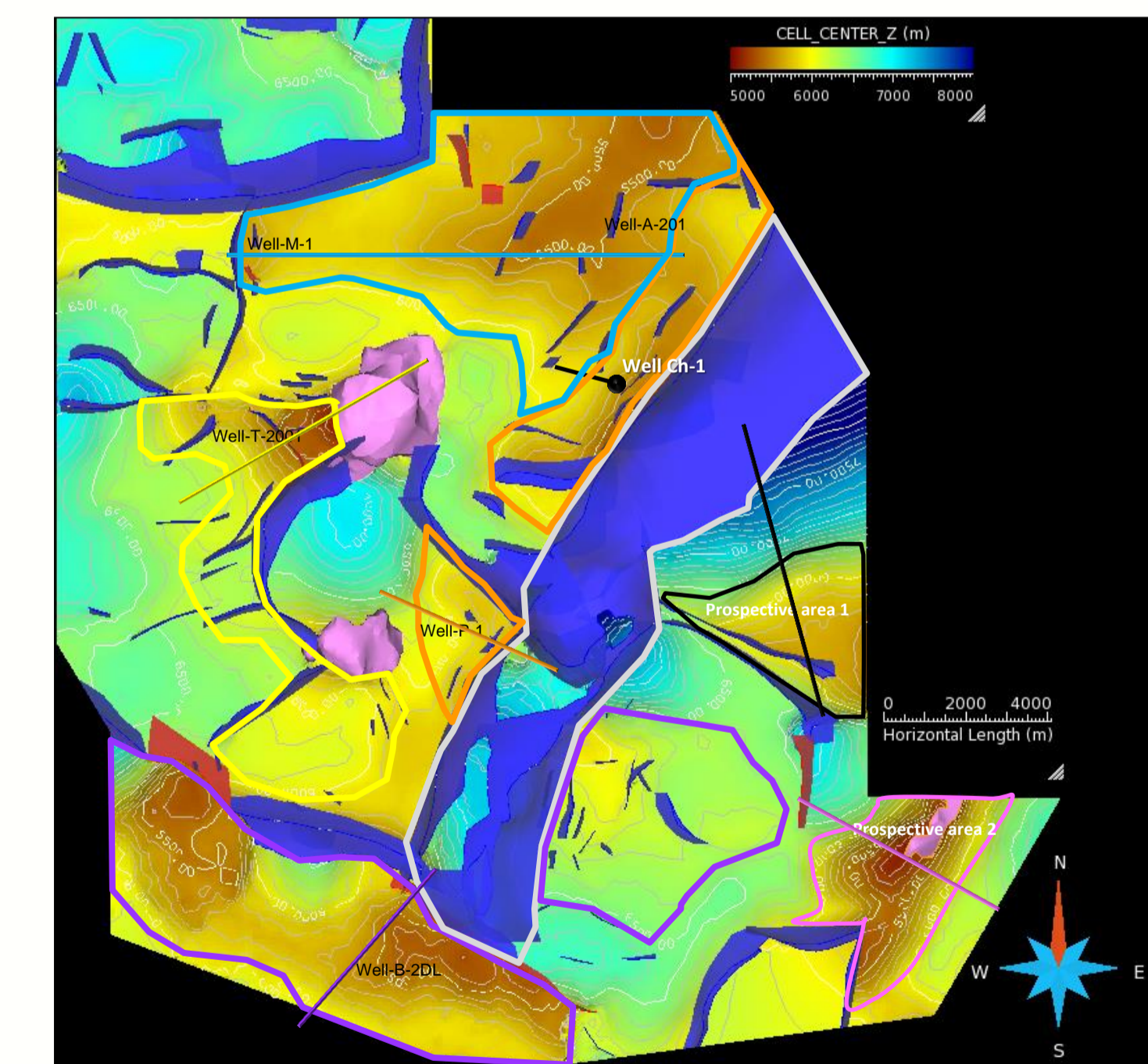
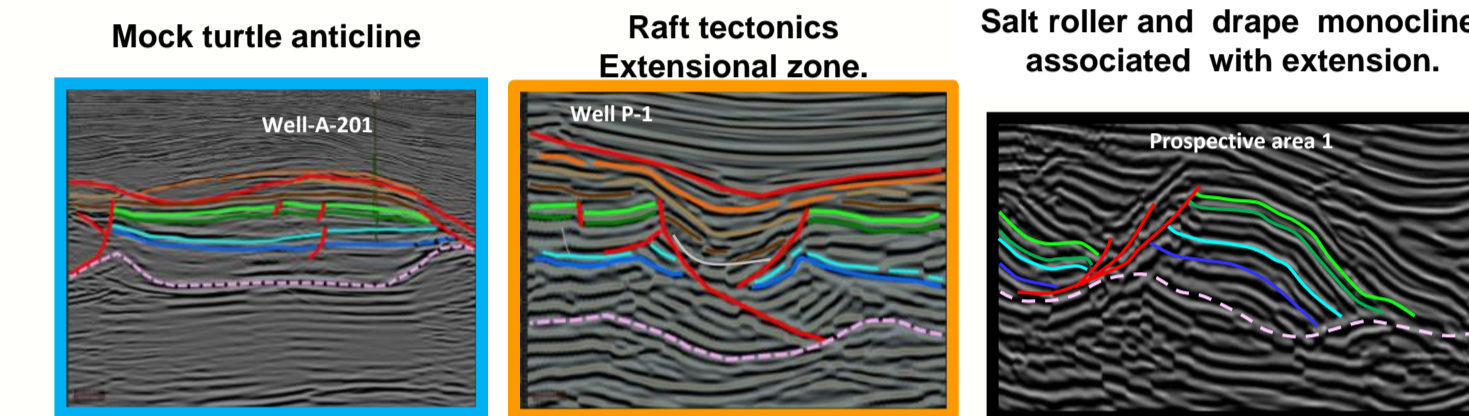


RESTORATION

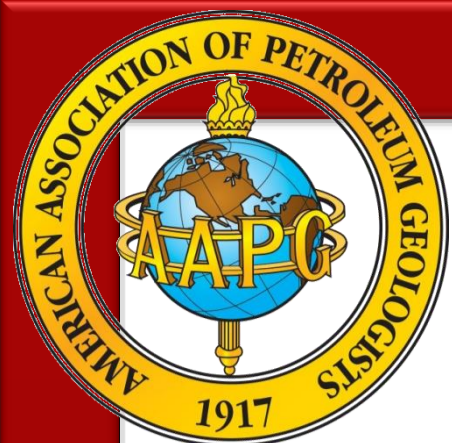


STRUCTURAL STYLES IN THE STUDY AREA

We can divide in two regional structural styles .
North part extensional area and South part compressional area.



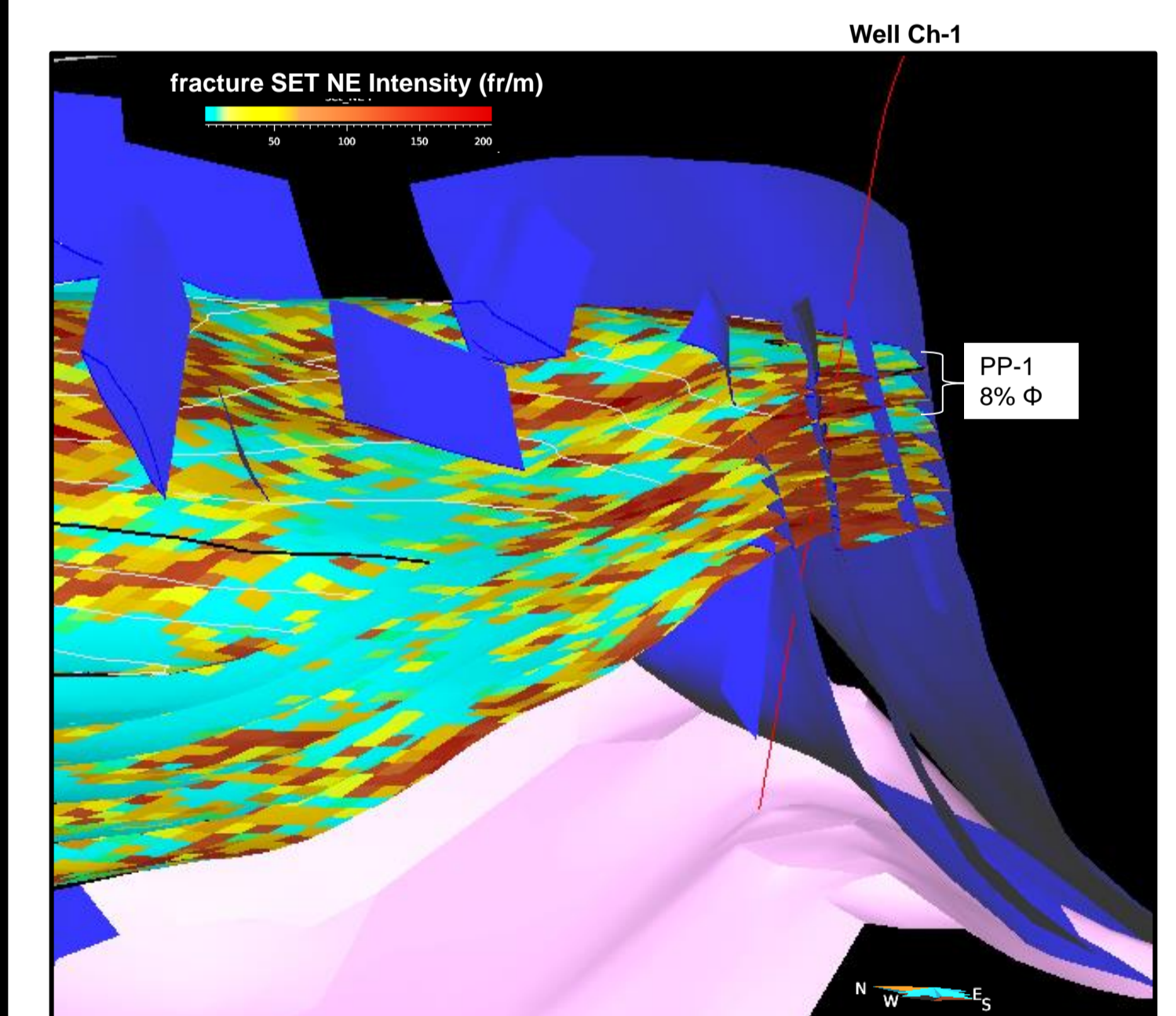
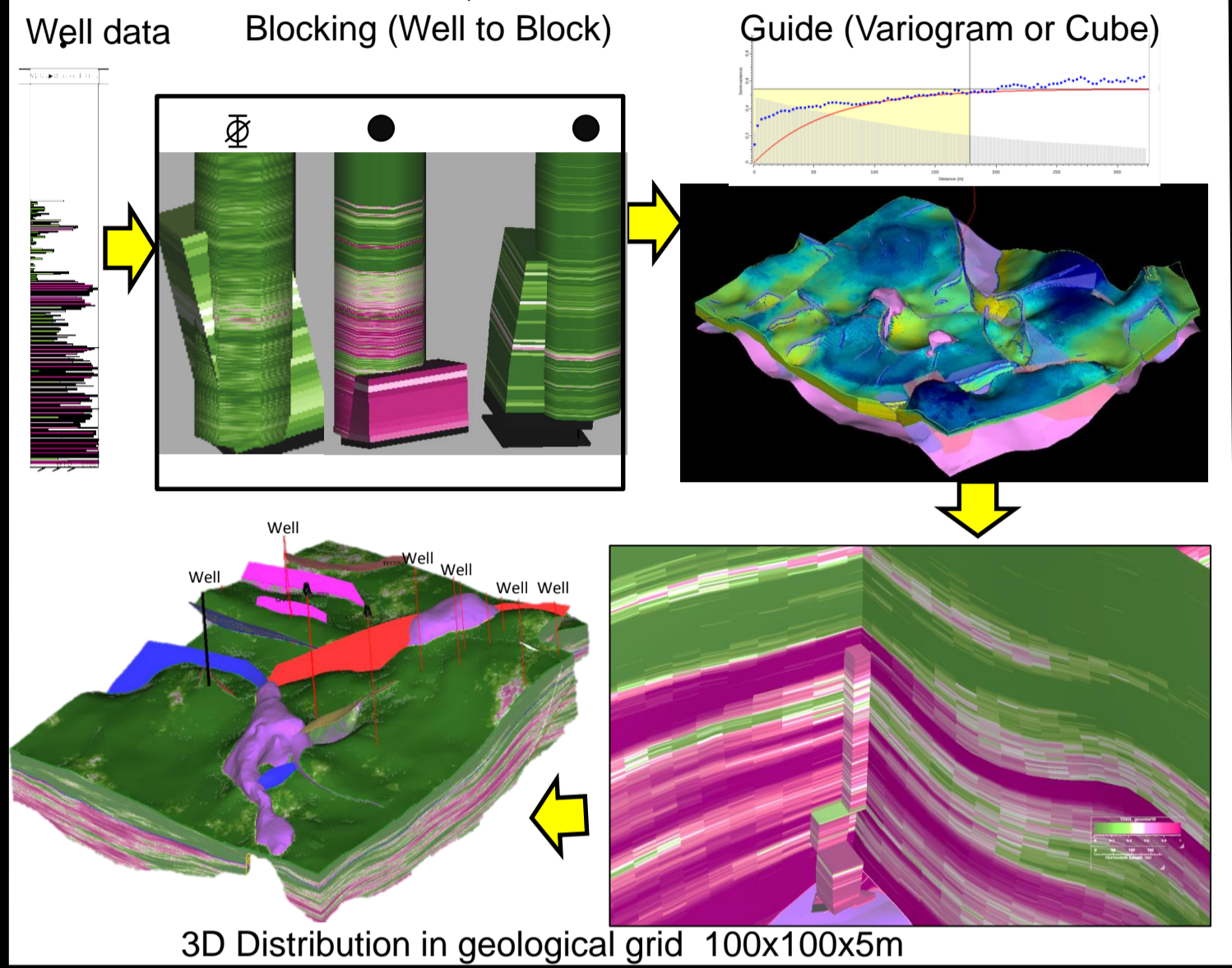
- The relationship between the deformation and fracturing events, was analyzed in 6 structural styles, and also the relationships between the structural position and fracture distribution.
- Zones with more deformation were identified, and related with the mechanical classes, for the 3D fracture model.



UPSCALING

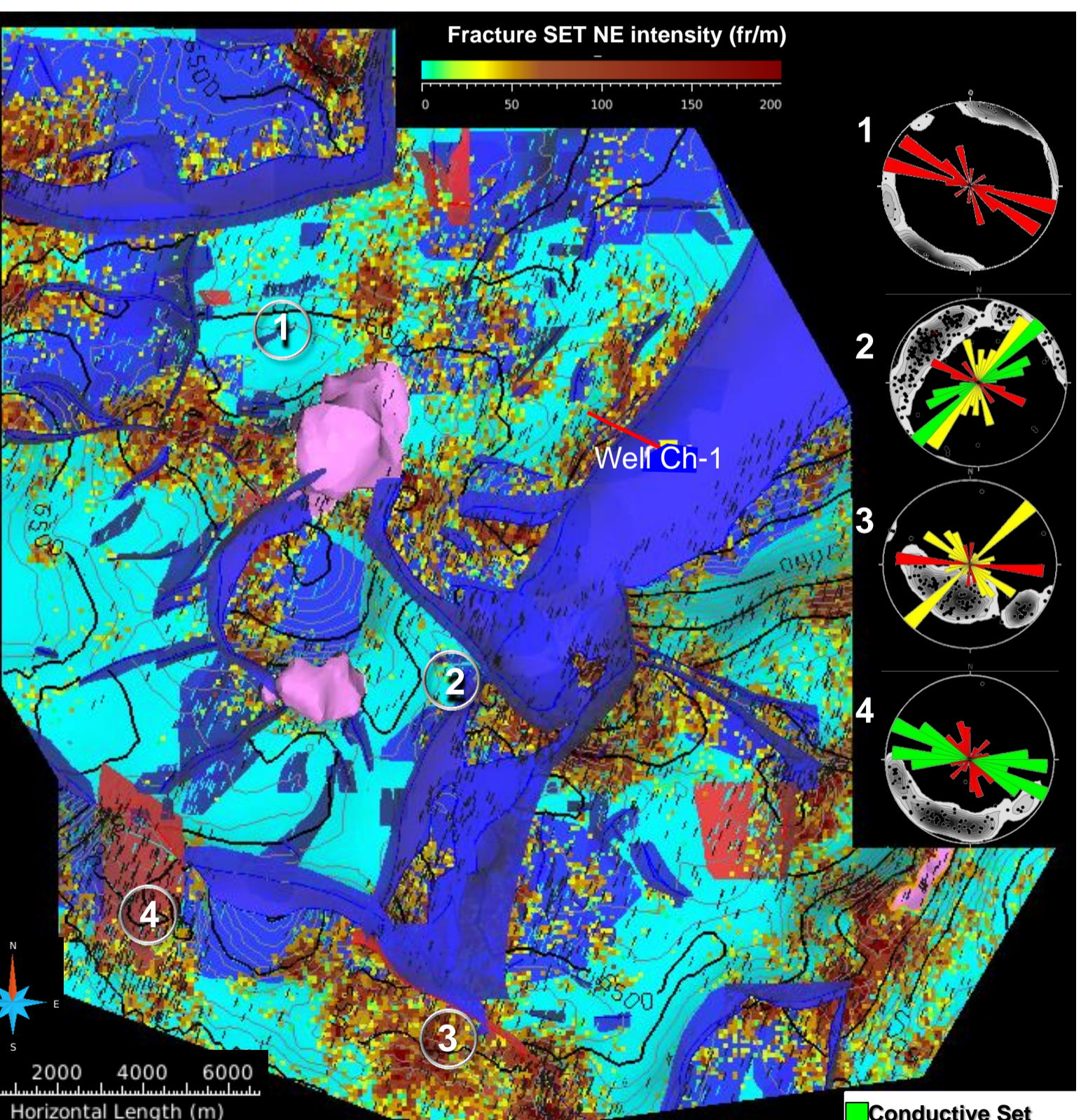
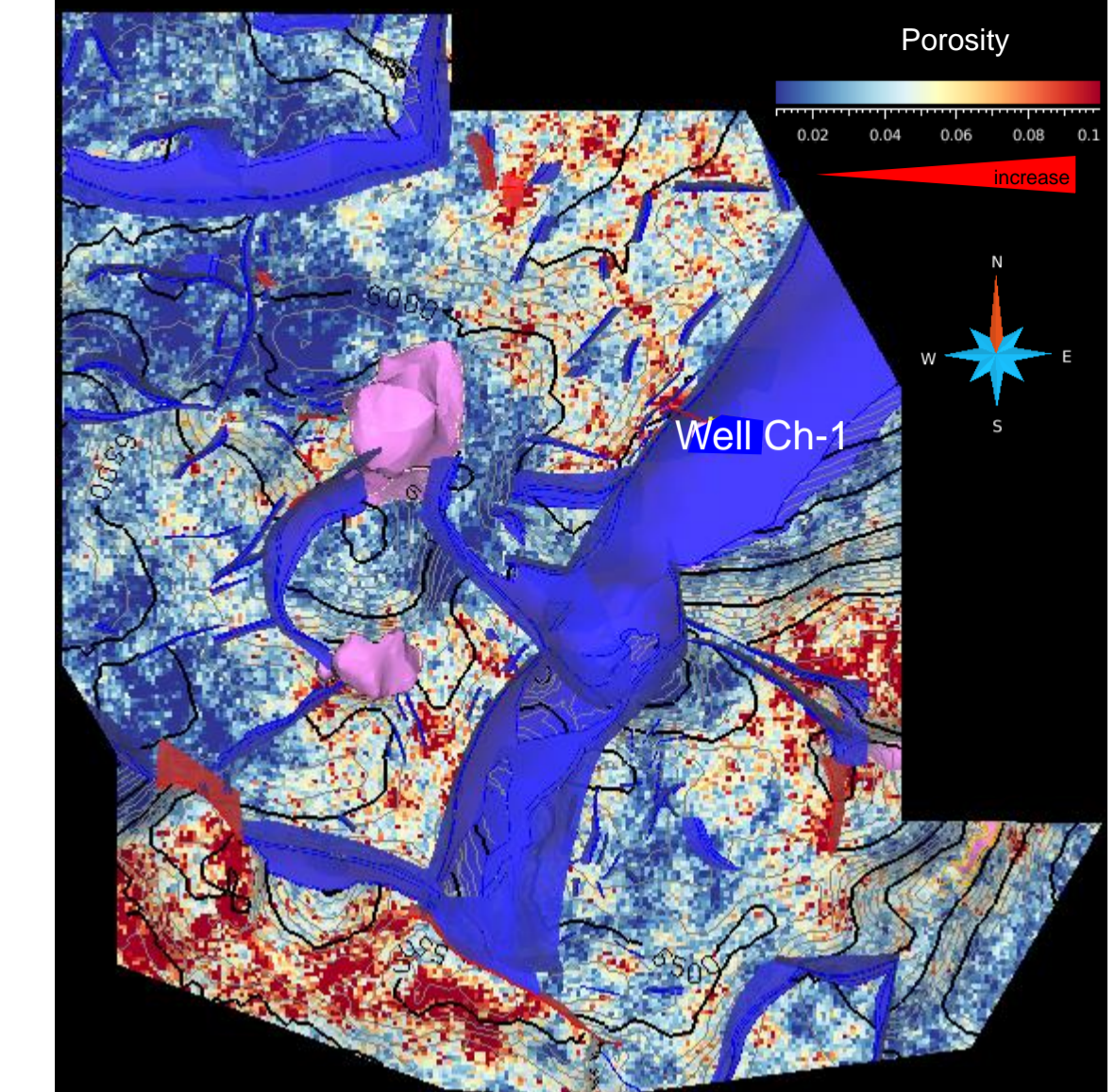
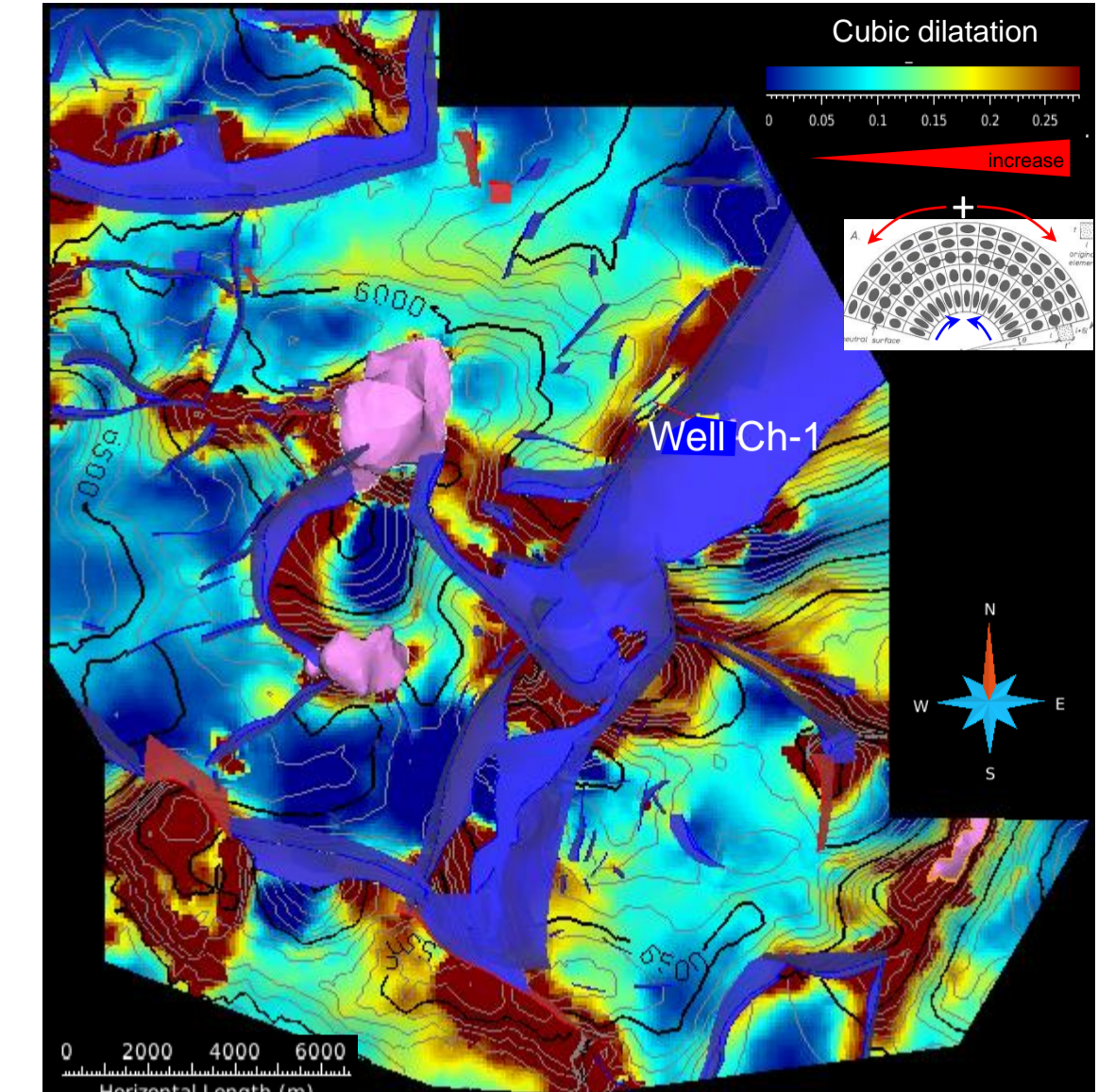
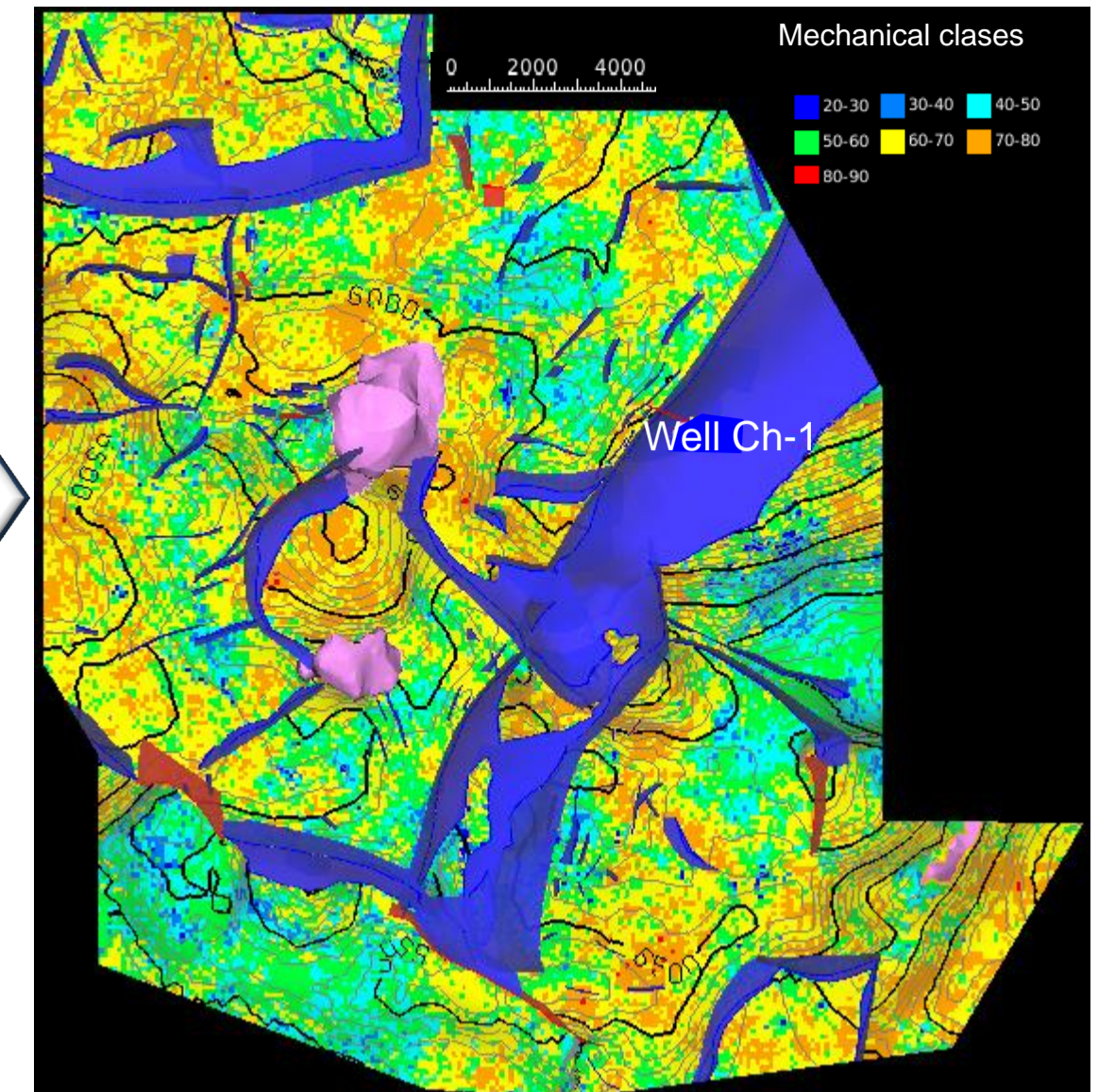
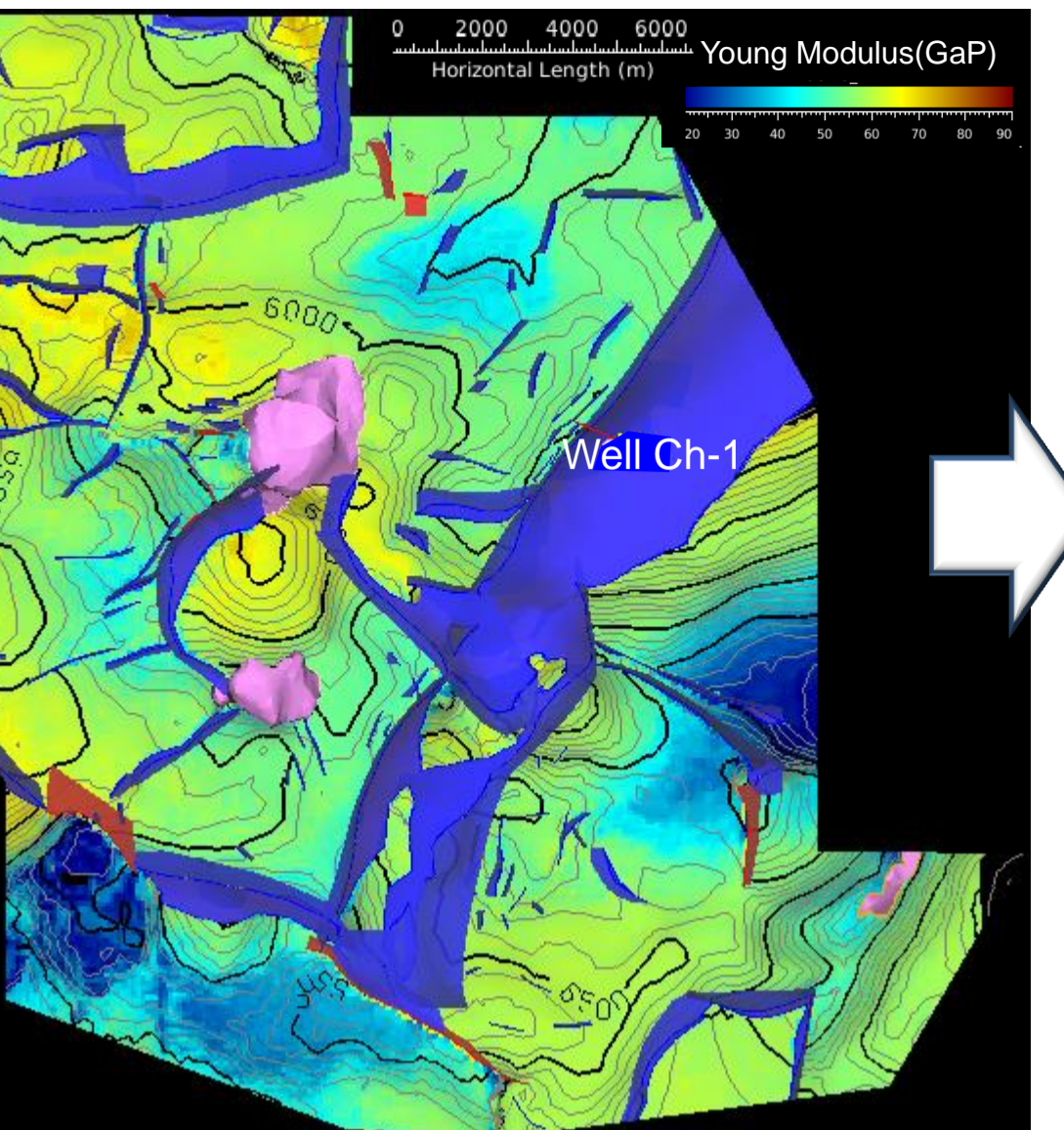
WELL DATA BLOCKING

- Upscaling reservoir properties of data wells to geological grid.
- For the propagation use a cube guide (VP, VS, RHOB, Young modulus, Cubic dilatation, Strain) or variogram statistic, etc.

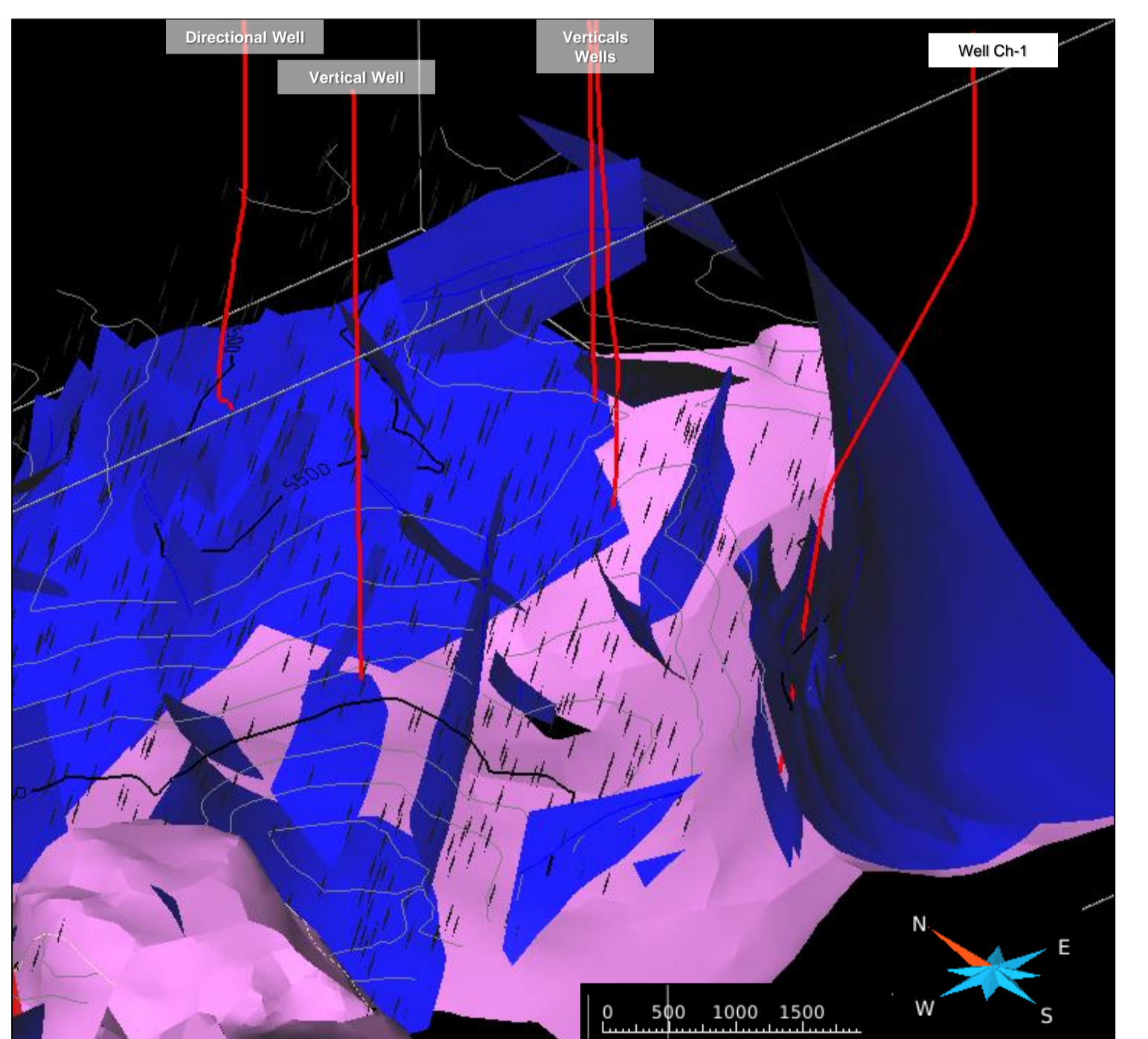


The well Ch-1 cut the fracture Set NE in Cretaceous sequence

RESULTS



Fracture Set NE Intensity and DFN distribution 3D



- The original well trajectory was designed vertical with only one target, the Upper Jurassic Kimmeridgian.
- As a result of this fracture study for the Cretaceous sequence, the original well design was modified to "S" type.
- This new trajectory was designed to intersect, at high angle, the NE conductive fracture set.
- In the study area 4 wells were already drilled (three have vertical trajectories and one was drilled parallel to set NE). No one of these four wells was successful.



The well Ch-1 is locate in a swamp -flood area.

CONCLUSIONS

- Both intensity fractures sets were modelling: conductive NE-SW, NW-SE, and non-conductive N-S, E-W.
- A 3D visualization of potentially fractured sequences targets for exploratory prospects was done, and also the proposals of well trajectories that can intercept open fracture sets.
- The trajectory of an exploratory proposal was redesigned. The well is currently drilling, and had a very good oil indicators of hydrocarbon while it was drilling the carbonated Cretaceous sequence.
- The study results offer the possibility of the incorporation of reserves in the study area for this sequence, that it already had been perforated by 4 wells without success, due mainly to have trajectories that cut the open fracture sets at low angle.
- This integrate multiscale methodology is applicable in naturally fractured reservoirs, and can be used also for reservoir characterization and for development of oil and gas fields as well.

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