[PS]Influence of Basement Fault Geometry and Orientation in Extensional Architecture: A Study Case at Manantiales Behr Oilfield at North Flank, Golfo San Jorge Basin*

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Abstract

Pre-existing structural features in the basement of the Manantiales Behr (MB) oilfield show NNW-SSE and ENE-WSW oriented faults which were evaluated with emphasis on their geometry and kinematics. To understand how these inherited structures may have played a role in the structuration of the sedimentary succession of the area, strike orientation and displacement analysis using 3D seismic data. The NNW trending faults have relative straight lines relating to planar faulting, while the other ENE oriented faults are defined by two strongly curved collinear traces and are associated with a listric faulting. Both lineament in time slice at 1760 mseg (TWT) shows “V” shape in the oriental zone of MB. For the late Jurassic- early cretaceous the first NNW oriented basement faults show a complex horst, main target of the field, associated with smaller curved faults connected to a hard-linked synthetic relay ramp. For the upper Cretaceous-Tertiary this fault complex evolved to an echelon system with individual E-W strikes developed over basement structures. Another fault complex oriented ENE - WSW is characterized by small parallel faults segments to the main basement structures and associated to collinear faults linked by transfer faults with a general fault network arrangement that mimic the strongly curved trace underlaying. The differences exposed in this work evidence the influence of basement faults during the propagation of smaller faults on the overlaying sedimentary sequences, which are oil-bearing units. The modern stress shows a SH min 10°-190° and SH max 280°-100° at Lower Mina del Carmen Formation (Albian) levels according to breakouts and induce fractures analyzed in two boreholes at 5 and 15 kilometers from the study area, this framework correlates with paleostress reconstructions from Upper Cretaceous sequences at the Cerro Dragón field. The interaction of this extension direction and the basement faults must have developed a coaxial and no-coaxial extension phase during the Late Cretaceous at an oilfield scale. This has important implication to evaluate flow pathways and horizontal migration linked to faults architectures. At the same time, it is a contribution for understanding the faults-controlled topography to infer orientation of coeval fluvial systems.

INFLUENCE OF BASEMENT FAULT GEOMETRY AND ORIENTATION IN EXTENSIONAL ARCHITECTURE: A STUDY CASE AT MANANTIALES BEHR OILFIELD AT NORTH FLANK, GOLFO SAN JORGE BASIN

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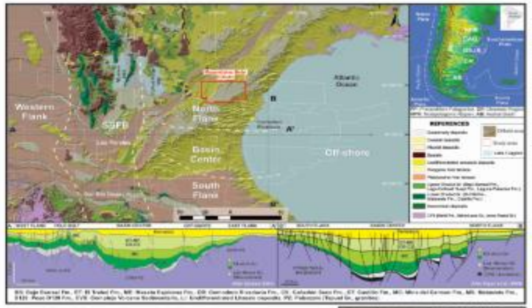
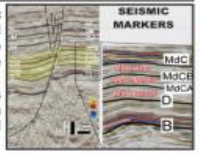
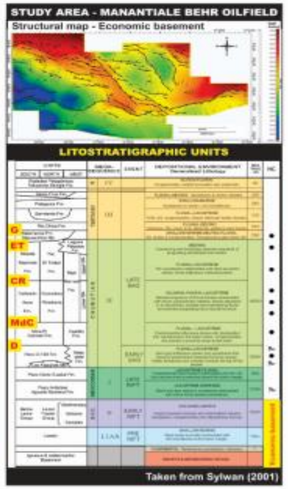
1. GEOLOGICAL FRAMEWORK





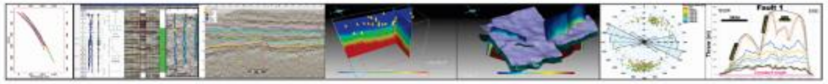
The Golfo San Jorge Basin is an intracratonic basin located in central Patagonia. It is linked to the Gondwana breakup, and the Cretaceous oil-bearing sequences are associated with an extensional framework. The North Flank is dominated by E-W faults south-dipping (Sylwan 2001). Petroleum systems are associated with continental sequences (fluvial and lacustrine).



2. OBJETIVES

- Evaluate the influence of basement faults in coverture fault network architecture.
- Analyze the geometric and kinematic evolution of master faults at an oilfield scale.
- Understand the influence of the basement fabric in the extensional architecture.

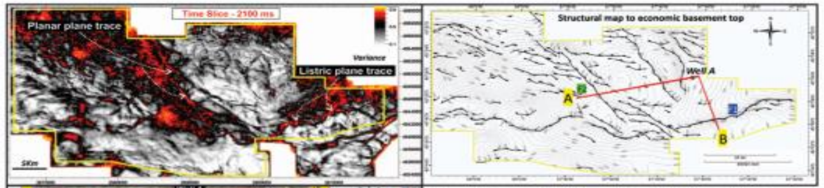
3. METHODOLOGHY - DATA SOURCE

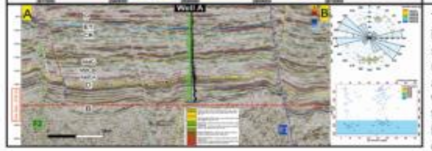


The study covers an area of 970km2 being imaged by a 3D pre-stack time migrated seismic, 390 faults and 6 main horizons described in the lithostratigraphic chart were interpreted using Petrel Software, plus 2 intermediate seismic horizons inside Mina del Carmen Formation (MdCA and MdCB). Fifteen widely distributed wells with measured sonic, density and borehole seismic data (checkshots or VSP) were selected to create a velocity model with calibrated TxD laws. Along with seismic velocities, the well velocity was interpolated using a geostatistical method (kriging with external drift) in a stratigraphic constrained 3D framework generated in SKUA-GOCAD™. Then a 3D sealed structural model created in depth enabled the automatic calculation of vertical throw values for each fault-horizon contact throughout the model.

4. RESULTS

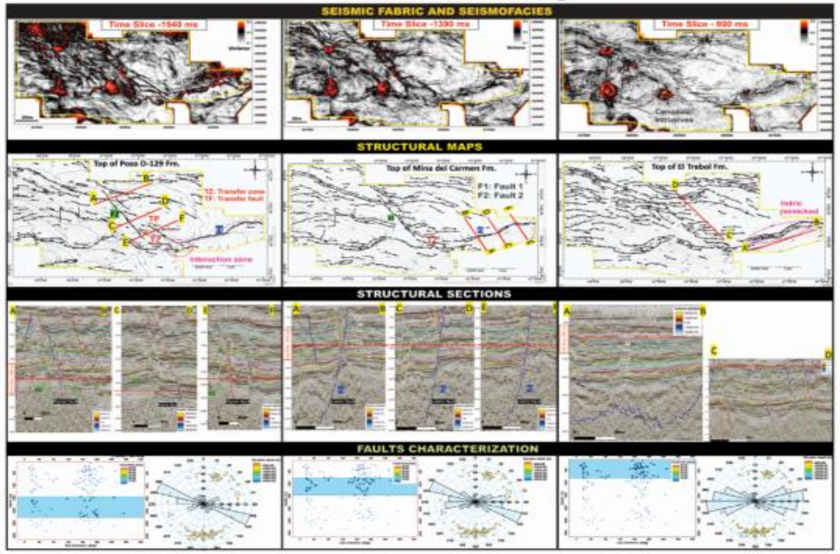
4.a. Economic basement fabric





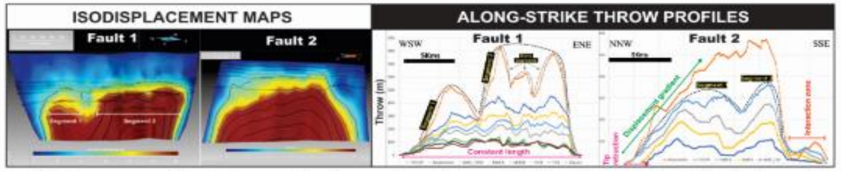
Time slice at -2100 ms. The intrabasinal basement highs show NNW-SSE and NE-SW strikes. The structural map shows the regional E-W faults and a secondary mode NNW-SSE. Structural section shows a small graben linked to Neocomian deposits, and wedge geometry in Pozo D-129 seismofacies that thickens to the west. Well A reached crystalline basement. Note de master faults have planar or listric geometries.

4.b. Master faults: Planar vs. Listric geometries



Inherited basement fabric conditioned the geometry of the coverture secondary fault network. Bimodal strikes of faults respond to the influence of the master faults. Along-strike seismic profile shows transversal syncline linked to variability in hanging-wall displacement. Note the reticulate pattern of the complex-horst in time slice at the top of Pozo D-129 Fm.

4.c. Kinematic analysis



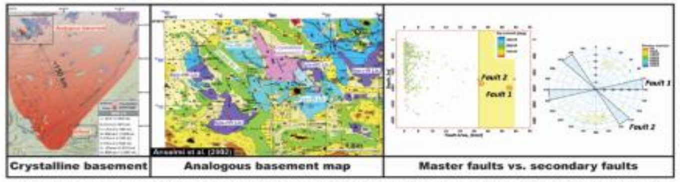
Fault 1 shows segmentation in basement level, suggesting colinear soft-link transfer zones. Later the structure acted as a unique fault with upward propagation and a decrease in the vertical throw. Fault 2 shows a displacement pattern asymmetric toward the interaction zone with fault 1, where the fault has a blocking trend. The tip migration toward the fault center evidences the fault retraction. The fault segmentation suggests dip-linkage of basement fault with intraformational Chubutian faults. Note Upper Cretaceous subsidence increase toward the abutting node.

5. DISCUSSION AND CONCLUSIONS

5.a. Coaxial vs. non-coaxial reactivation

Non-coaxial extension and depocenters controled the Cretaceous seismosequences. Regional absolute plate motion follows Müller et al. (2016). Semi-regional and local minimum horizontal stress (Shmin) is inferred from major depocenters with sin-tectonic sedimentation. Note: 1) the low-accomodation setting induced by the long-lived horst, 2) the frozen depocenter, and 3) the listric fault shows a strong control in Upper Cretaceous sequences (El Trébol Fm.)

5.b. Active basement fabric



The NNW-SSE structural trend correlates with the outcropped fabric of crystalline rocks. Their rock-type is analogous to the cutting record of Well-A. The fault area of faults 1 and 2 evidence polihistory major structures. The absence of positive tectonic inversion of the NNW-SSE fault is interpreted as a consequence of the stress shadow induced by the crystalline paleohigh located westward. This semirigid element acted as a basin-scale shield for the North Flank during the Andean compresion.

5.c. Potential Aplications

- Master faults have ***listric or planar geometries***, which control the architecture of the coverture-propagation structures like secondary-faults network, transversal folds, and parallel folds.
- Master faults should have developed wide damage zones, so anisotropy fluid flow is predicted respect to fault strike. This structural element can act as an along-strike kilometric and tortuous ***fluid pathway***.
- Manantiales Behr oilfield shows Cretaceous ***non-coaxial*** extension linked to inherited basement fabric. This scenario perturbs the regional paleostress direction. Tectonic fractures can not be predicted from regional absolute plate motion (gobal paleostress). ***Hydraulic stimulations*** should consider the stratigraphic interval evaluated and the basement influence to optimize the fractures development.

REFERENCES

- **Anselmi, G., Panza, J., Cortés, J., Ragona, D., Genini, A., 2000.** Hoja Geológica 4569-II, El Sombrero, Provincia del Chubut. Instituto de Geología y Recursos Minerales, Servicio Geológico Minero Argentino, Boletín 271, 92 pp, Buenos Aires.
- **Figari, E., Stelkov, E.E., Laffitte, G., Cid de la Paz, M., Courtade, S., Celaya, J., Vottero, A., Lafourcade, P., Martinez, R., Villar, H., 1999.** Los sistemas petroleros de la Cuenca del Golfo San Jorge: Síntesis estructural, estratigráfica y geoquímica. In: 4° Congreso de Exploración y Desarrollo de Hidrocarburos, 197-237, Bs. As.
- **Müller, R.D., Seton, M., Zahirovic, S., Williams, S.E., Matthews, K.J., Wright, N.M., Shephard, G.E., Maloney, K.T., Barnett-Moore, N., Hosseinpour, M., Bower, D.J., Cannon, J., 2016.** Ocean basin evolution and global-scale plate reorganization events since Pangea breakup. Annual Review of Earth and Planetary Sciences 44, p. 38-107.
- **Sylwan, C.A., 2001.** Geology of the Golfo San Jorge basin, Argentina. Journal of Iberian Geology, 27:123-157.

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