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Stress Organization along Neuquen Basin in Vaca Muerta Formation and their Impact in Microseismic Response

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Summary

This work presents the results of the analysis of stresses organization that includes the Shmax orientation and 1d geomechanical model information. The borehole breakouts and drilling induced tensile fractures (DITF) from wells within Total Austral blocks and surrounding areas in Neuquen Basin (Argentina) were used to compute Shmax orientation. This analysis was complemented with information obtained from World Stress Map Project and previous works [e.g. Guzman et al., 2007]. The results show a regional anticlockwise rotation of the SHmax from south to north of the Neuquen Basin.

The 1D geomechanical stresses model was computed in Total Austral wells and using to compute the ratios Shmin /Sv and Shmin /Shmax representing the stress regime and the horizontal stress anisotropy respectively.

The results show variations of stress regimes from strike-slip to thrust and a decrease of the stress anisotropy from south to north. These variations lead to different microseismic responses and allow characterizing in terms of hydraulic fracture creation the selected landing point in each area.

Introduction

A comprehensive knowledge of regional stress organization is one of the most important inputs for drain direction optimization and stimulation design of unconventional wells. The main geomechanical parameters to be considered to assess the stress organization are the SH_{max} orientation and the stresses model.
The SH_{max} map orientation achieved for Neuquen basin shows that along the study area this parameter is not completely uniform. An integrated study was performed using Word Stress Map (WSM) information, data from literature (Guzman et al. 2007) and the dataset of Total Austral (TA) wells to understand the behavior of this important geomechanic property.
The relations between the Sh_{min} /S_v and Sh_{min} /Sh_{max} magnitudes were computed at the selected landing point in Vaca Muerta (VM). Both stresses relationships have a strong impact in the development of new hydraulic fractures and SRV creation. Microseismic results confirm this dependence in TA blocks

Method

Several works have shown the relation between drilling occurrences, such as breakouts and drilling induced tensile fractures (DITF) with the in situ stress organization. In the present work, the breakout and DITF determined by image log (FMI) were used to infer the stress orientation within TA areas in Neuquen basin.
The SH_{max} orientations were statistically computed as the mean value of the drilling occurrences identified below Top Quintuco and qualified using the WSM quality ranking system version 2008 (only A, B and C data were included).
In order to compute the relation between the magnitudes of stresses the 1D single well stress model were computed by Total internal software and expertise.
Borehole and surface microseismic was acquired in several wells and were displayed together with the stress organization information to confirm the VM fracture behavior.

Results

The regional behavior shows an anticlockwise rotation of SH_{max} from ~N110° in the southern area to ~N70° in the northern area (figure 1).
The relationship of Sh_{min}/S_v and Sh_{min}/SH_{max} was analyzed in particular in two blocks operated by TA in the identified landing point within VM. The microseismic acquisition was also displayed to confirm the SRV creation (figure 2)

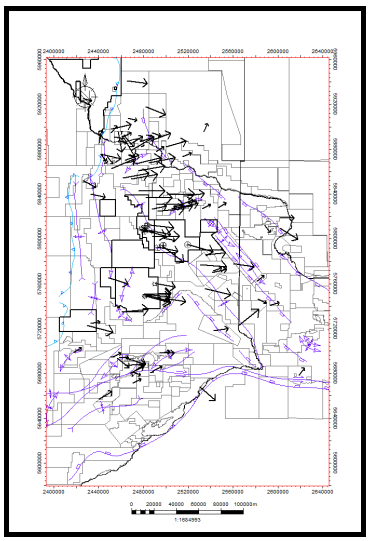

Figure 1 *Shmax orientation along the basin using 91 wells information form drilling occurrences.*

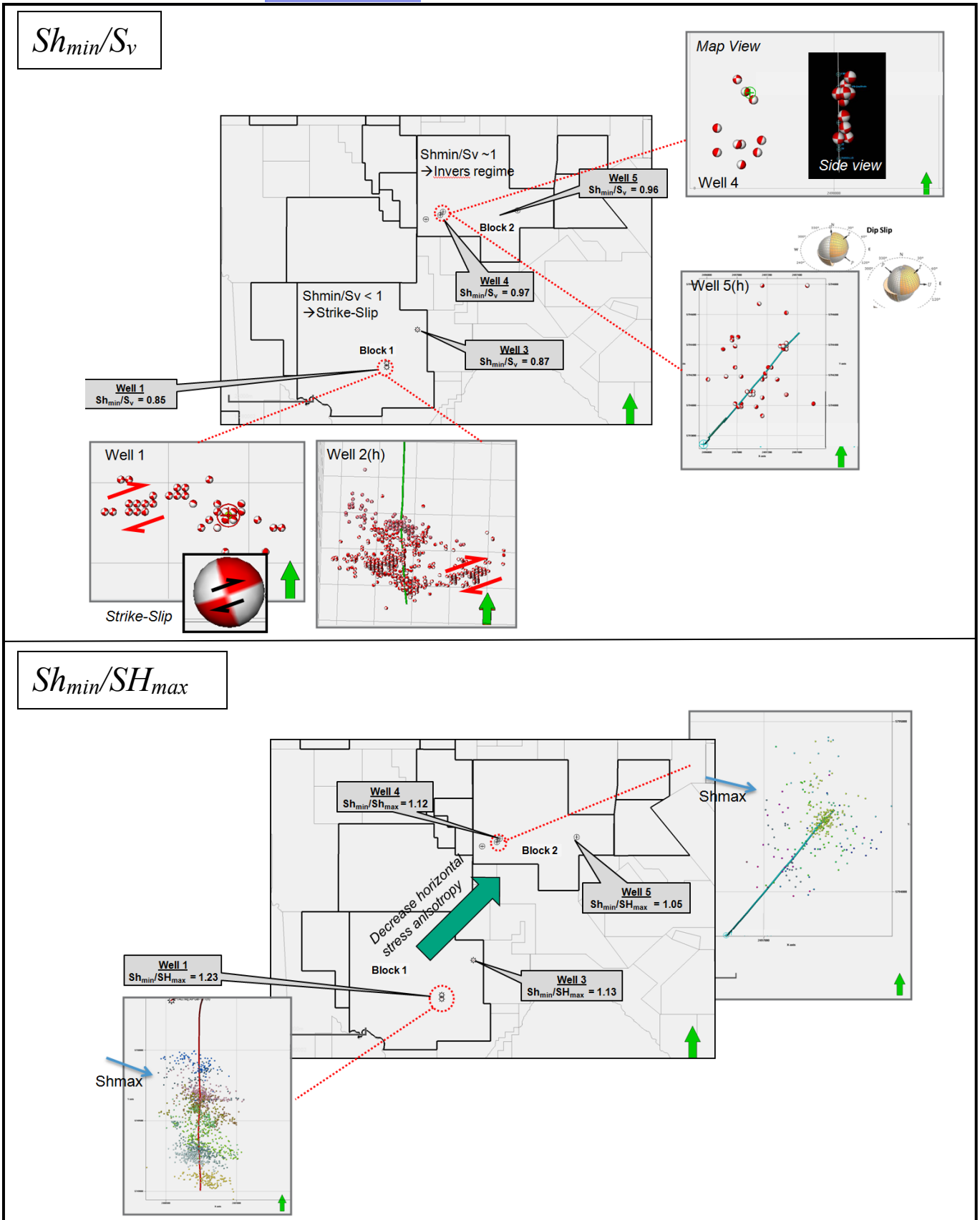

Figure 2 *Sh$_{min}$/S$_v$ (upper panel) and Sh$_{min}$/SH$_{max}$ (lower panel) in well computed in two blocks operated by TAU compared with microseismic.*

Conclusions

- The SH_{max} orientation presents an anticlockwise rotation from South towards North from 80° to 110° N.
- One of TA's blocks shows strike-slip tectonic regime and the other slightly reverse regime.
- TA's blocks shows variation in the horizontal stress anisotropy: high stress contrast, in zones such as block1, more isotropic zones in block2
- The SRV created in these two block are different observed in microseismic and in line with the stress relations. Thus the ratio between the stresses should be taking into account to evaluate the capability to create SRV of the selected landing point.

References

Guzmán, C., et al. [2007]. Contemporary stress orientations in the Andean retroarc between 34°S and 39°S from borehole breakout analysis. Tectonics, 26(3).