Successful Identification of Complex Cleat Systems in Coals

Ahmed Al-Jubori*
Schlumberger Canada, Calgary, AB
al-jubori@calgary.oilfield.slb.com

S. Khalid
Schlumberger Canada, Calgary, AB, Canada

and

T. Natras and I. McIlreath
Encana Corporation, Calgary, AB, Canada

Summary

Coals of the WCSB often exhibit a cleat system that is much more complex than what is typically associated with coals in general. This cleat system, or network, has a direct bearing on gas production due to its direct relationship with permeability. The ability to determine, or characterize, these cleat networks is a valuable exercise that can ultimatly lead to added production benefits. . While there are many methods to identify cleat systems in vertical wells, innovative use of resistivity micro-imaging in horizontal wells, combined with state-of-the-art modelling software has been found to give superior results.

Introduction

Many factors have an effect on production of gas from coals. These may be broadly classified as quality related (rank, brightness, ash content etc), and mechanical properties related (stress, natural fractures and cleating). For someone developing a coal play, sufficient understanding of all these parameters is very important before one can choose appropriate completion and production techniques. This poster specifically focuses on the determination of one of these parameters, i.e. cleats in a coal system

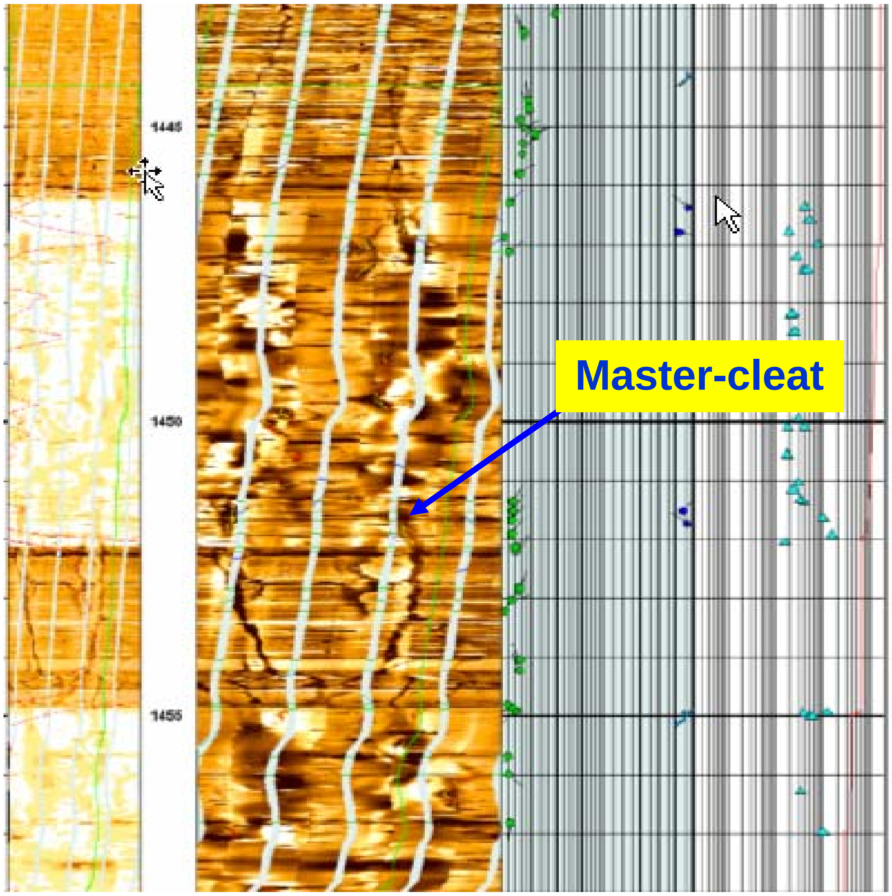

Figure1: Master-cleat on FMI image shown extending out of the coal seams and into the adjacent shales in a vertical well

Method

Simple cleat systems can be understood with many techniques. Various wireline logging methods and laboratory measurements can help understand these systems. Some of these are described below;

1) Anisotropy analysis of shear waves
2) Geochemical logging to identify secondary minerals which can then be related to cleat systems
3) Laboratory measurements of coal maturity may help infer the quality of cleat system
4) Formation micro-imaging may allow direct visualization of coal cleats if significant resistivity contrast exists between a cleat and it surroundings.

Many of these methods have been employed in the industry with varying degrees of success in vertical well bores. In the case of horizontal wellbores, method 4 has been found to have the most merit. This method is specially relevant when the possibility of complex cleat structures exists in areas with multiple stress regimes, histories of dramatic subsidance and elevation etc. Many Canadian coal deposits fall under this category.

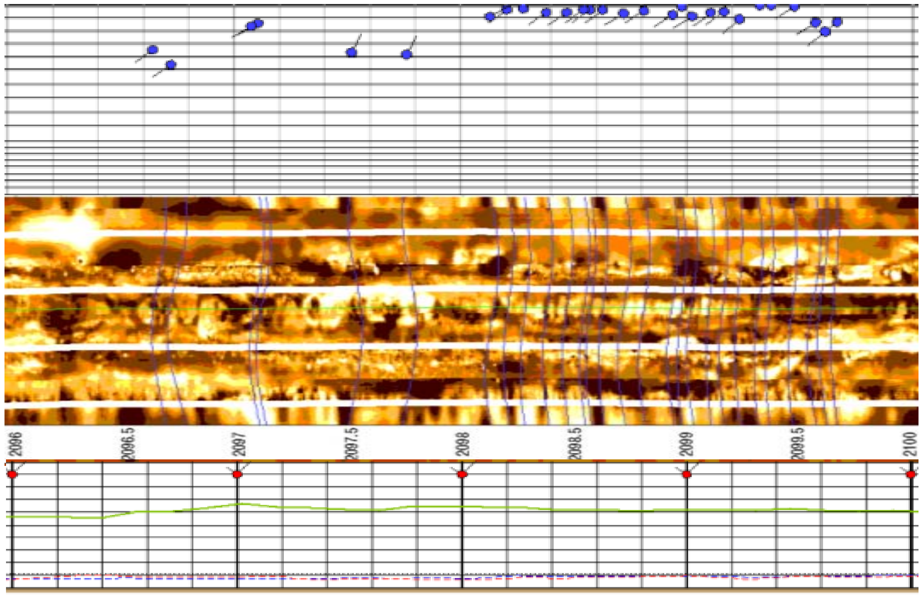

Figure2: In a horizontal well, master cleats can be seen on FMI image in the shale in between the coal seams

Examples

Figure 1 shows results of an FMI* (Formation Micro-Imager) device in a vertical well. The image shows a significant feature (marked with an arrow) which is a master-cleat superimposed on the conventional cleat structure. Of particular interest is the fact that this feature has extended beyond the coal and into the adjacent shale bed. This feature can also be seen in the interbed shale. Figure 2, shows a horizontal well log image. In this case the well trajectory takes one through the interbed shale at a very high angle. Clearly visible in the interbed shale are master-cleats at a significant frequency of occurance, which seems to increase as one gets closer to the coal seam.

Figure 3 is a steronet showing the general direction of these master-cleats. Also noticeable is the consistency in the direction of these features.

This cleat data when properly used can be very helpful in predicting the flow quality of these coal seams. In order to best use this data and to be able to better visualize and correlate it with other data sets (for example seismic, petrophyscial and production data) , it was imported into a highly sophisticated 3D visualization and modelling software called Petrel*. Figure 4 shows a plot of the cleat data superimposed on the well trajectory in a horizontal well.

Conclusions

A very comprehensive technique is now available to look at complex cleat systems in coals. This technique has been tested in a number of wells in Canada and has given promising results. The use of state-of-the-art resistivity imaging hardware and interpretation methods, combined with latest modelling and visualization software has allowed this to be possible.

Acknowledgements

The authors wish to acknowledge the following people for their contribution to this project.

ChristianAbaco (Geophysicist), Catherine Lutzak (GeologicalTechnologist), MikeYu (Production Technologist), Randy Hnatuik(Group Lead) of Encana Corporation, Calgary, AB, Canada

Nader Khosravi (Project Manager), Malcolm Lamb (Geologist), Leon Halwa (Geologist), Bazlur Rahman (Geologist), Oscar Skold (Petrel Modeling), Trevor McLeod (Unconventional Gas Stimulation), Drazenko Boskovich (Geological Technologist), Patrick Fothergill (Geologist), John Kovacs (Technical Advisor, now at EOG Resources) of Schlumberger, Calgary, AB, Canada

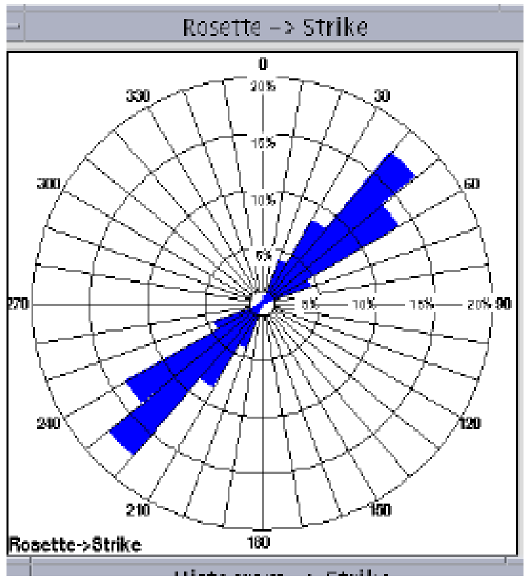

Figure3: Stereonet indicates selectively filtered data showing the direction of mega cleats.

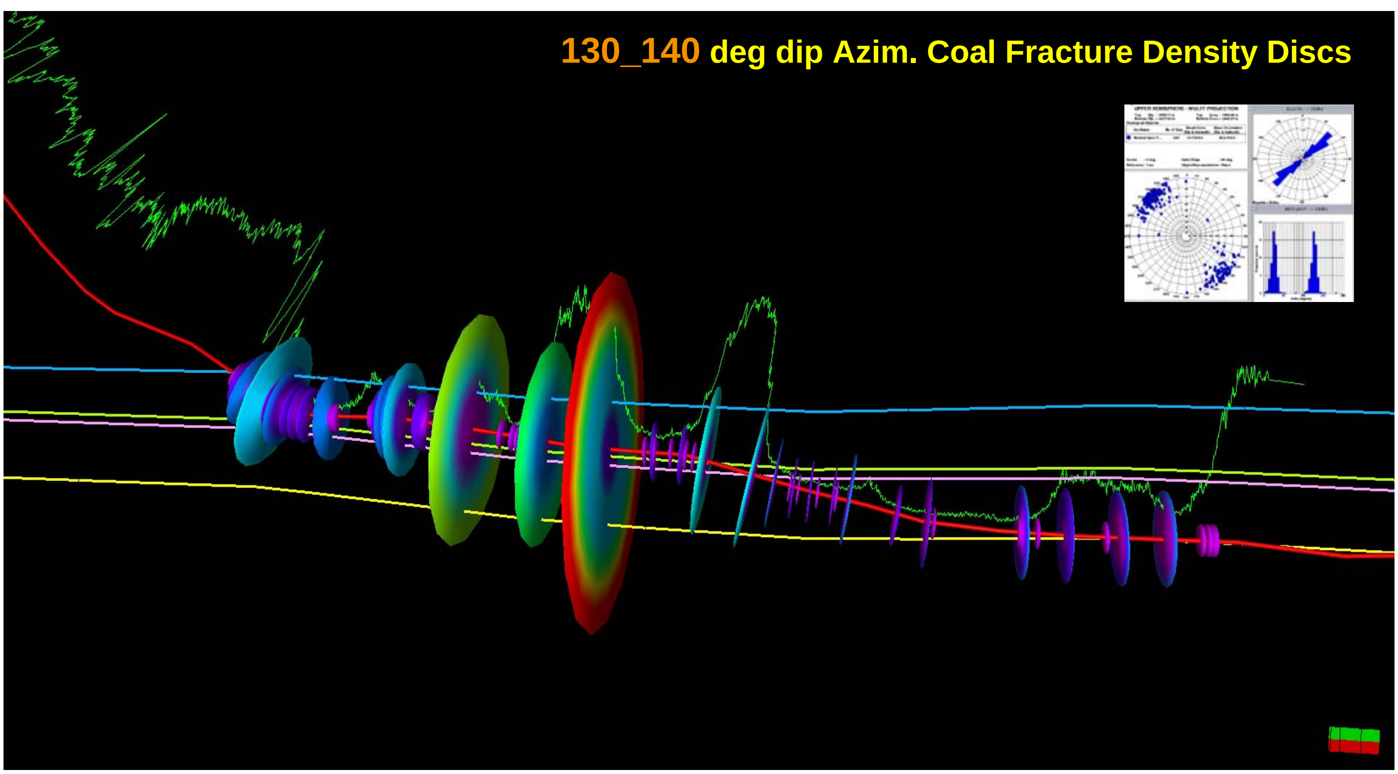

Figure4: Sophisticated modeling software allows correlation of cleat information with other critical datasets like seismic, petrophysical and production information.