Wellbore logs in Rittershoffen, Alsace: acquisition, analysis and integration for fractured reservoir characterization

Giovanni Sosio, Andreia Mandiuc, Annalisa Campana, Schlumberger Jeanne Vidal, Régis Hehn, ES Géothermie





The ECOGI project in Rittershoffen, Alsace







The ECOGI project in Rittershoffen, Alsace



PDEANNIALD

Brühl





The ECOGI project in Rittershoffen, Alsace







Schlumberger



















Schlumberger





PMIT

EMS

DSI



eferenc (m)

1:5000

500

1000

1500 --5000

2000

-8000 2500

feren (ft)





Schlumberger

Geological interpretation: natural fractures



1500 m of ultrasonic images analyzed in GRT-1 and GRT-2

360 individual fractures observed in both wells

- → GRT-1: N10°E to N20°E steeply dipping westward
- → GRT-2: N160°E to N-S steeply dipping eastward





Geological interpretation: natural fractures

1500 m of ultrasonic images analyzed in GRT-1 and GRT-2

360 individual fractures observed in both wells

- → GRT-1: N10°E to N20°E steeply dipping westward
- → GRT-2: N160°E to N-S steeply dipping eastward

Fracture orientation more homogeneous in GRT-1: GRT-2 collinear to the main fault intersects fractures with different orientations

(Vidal et al., EGC 2016)





Schlumberger

Geological interpretation: natural fracture permeability

SAID

Permeable fracture zones associated to total mud losses and negative thermal anomaly







Geological interpretation: natural fracture permeability



Permeable fracture zones associated to total mud losses and negative thermal anomaly



Less than 3% of fractures in GRT-1 and 1% in GRT-2 are permeable







Computation of mechanical properties and stress magnitude based on sonic (DT, DTS) and density logs







Computation of mechanical properties and stress magnitude based on sonic (DT, DTS) and density logs

Stress orientation derived from drilling-induced tensile fractures *(Hehn et al., EGC 2016)*

"Mechanical earth model" validated against observed wellbore stability events (drilling-induced fractures from wellbore images and ovalization from caliper)



















GRT-2 (prediction)







GRT-2 (prediction)



From data acquisition to modeling









Microseismic data





Seismic data



Structural model



Logs & offset well info



Drilling data







Microseismic data













Microseismic data











Integration and modeling: natural fractures



Discrete fracture network using image interpretation and structural model – tectonic-based approach



Input – image log interpretation and structural model





Integration and modeling: natural fractures

Discrete fracture network using image interpretation and structural model – tectonic-based approach

315

Geomechanical engine identifies stress regime linked to observed faults/fractures





Strike slip

Normal

180

Reverse







Integration and modeling: natural fractures

Discrete fracture network using image interpretation and structural model – tectonic-based approach

315

Geomechanical engine identifies stress regime linked to observed faults/fractures





Strike slip

Reverse

Normal





Mechanical properties propagated based on 2D seismic inversion





Mechanical properties propagated based on 2D seismic inversion



Stress tensor













Estimated microseismic events







Estimated microseismic events
Measured microseismic events



Conclusions



Accurately designed **log acquisition plan:** wellbore images and dipole sonic logs from surface

→ Detailed analysis of natural fracture geometry and of mechanical properties





Conclusions



Accurately designed **log acquisition plan:** wellbore images and dipole sonic logs from surface

→ Detailed analysis of natural fracture geometry and of mechanical properties

Integration of different domain data (images and temperature; sonic and images; etc.)

 \rightarrow Insight on reservoir behavior (permeability, stress...)





Conclusions

Accurately designed **log acquisition plan:** wellbore images and dipole sonic logs from surface

→ Detailed analysis of natural fracture geometry and of mechanical properties

Integration of different domain data (images and temperature; sonic and images; etc.)

 \rightarrow Insight on reservoir behavior (permeability, stress...)

Multi-disciplinary **3D model** (geological, fluid flow and geomechanical) based on the above

 \rightarrow Understanding of site **performance and risks**





Schlumberger

Acknowledgments



Schlumberger

Thanks for your attention!

gsosio@slb.com

Many thanks to Charidimos Spyrou, Oleksandr Burachok, Ann-Sophie Boivineau, Claudia Sorgi, Vincenzo De Gennaro, Karsten Fischer, Clément Baujard, Albert Genter



Data kindly provided by the ECOGI consortium Modeling software used courtesy of Schlumberger

