geoconvention
Calgary • Canada • May 12-14 2025

Bentonite Swarms and SAGD Casing Impairments – Stratigraphic Correlations, and Coupled Reservoir and Geomechanical Modelling at Meota, Saskatchewan.

Sean Fletcher and Gokhan Coskuner
Strathcona Resources Ltd.

Summary

Casing deformation and impairments at Meota Steam-Assisted Gravity Drainage (SAGD) Operations have impacted the integrity of numerous wells leading to loss of pressure containment, deformation of the production casing, or an inability to lower workover tools. Caliper logs have identified numerous zones of deformation across multiple wells in a SAGD pad, and across multiple pads in different assets areas that correlate strongly with regional stratigraphy. We present here the results of a study to identify the stratigraphic root causes of these impairments including a shallow geology coring program, image logs, and geomechanical testing observing strong correlation to zones with a high prevalence of bentonite beds. We then use coupled reservoir and geomechanical modelling using the results from our data collection program that reproduce the thermally induced deformation of the casing in bentonite bearing zones which may suggest some mitigation strategies.

Observations and Data Collection

When plotting caliper logs of casing deformations and impairments across the area of operations in sub-sea depth, a strong correlation in the shallow caprock indicates a geological control over the zones of likely casing deformation. These zones in the Upper Colorado group are typically only logged with standard triple-combo wireline tools that did not indicate any anomaly that may result in these failure zones. Strathcona undertook a wellbore integrity investigation to understand the failure mechanism, collecting data on these deformation zones by coring the correlated zones, and adding high resolution image logs to the standard log suite for this uphole section. The core was able to identify several discrete bentonite ash beds within these zones, which range from 1 to 20 cm thick and correlate well with the depths of casing deformation and impairment. Core analysis was conducted to derive geomechanical properties for the surrounding shale, silt and bentonite beds. The recognition that resistivity image tools were able to resolve and identify the bentonite beds reduced the need for further coring, and a logging program of over a dozen stratigraphic wells in the asset areas was undertaken that provided a regional dataset capable of correlating individual bentonite beds over tens of kilometres.

Geological, and Coupled Reservoir and Geomechanical Modelling

The data derived from the stratigraphic framework from surface to the reservoir zone, core analysis, and bentonite bed correlations were used in numerically simulating the response of the reservoir and the overlying formations to steam injection through geomechanical modeling coupled with reservoir simulation. Although relatively thin, the addition of the bentonite beds

with their specific thermal and geomechanical properties was key to understanding the impact of operational temperatures in the overburden.

Near Wellbore Modelling

Using the boundary conditions provided from the 3D Mechanical Earth Model (MEM), the response of the wellbore tubulars and the cement to the calculated stresses and strains in the formation was investigated using a near-wellbore model. In such modeling, a homogenous overburden model without the recognized bentonite zones that show a significant deviation in geomechanical properties from the surround shale, does not replicate the casing impairments measured in our area. However, with the inclusion of the naturally weak layers, such as the bentonite layers mentioned above, results demonstrate shear slip could develop along the boundaries between the bentonite layers and the surrounding shales, thereby leading to casing impairment.

Conclusions

The contrast between the mechanical and thermal properties of the bentonite and shale layers causes differential stresses and strains when subjected to heating/cooling due to SAGD operations. The response of the shallow formations to heat transfer from the vertical and build sections of the wellbore, rather than the heave from the steam chamber, is the main culprit.

References

Mossop, G. D., & Shetsen, I. (Eds.). (1994). Atlas of the Western Canada Sedimentary Basin (Chapter 20: Cretaceous Colorado/Alberta Group). Canadian Society of Petroleum Geologists and Alberta Research Council. https://ags.aer.ca/publications/WCSB_Atlas

Zhang, Y. (2023). Characterization of Cenomanian-early Turonian bentonites in southwestern Saskatchewan through lithostratigraphy and chemostratigraphy analysis (Master's thesis). [University of Regina].