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Validating geologic representations with dynamic modeling

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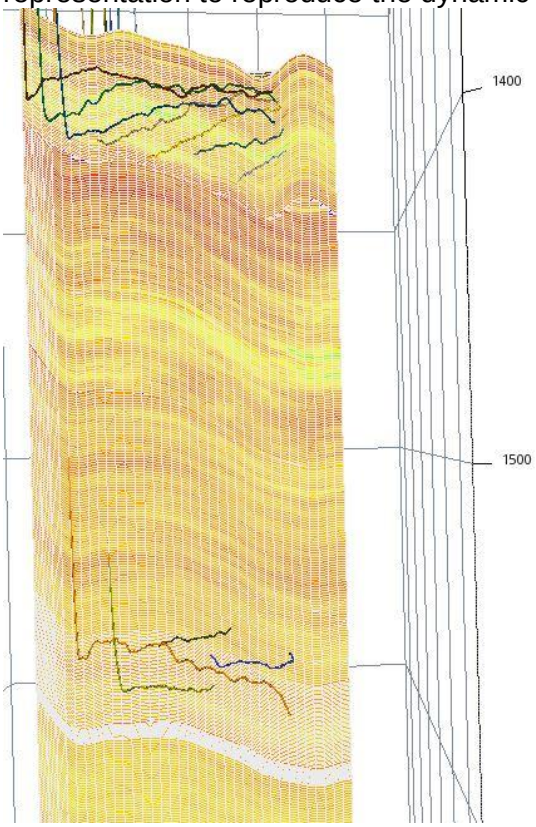
Summary

Subsurface geoscience is a challenging field in part because absolute truth is rarely available. Instead, multiple diffusive and indirect signals are combined to create a representation of the subsurface: permeability, porosity, pore pressure, water saturation, and geomechanical properties. Very rarely is direct measurement of these data available.

Dynamic modeling is similarly challenged by the scarcity of direct observation data to match and calibrate to. Rarely are the degree of pressure depletion or saturation changes spatially known.

Integrating static and dynamic modeling allows for the synthesis of data into a coherent ordering. Dynamic data can falsify certain geologic representations and vice versa. In this work we demonstrate constructing multiple dynamic, coupled fracture and reservoir models from three geologic representations and through the model calibration process show the feasibility of each representation to reproduce the dynamic data.



Example geologic model imported into dynamic model

Theory / Method / Workflow

Three different geologic representations of the same well pad are imported into a coupled fracture-reservoir model. Import and upscaling process is shown and discussed. Each model is then calibrated to observations of fracture dimensions, instantaneous shut-in pressure, and production pressures and volumes. Model parameters are adjusted within reason; however, if a if a parameter is adjusted to its logical extreme without replicating the desired response, the geologic representation is considered falsified.

Results, Observations, Conclusions

This work is still underway; however it will build upon the work in Fowler et al., 2019. Fowler et al. show how effective fracture length can be varied to match the same production data in models with two different permeability realizations. However, interference data show a deviation from linear flow in the field data within weeks of bringing the wells online, suggesting direct well to well communication. As well spacing is fixed, effective fracture length *must be* at least half the well spacing in order for direct, well-to-well interference to occur, thus falsifying the high permeability model.

A similar workflow and conclusion is show here, but with more complicated geologic models and greater variety of properties.

Novel/Additive Information

The presented workflow provides geoscientists with another tool for validating and falsifying subsurface interpretations. Absolute truth is never known in the subsurface; however, by assimilating and reconciling multiple data sources the band of uncertainty can be substantially reduced, enhancing the predictivity of models.

Acknowledgements

References

Fowler, Garrett , McClure, Mark , and Craig Cipolla. "A Utica Case Study: The Impact of Permeability Estimates on History Matching, Fracture Length, and Well Spacing." Paper presented at the SPE Annual Technical Conference and Exhibition, Calgary, Alberta, Canada, September 2019. doi: https://doi.org/10.2118/195980-MS