Shale Transformations and Physical Properties—Implications for Seismic Expression of Mobile Shales

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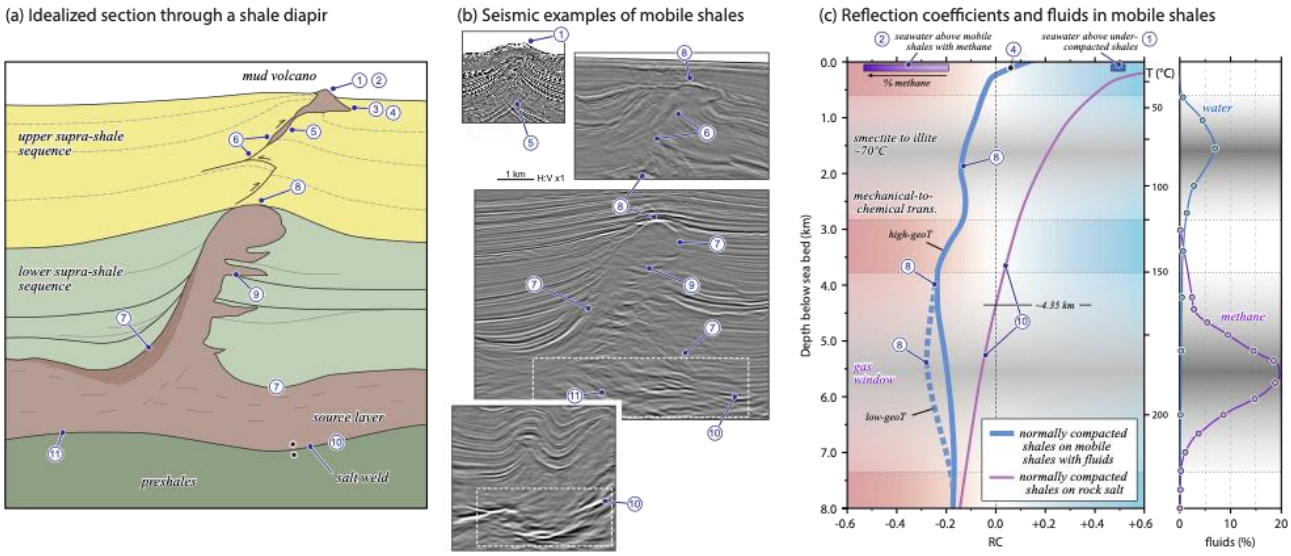

Study Summary

Seismic interpretation of mobile shales is challenging, mostly because of their unclear seismic expressions. Imaging of mobile shales is difficult because of their low seismic-impedance contrast with many sedimentary rocks, spatial variation of their seismic properties, the complex geometries of mobile-shale structures, and the shales' complex internal structures.

To unravel this problem, we reviewed the physical properties of shales, merging data from in situ determinations of density and sonic velocities with experimental data and modeling results. We analyzed how diagenetic transformations during shale burial modify physical properties and seismic characteristics. We reviewed conditions for smectite–illite transformation and gas generation (mostly methane) by oil cracking to evaluate how thermal gradient, shale composition, and hydrocarbon content modify the densities, sonic velocities, and seismic expressions of mobile shales. We then incorporated the amount and type of fluids released in shales during diagenesis into a study of seismic reflectivity of mobile shales.

Results derived theoretically for various types of mobile-shale contacts are compared with high-quality seismic examples, including mud volcanoes and a variety of complex shale diapirs. Observed reflectivity and seismic fabrics are discussed to infer clay composition, fluid content and type, and temperature.

Why is this research important and why do the results matter?

- Deformation involving shales in continental margins and basins produces complex structures that are difficult to image by seismic profiling.

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- Clay transformations and generation of hydrocarbons promote significant changes in the physical properties of mobile shales.
- Physical properties of mobile shales were computed for various fluid contents from diagenetic and hydrocarbon transformations like the smectite–illite reaction and oil cracking producing thermogenic methane.
- Seismic expression of mobile shales was analyzed using theory and examples.
- Seismic interpretation of mobile shales is discussed, with a varied catalogue of examples of mud volcanoes, shale sheets, and shale-cored folds.

Link(s)

https://www.beg.utexas.edu/agl
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