13.10: Modeling creep & smectite-illite transformation: implications for preconsolidation stress and overpressure

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ABSTRACT

We developed a one-dimensional numerical model of sedimentation and compaction with creep and smectite-illite transformation. With our model, we showed that both creep and smectite-illite transformation cause rocks to be more pressured, more compacted (Fig. 1), and apparently overconsolidated (Fig. 2). The rate of creep is highest near the seafloor and decreases rapidly with burial. Creep is essential to upscale the laboratory measured normal compression behavior to field scale. Smectite-illite transformation is critical in deep rocks and at high temperature which generates extra compaction and higher overpressure compared with shallow rocks (Fig. 1). These findings are important for understanding pore pressure and hydrocarbon migration in the field.

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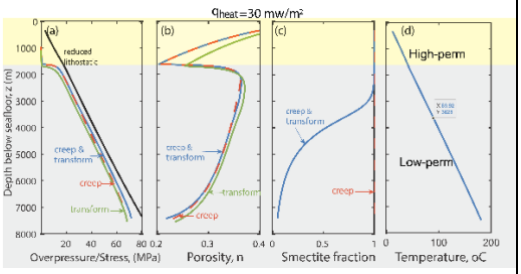


Fig 1: Simulated depth profile of (a) overpressure, (b) porosity, (c) molar fraction of smectite, and (d) temperature at 8.5 m.y. with a constant geothermal heat flux of 30 mw/m^2 for cases with only creep (dashed red lines), only smectite-illite transformation (solid green lines), and with both creep and smectite-illite transformation (solid blue line). Yellow color means high-permeability sediment; gray color means low-permeability sediment.

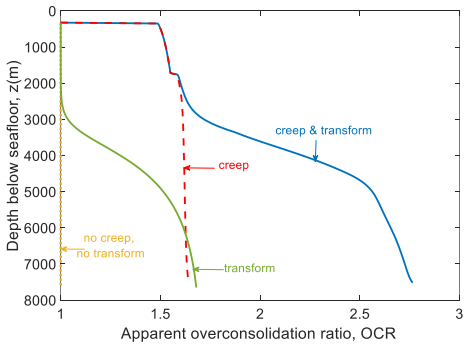
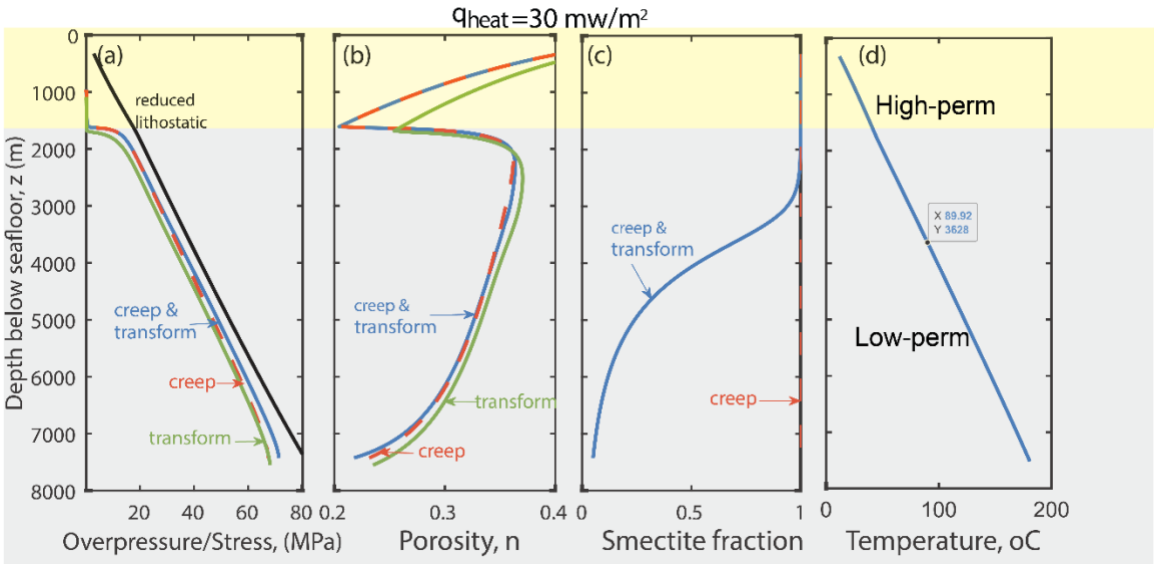


Fig 2: Creep causes an apparent overconsolidation ratio up to 1.52 in shallow depth (dashed red line). Smectite-Illite transformation causes extra overconsolidation in deep depth (solid blue line).



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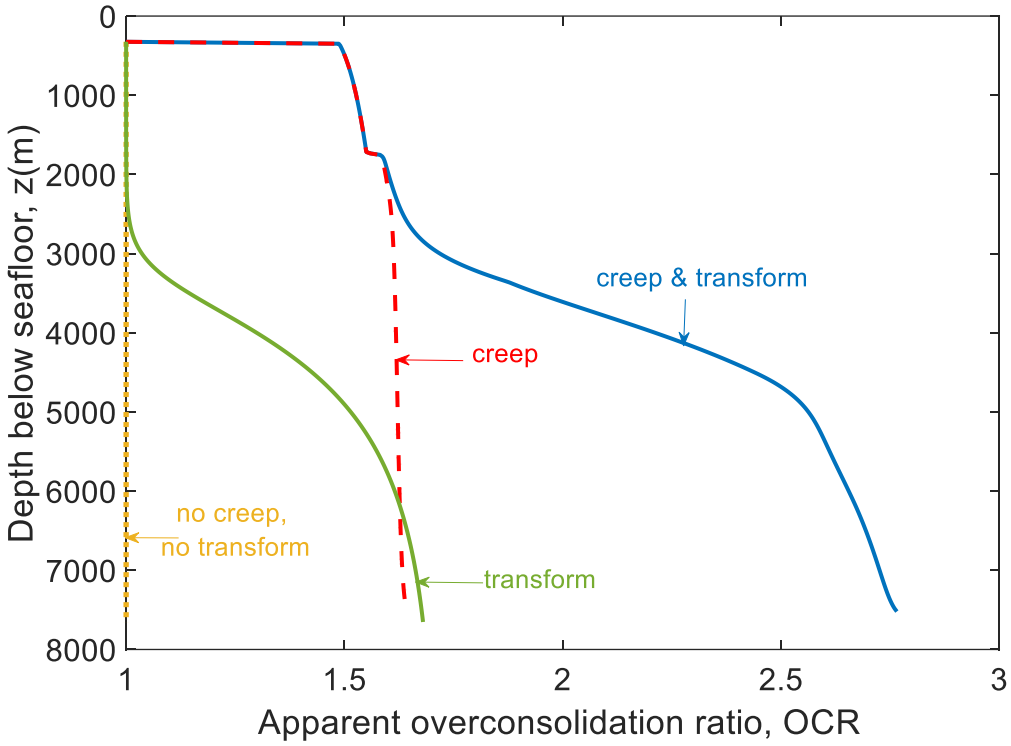

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