12.10: The Origins of Overpressure

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ABSTRACT

I review how overpressure is generated in sedimentary basins. I begin by describing how pore pressure is generated under conditions of uniaxial strain. I then explore the overpressure that results during sedimentation under conditions of vertical uniaxial strain. I illustrate how these types of basin models provide insight into the evolution of pressure and stress in basins. I then discuss hydromechanical models that couple the full stress state with pore fluid flow under three-dimensional strain. These models illustrate that in settings of non-uniaxial strain, the full stress field must be calculated in order to estimate the pore pressure (Fig. 1). The effect is particularly dramatic around salt bodies and in thrust belts. Finally, I explore the potential role of viscous compaction in pore pressure generation. During viscous compaction (or creep), porosity is lost as a function of time and temperature at a fixed effective stress (Fig. 2).

We have debated for decades the relative role and importance of different mechanisms for generating overpressure. I emphasize that in a growing sedimentary basin, the role of sediment loading and tectonic forces are dominant, while the overpressure generated by either diagenesis or thermal expansion are small. However, viscous compaction may play a significant role in pore pressure generation in many basins around the world and a better understanding of this behavior will improve our ability to predict pressure.

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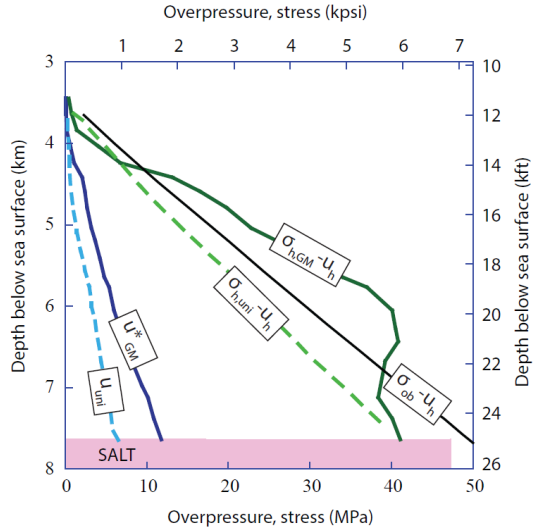


Fig 1: Overpressure predicted by the geomechanical model near salt (solid dark-blue line) is higher than that predicted by a uniaxial model for the same average sedimentation rate (dashed light-blue line). Reprinted from Nikolinakou et al. (2018).

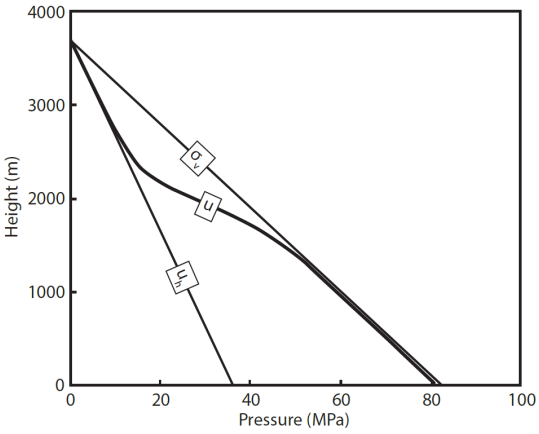
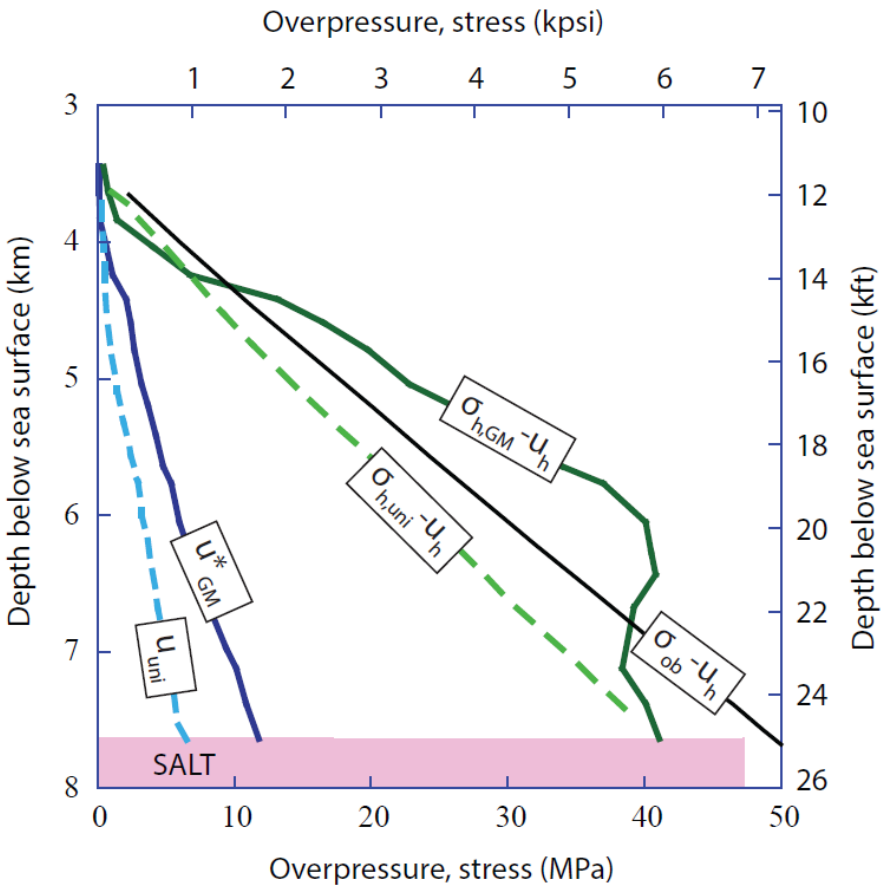


Fig 2: Simulated overpressure during constant sedimentation of one lithology. Sedimentation rate is low and mechanical loading produces little overpressure. However, viscous compaction in older, deeper, sediment generates significant overpressure. Modified from Morency et al. (2007).



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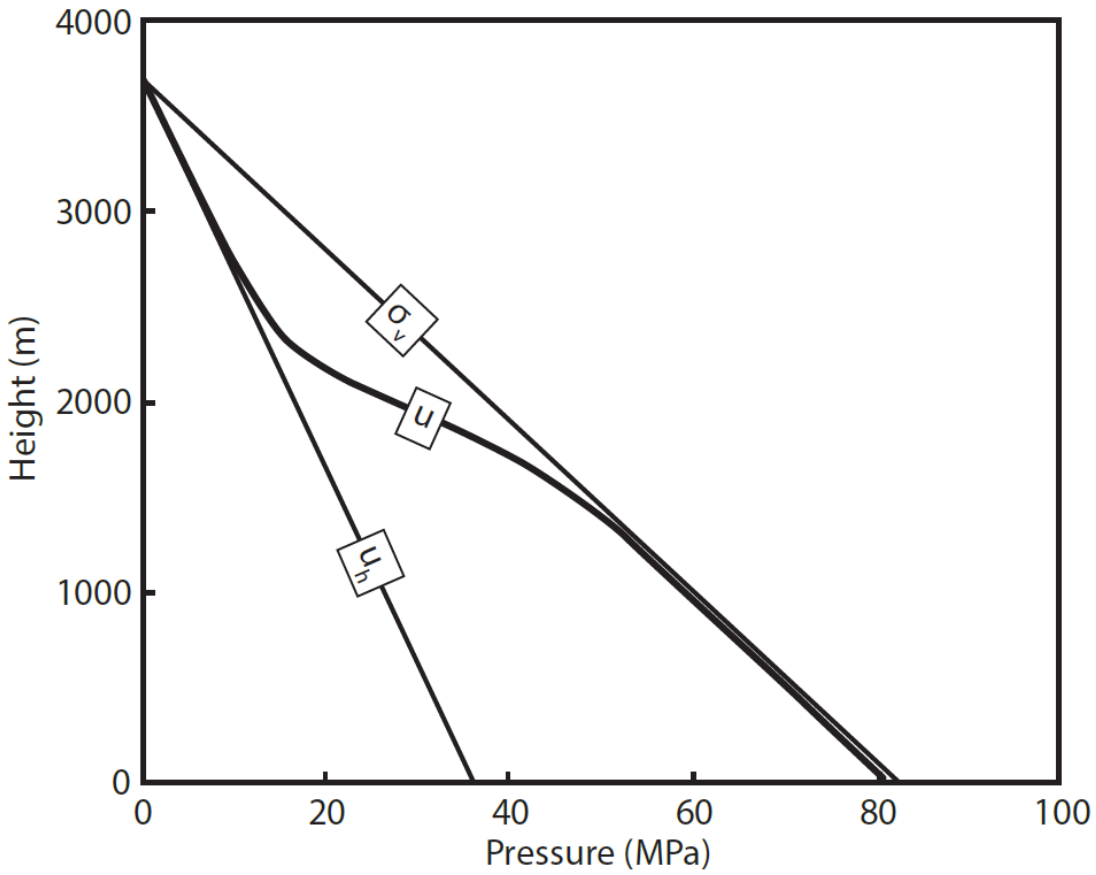

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