Pore Pressure and Stress in Dipping structures

Maria A Nikolinakou, Research Associate, The University of Texas at Austin

ABSTRACT

We show that both horizontal and vertical stresses change around the ends of dipping structures; however, these changes can be easily estimated using stress-porosity relationships (base) and simple elastic flow models (tip). We use a poro-elasto-plastic model (Modified Cam Clay). At the base of the structure, the local flow field loads the surrounding sediments, leading to elastoplastic strains (Fig. 1). We show that the behavior can be approximated as uniaxial consolidation, thus field-derived effective-stress porosity models can predict the new stress state.
At the crest of the structure, the local flow field causes unloading. Both horizontal and vertical stresses increase and may become higher than the lithostatic. Our results show that very high leakoff values, even greater than the overburden, are locally possible near the crest of a dipping structure (Fig. 2). Simple equations on flow in an elastic medium provide a very good estimation of the stress changes around the tip.
Overall, our analyses illustrate that the classic assumption that the vertical stress equals the overburden and the horizontal stress equals a fraction of the overburden is not valid around dipping structures and may misrepresent borehole stability and the risk for trap failure.

CLICK ON IMAGE FOR LARGER VIEW

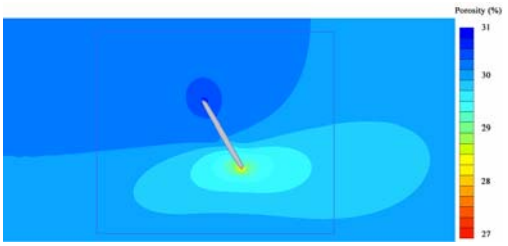

Figure 1: Volumetric changes around the base of a dipping structure. The sediments yield, resulting in much higher deformations than at the crest, where the mudrocks are being unloaded.

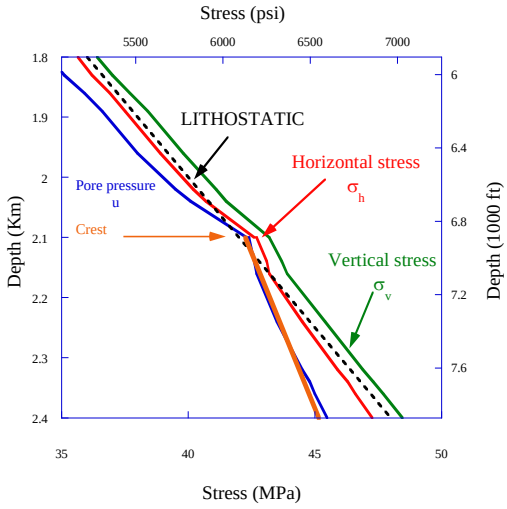

Figure 2: At the crest of dipping structures, the local flow field causes unloading. As a result, the in-situ stresses, including the least principal stress, can be higher than the overburden.

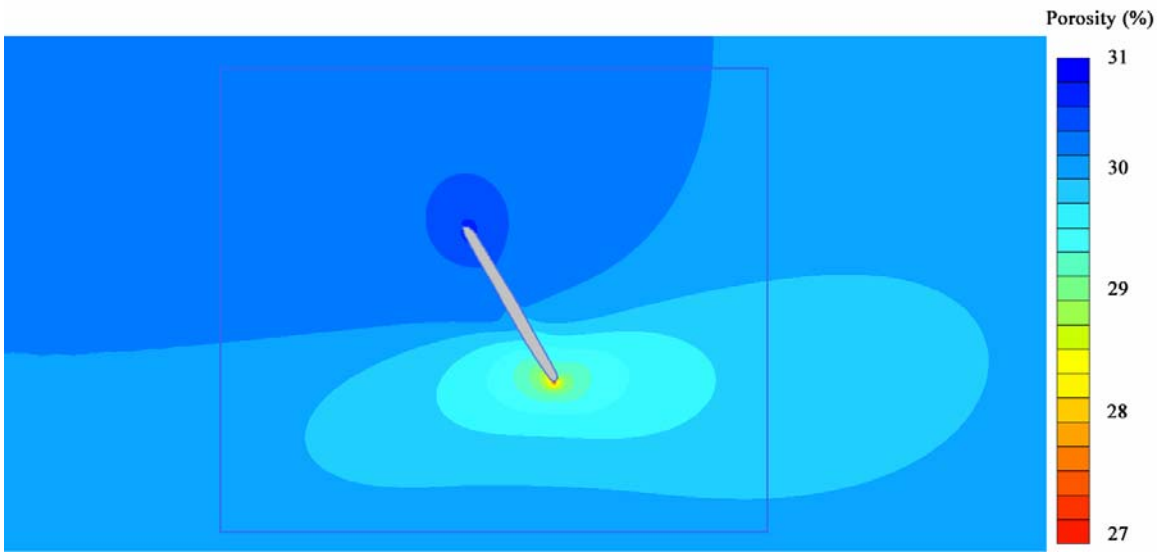

Figure 1: Volumetric changes around the base of a dipping structure. The sediments yield, resulting in much higher deformations than at the crest, where the mudrocks are being unloaded.

Back

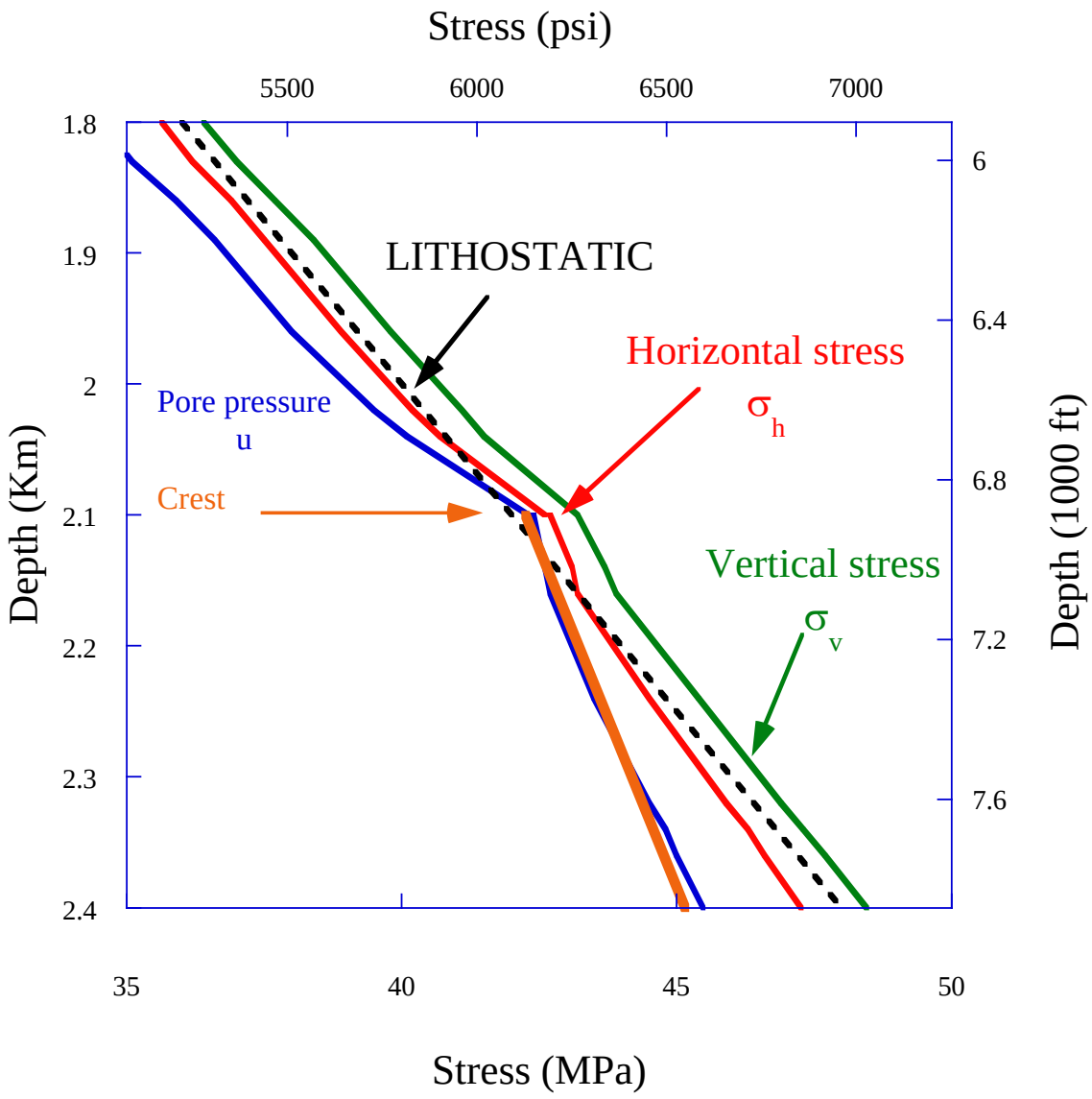

Figure 2: At the crest of dipping structures, the local flow field causes unloading. As a result, the in-situ stresses, including the least principal stress, can be higher than the overburden.

Back