08.23: Critically Tapered Wedges and Critical State Soil Mechanics: Porosity-based Pressure Prediction in the Nankai Accretionary Prism

Peter B. Flemings, Professor

ABSTRACT

We predict pore pressure from porosity measurements at ODP Sites 1174 and 808 in the Nankai Accretionary prism, offshore Japan (Fig. 1). For a range of friction angles (5-30 degrees), the pore pressure supports 50% to 80% of the overburden. Higher friction angles result in higher pressures. For the majority of the scenarios, pressures within the prism parallel the lithostat and are greater than the pressures beneath it. Our results support previous qualitative interpretations at Nankai and elsewhere suggesting that lower porosity above the décollement than below reflects higher mean effective stress there. However, by coupling a critical state soil model (Modified Cam Clay), which describes porosity as a function of mean and deviator stress, with a stress model that considers the difference in stress states above and below the décollement, we quantitatively show that the observed porosities in the prism record significant overpressure despite their lower porosity. As the soil is consumed by the advancing prism, changes in both mean and shear stress drive overpressure generation. Even in the extreme case where only change in mean stress is considered (a vertical end cap model), significant overpressures are generated. By coupling the critical wedge model with an appropriate constitutive model, we present a systematic approach to predict pressure in thrust systems.

CLICK ON IMAGE FOR LARGER VIEW

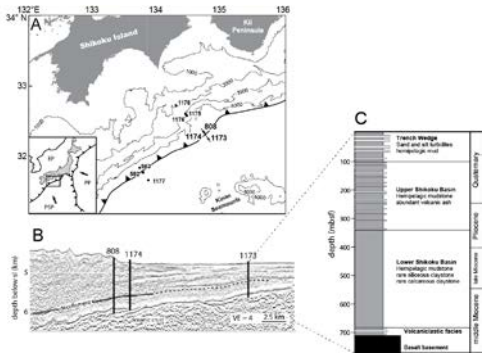

Figure 1: ***A)*** *Map of the Nankai Trough, with DSDP and ODP drillsites noted; inset shows tectonic setting. PP = Pacific Plate; PSP = Philippine Sea Plate; EP = Eurasian Plate.* ***B)*** *Seismic depth section (location shown in panel A) showing the locations of Sites 1173, 1174, and 808. VE = vertical exaggeration.* ***C)*** *Stratigraphic section from continuous sampling and core descriptions at Site.*

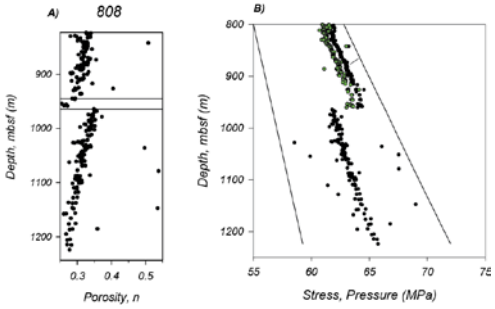

Figure 2: ***A)*** *Porosity vs. depth at ODP Site 808 within the Lower Shikoku Basin facies. B. A) Total predicted pressure (u, black circles) and pressure induced by change in mean stress within the accretionary prism (u_s, green circles).*

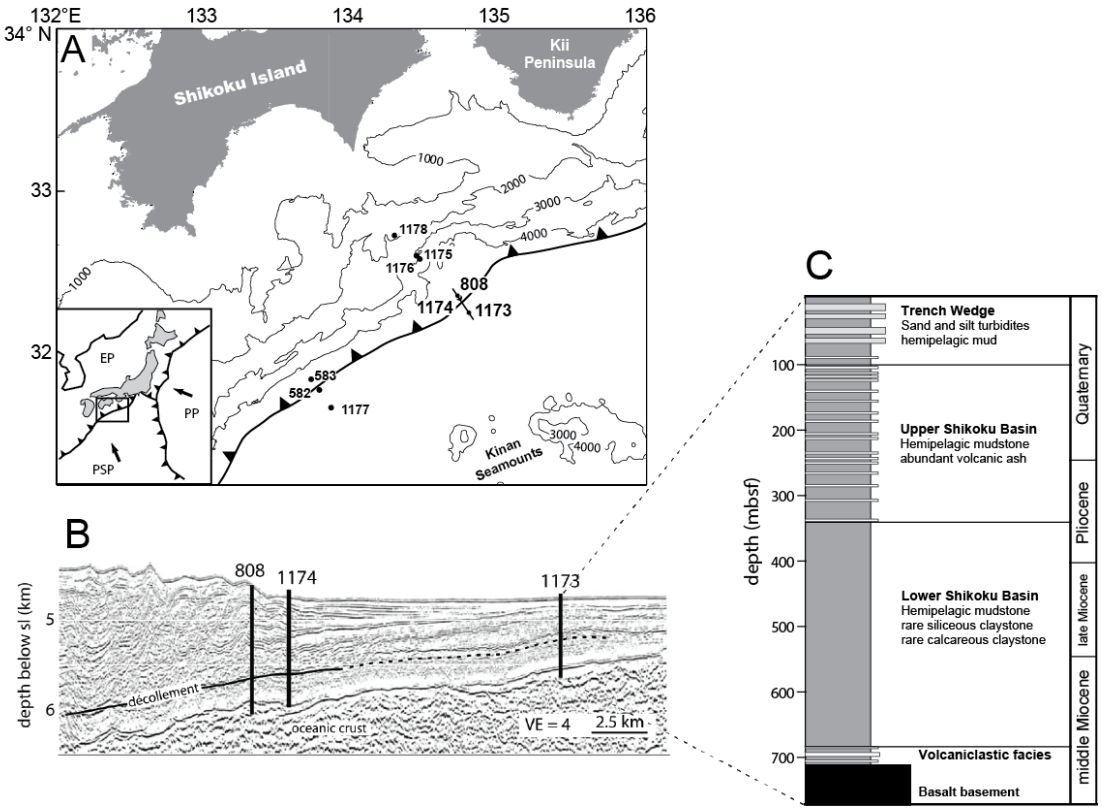

Figure 1: ***A)*** *Map of the Nankai Trough, with DSDP and ODP drillsites noted; inset shows tectonic setting. PP = Pacific Plate; PSP = Philippine Sea Plate; EP = Eurasian Plate.* ***B)*** *Seismic depth section (location shown in panel A) showing the locations of Sites 1173, 1174, and 808. VE = vertical exaggeration.* ***C)*** *Stratigraphic section from continuous sampling and core descriptions at Site.*

Back

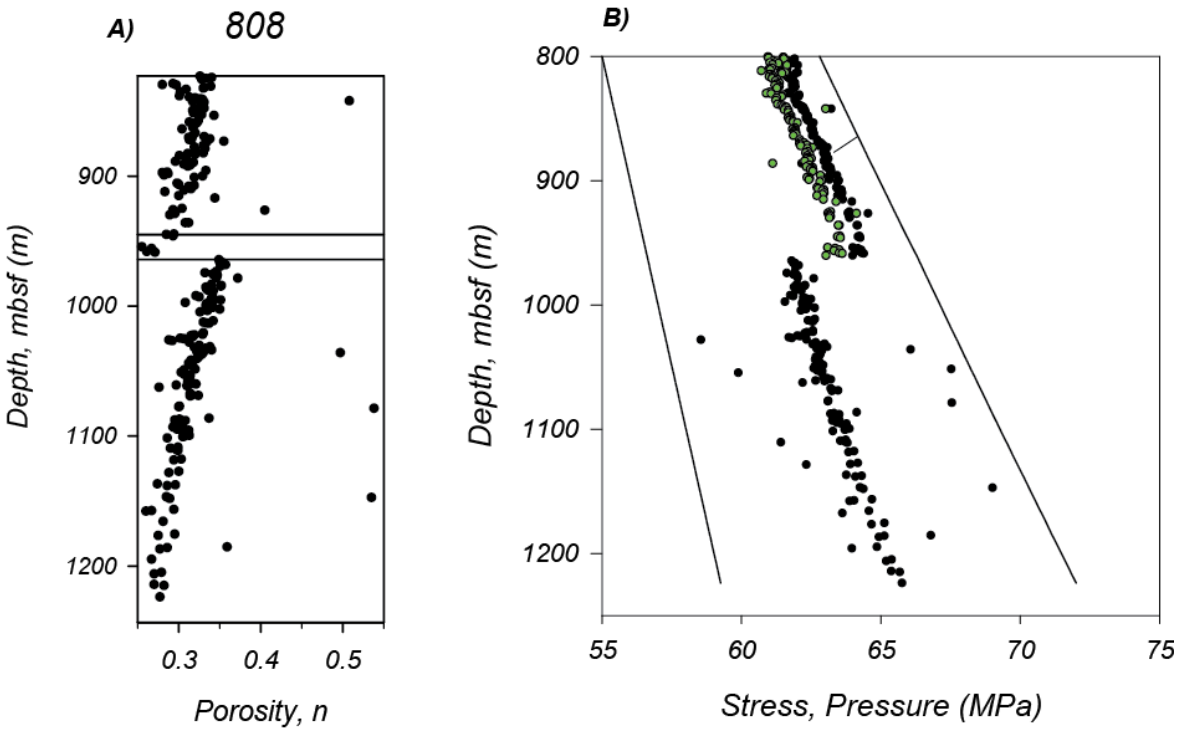

Figure 2: *A) Porosity vs. depth at ODP Site 808 within the Lower Shikoku Basin facies. B. A) Total predicted pressure (u, black circles) and pressure induced by change in mean stress within the accretionary prism (u_s, green circles).*

Back