Supplementary Information: Data Used in Computing Porosity, Pore Pressure, and Effective Stress, and Results for Seismic Line 284

Accompanying: Tobin, H. & Saffer, D., Elevated Fluid Pressure and Extreme Mechanical Weakness of a Plate Boundary Thrust, Nankai Trough Subduction Zone

The transform function used to compute porosity in the underthrust section from PSDM interval velocity is based on Hoffman and Tobin (2003) and is shown in figure DR1. It uses a function that accounts explicitly for the changing mechanisms of sediment stiffening and concomitant velocity increase during compaction, cementation, and lithification (Erickson and Jarrard, 1998), parameterized to achieve a least-squares minimization of error for the borehole core data from this transect. The transform used in turn to compute maximum past effective stress in a given element of underthrust sediment from porosity (or its corollary, void ratio) is also locally calibrated to corrected borehole data (Figure DR2). We performed the computations shown in Figure 2 using the functions derived from these two analyses.

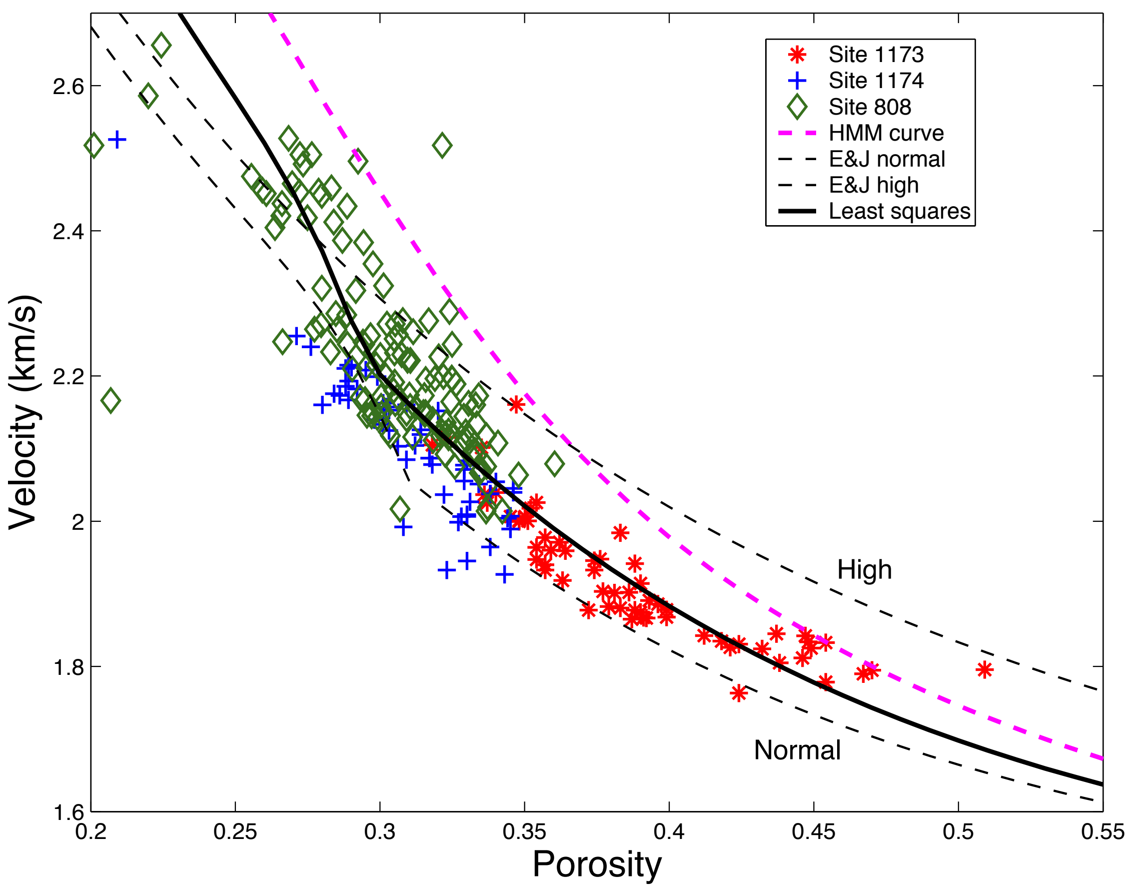
In addition to Line 215 as presented in the main body, we performed an analogous analysis of a second seismic reflection line (line 284) taken from the same survey. Line 284 parallels Line 215 and lies ~ 7000 m northeastward along strike of the trench and plate boundary décollement. PSDM velocity near the top of the underthrust section was extracted in the same way, and all calculations were performed using identical procedures. Results (Figure DR3) show very similar results to Line 215, and are entirely consistent with the results and conclusions presented for that line. Calculated pore fluid pressure is generally slightly higher than for line 215, and therefore effective normal stress and resolved shear stress are slightly lower. Along line 284, resolved shear stress has a maximum value of 3.57 ± 0.5 MPa.

Figure Legends

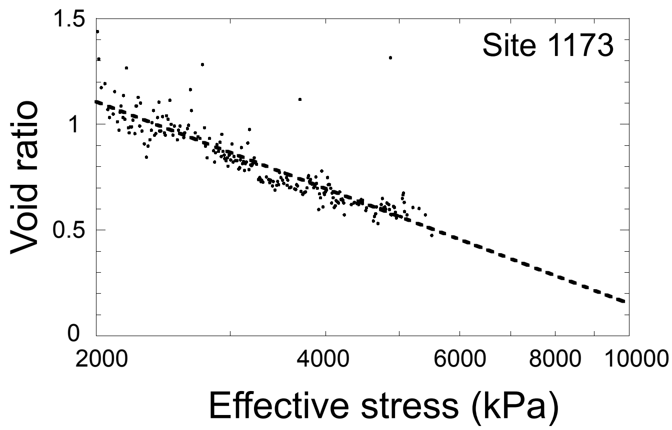
Figure DR1. P-wave velocity vs. porosity for elastic rebound-corrected core sample data from Sites 1173, 1174, and 808, with several transform models (Hoffman and Tobin, 2003). Core data are from underthrust interval only. “HMM” curve (Hyndman et al., 1993) is a commonly used fit to Site 808 data that includes the turbidites of the trench fill section, and would be inappropriate for this study on lithological grounds and also fit the data poorly. “E+J” curves (Erickson and Jarrard, 1998) are global average clastic sediment functions for normally consolidated and highly consolidated sections, computed using a threshold porosity formulation, merging a mechanical compaction based, concave-up function at high porosity with a cementation-dominated, convex-up function for porosity lower than the threshold value. The transform used in this study (solid line) uses the Erickson and Jarrard approach and a threshold porosity of 0.31 to fit the core data, minimize error, and best predict the porosity at higher velocity. For further details, see Hoffman and Tobin (2004).

Figure DR2. Void ratio vs. effective stress for reference Site 1173 (Saffer, 2003). Values of void ratio were determined from shipboard measurement, and corrected for rebound; values of effective stress were calculated from rebound-corrected bulk density measurements, assuming hydrostatic pore pressure. Dashed line shows best-fit virgin compression curve.

Figure DR3. Velocity, pore fluid pressure, and effective stress calculation results for seismic line 284. All parameters are calculated as in figure 2.



Site 1173
Site 1174
Site 808
HMM curve
E&J normal
E&J high
Least squares
High
Normal
Velocity (km/s)
Porosity
2.6
2.4
2.2
2
1.8
1.6
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55



Tobin & Saffer

Figure S-2

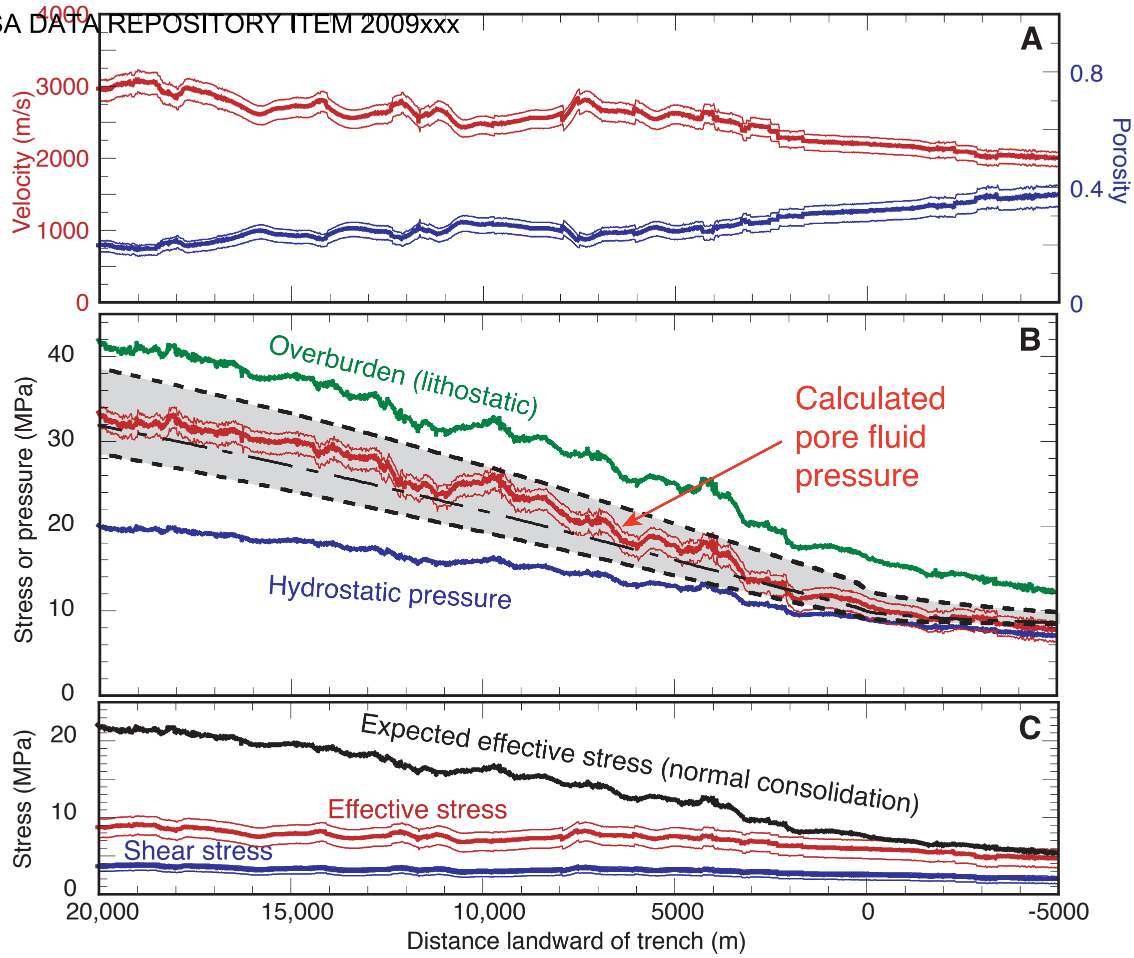


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Figure S-3