SEIZE	Benthic Flux Meter Study Across the Costa Rica Margin	
	K.M. Brown, U of Cal, SD, Scripps Inst	
	9/1/1999 – 8/31/2001	OCE 99-07201

We report a summary of work currently in preparation for publication. The data comes from 14 combined Ocean Bottom Seismometers (OBS) and fluid flux meters deployed in 1999-2000 in a ~15 km gridded array across the subduction forearc and incoming plate off the Nicoya Peninsula of Costa Rica during the CRSEIZE experiment (Fig 1A). Fluid flow measurement systems were included as part of an add-on pilot study.

- *Novel Instrumentation – Use of osmotically driven flow meters for hydrotectonic studies:* The osmotically driven flux meters measure and record flow in and out via a tracer dilution method. Our instruments can record through seabed Darcy fluid displacement rates of as little as 10^{-7}m/day (orders of magnitude less than existing methodologies can measure). In the context of some first order sediment properties, typical compressibility (β) of a clay-rich sediment is **O**10^{-6}-10^{-8} Pa^{-1} where $\beta = (\Delta V/V_t)/\Delta\sigma'$ (ΔV is the volume change, V_t is the total volume and $\Delta\sigma'$ is the effective stress change in Pa). Hence we can record flow responses to a stress rate change of ~0.1-10 Pa/day in a 1 cu. m. region directly under the meters if all the induced flow is vertical.
- *Possible detection of hydrotectonic pulsing in the forearc:* We propose that our forearc toe instruments can detect transient volumetric strain related flow events. Three correlated enhanced flow (increased outflow and inflow) periods were observed over trench parallel distances of ≥30km by instruments spaced ~15km apart (Fig. 1A). The events did not correlate with recorded flow signals 15km E up the trench slope (Site 6, Fig. 1D) or 15km W on the incoming plate (Site 1, Fig. 1C). The correlated effects appear to be focused near the trench. The most likely source is slip (aseismic creep?) on the subduction thrust beneath and/or near the out of sequence thrust.
- *Flow and seismic noise correlations:* Significantly, a study of the RMS noise patterns computed by H. Deshone at Santa Cruz for the OBSs with the flux instruments shows a strong temporal correlation of three anomalous fluid flow periods (Sites 2, 3, 5, Fig. 2) and three noise excursions with the same pulsing structure as the flow records. Remarkable correlation of peaks in the local Site 5 noise source with flow through instruments separated by 30km along subduction zone strike suggests a causal linkage (Fig. 2A). The correlated noise could be generated by fluids in fracture systems moving in forced response to creep in the forearc near Site 5.
- *Potential detection of prerupture instability in the outer rise region:* This region was subject to a series of pulsed accelerating inflow events. Perhaps the most provocative question concerning this outer rise flow event (Fig. 1C) is its potential association with the Mw 6.4 outer rise normal fault seismic event occurring just 75km SE of the instrument location <1 month after the instruments were retrieved (Fig. 2). Are they connected? The decreasing period between events (Fig. 2C) and increasing inflow rates suggest that an accelerating instability governs the system. A nonlinear prerupture phenomenon, such as accelerating pre-rupture dilational hardening and pore pressure recovery episodes leading to the eventual failure of the outer-rise region, would have to be invoked as the source of the impulsive inflow events.

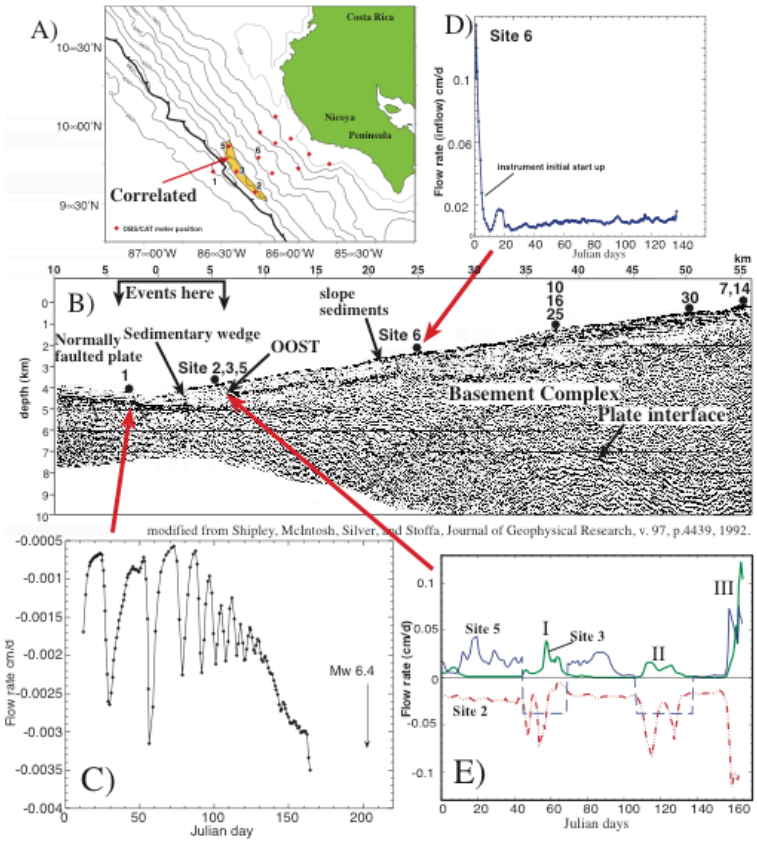

Figure 1. A) Map showing instrument locations of the 1999-2000 deployment. B) Seismic reflection section off the Nicoya peninsular showing the major tectonic elements of the forearc and instrument locations; hydrotectonically active instruments Sites 1,2,3,5; and non-correlated Site 6. C) Flow record from Site 1 on the incoming plate. D) Flow record from Site 6 up slope above the rigid basement complex. E) Records from site 2, 3, and 5 above the sedimentary wedge and OOST area. Correlated events marked as I, II, and III.

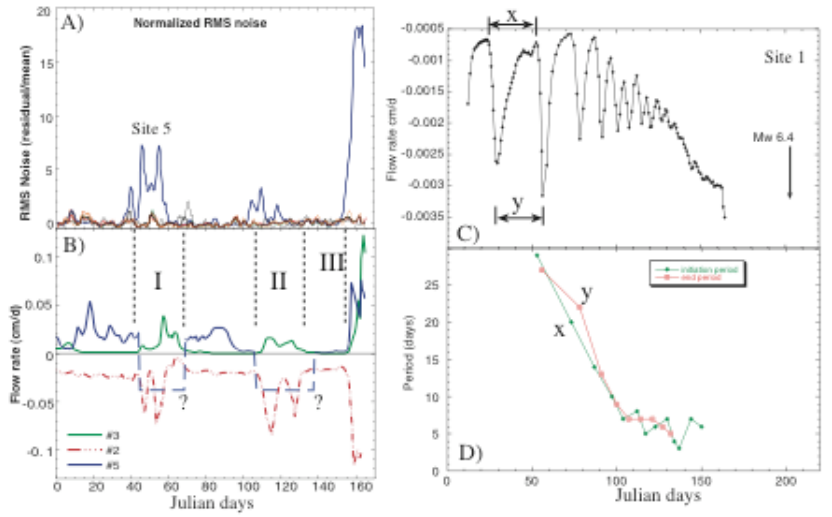

Figure 2. A) Root mean square (RMS) of the background seismic noise on the ocean bottom seismometer data. Two components are seen, a background regional noise component seen at nearly all stations and a local additional component that is highly prominent at site 5 (site 5 noise anomaly, S5NA). The S5NA component appears to correlate with the flow anomalies (I, II, and III, B) seen at meters 2 and 3 up to 30km away. Note the down flow coil of the site 5 instrument was broken, but the up flow event III was fully recorded and is similar in form to the noise anomaly. B) Instrumental flow data for the three sites (2,3,5) on the sedimentary wedge/OOST system at the toe of the forearc. C) Flow data for Site 1 on the incoming plate (note Flow rate in cm/y). The time of the outer rise normal fault event is marked. D) Elapsed time between impulsive inflow events (X) shown in Fig C. Note decrease in elapsed time and acceleration of the events.