SEIZE	Benthic Flux Meter Study Across the Costa Rica Margin	
	K.M. Brown, Univ. of California, San Diego, Scripps Inst.	
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We report here a summary of work that is currently in preparation for publication. The data we present here comes from 14 combined Ocean Bottom Seismometers (OBS) and fluid flux meters (see facilities section) that were deployed in 1999-2000 in a ~15 km gridded array across the subduction forearc and incoming plate off the Nicoya Peninsula of Costa Rica (as piggy back on the CRSEIZE experiment; PIs: Schwartz, Dixon and Dorman) (Fig 1). The fluid flow measurement systems were included as part of an add-on pilot study.

1) ***Novel Instrumentation—Osmotically driven flow meters were used to undertake hydrotectonic studies:*** The osmotically driven flux meters measure flow utilizing a tracer dilution method. Both in and out flow rates can be recorded. Our instruments can record Darcy fluid displacement rates of as little as 10^{-7} m/day through the seabed. These flow rates are orders of magnitude below what other existing methodologies can measure. It is worth placing this flow measurement range in the context of some first order properties of sediments. The typical compressibility (β) of a clay-rich sediment is on the order of 10^{-6} Pa^{-1} to 10^{-8} Pa^{-1} where $\beta = (\Delta V/V_t)/\Delta\sigma'$ (ΔV is the change in volume, V_t is the total volume and σ/σ' is the change ineffective stress in Pa). That is to say that we can record flow in response to a stress rate change of ~0.1-10 Pa/day in a 1 cubic meter (unit) region directly under the meters if all the resulting induced flow is vertical.

2) ***Possible detection of hydrotectonic pulsing in the forearc:*** We propose that our instruments at the toe of the forearc were able to detect flow events related to transient volumetric strains. The instrument locations are spaced ~15km apart and the three correlated periods with enhanced flow (both increased out flow and inflow) are observed over trench parallel distances of at least 30 km (Fig. 1A). The events did not correlate with flow signals seen on instruments 15 km up the trench slope to the east (Site 6, Fig. 1D) or 15 km west on the incoming plate (Site 1, Fig. 1C). The correlated effects appear to be focused near the trench. We propose that the most likely source is slip (aseismic creep?) either on the subduction thrust beneath and/or near the out of sequence thrust.

3) ***Flow and seismic noise correlations:*** We undertook a study of the root mean square (RMS) noise patterns computed by Heather Deshone at Santa Cruz for the Ocean Bottom Seismometers with the flux instruments. Significantly, a strong correlation exists between the timing of the three anomalous fluid flow periods (Sites 2, 3, and 5, Fig. 2) and three noise excursions, which have the same pulsing structure as the flow records. The remarkable correlation of peaks in the local Site 5 noise source with flow through instruments separated by 30km along strike on the subduction zone suggest a causal linkage (Fig. 2A). The correlated noise could be generated by fluids in fracture systems being forced to move in response to creep in the forearc near Site 5.

4) ***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 flow event on the outer rise (Fig. 1C) is its potential association with the Mw 6.4 outer rise normal fault event just 75Km to the

SE of the instrument location. The seismic event occurred less than 1 month (Fig. 2) after the instruments were retrieved. Are they connected? The decreasing period between events (Fig. 2C) and increasing inflow rates suggests that the system is governed by an accelerating instability. 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.

Figures and Captions

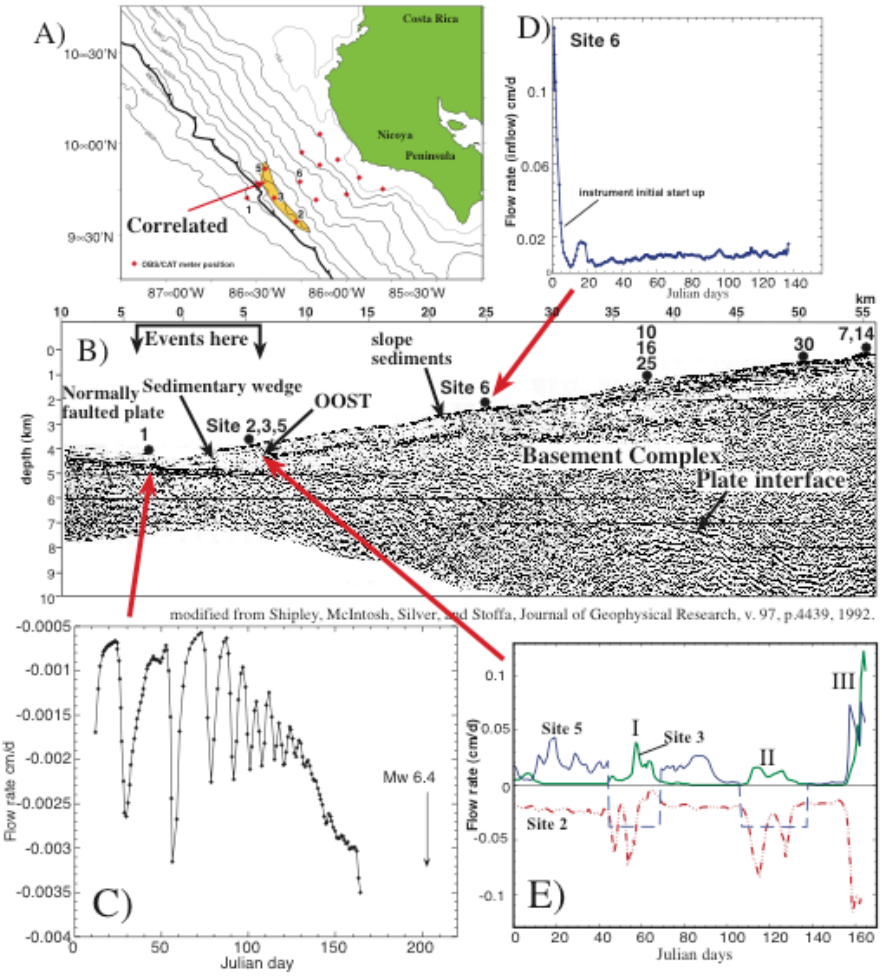

Figure 1: A) Map showing instrument locations of the 1999-2000 deployment. B) Seismic reflection section off the Nicoya peninsular showing the major tectonic elements of the forearc and instrument locations; hydrotectonically active instruments Sites 1, 2, 3 ,5; and non-correlated Site 6. C) Flow record 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.

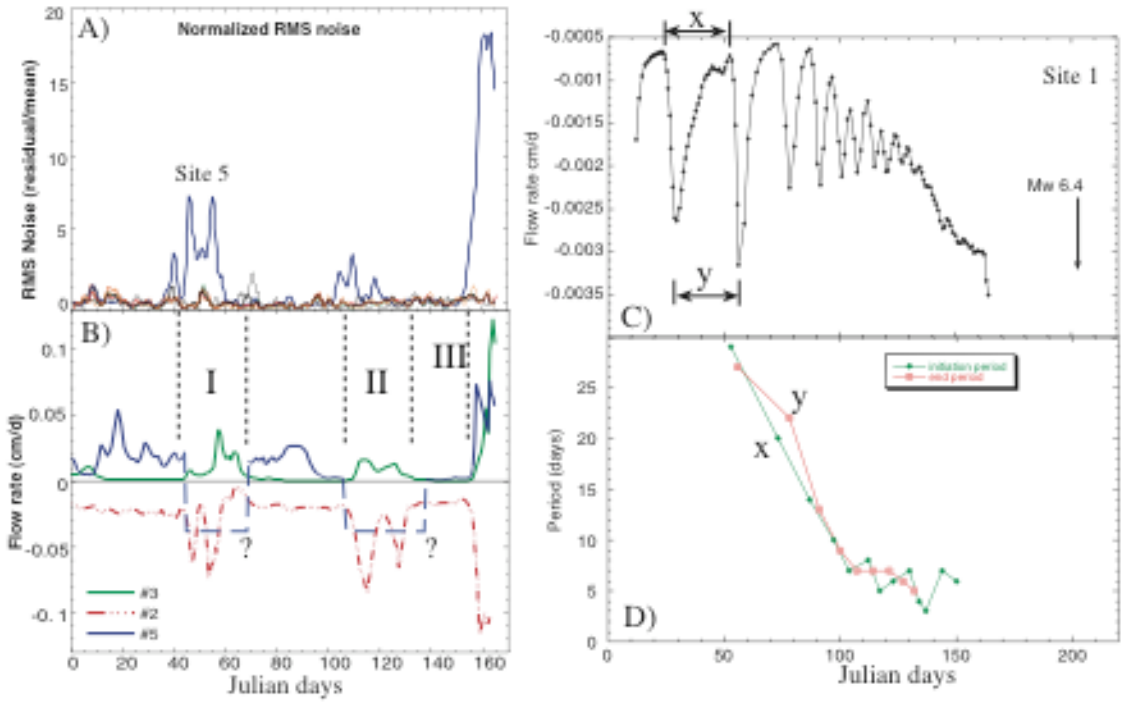

Figure 2: A) Root mean square (RMS) of the background seismic noise on the ocean bottom seismometer data. Two components are seen, a background regional noise component seen at nearly all stations and a local additional component that is highly prominent at site 5 (site 5 noise anomaly, S5NA). The S5NA 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.

Publications and Presentations

Publications:

Kopf, A. and K. M. Brown, 2003. Friction experiments on saturated sediments and their implications for the stress state of the Nankai and Barbados subduction thrusts. Marine Geology, Volume 202, Issues 3-4, Pages 193-210

Brown, K.M., A. Kopf, M.B. Underwood, and J.L. Weinberger, 2003. Compositional and fluid pressure controls on the state of stress on the Nankai subduction thrust: A weak plate boundary. Earth and Planetary Science Letters, 214, 589-603, 2003.

Brown, K.M., DeShon, H., Tryon, M.D., Dorman, L., and Schwartz, S.. Transient fluid pulsing and noise in the Costa Rican subduction zone: Nearly silent slip events? In prep.

Other activities:

1) Development of new benthic aqueous flux meters systems for Hydrotectonic monitoring.
2) Workshop Coordinator for IODP/OOI Workshop 2003, Seattle, USA, with A. Fisher.
3) Workshop Coordinator for Central America Drilling workshop Dec 2002, San Francisco, with Roland Von Huene.
4) Snowbird, SEIZE Tectonic Institute, NSF Margins Program- Assistant Workshop Coordinator and report writer for SEIZE update
5) A Lead PI for The NANTROSEIZE, (IODP) drilling program, Phase II Drilling Proposal:
6) NanTroSEIZE Drilling and Observatory -Phase 2 Mechanical and Hydrologic State of Mega-Splay Faults: Implications for Seismogenic Faulting and Tsunami Generation: Main proponenets: Masataka Kinoshita, Kevin Brown, Demian Saffer, and Pierre Henry (+ 19 others)

Talks:

Tryon, M.D., and K.M. Brown, Results from long-term aqueous flux measurements on the Costa Rican convergent margin, Eos, (Transactions, American Geophysical Union), 81 (48), 1161, 2000.

Brown, K.M., and M.D. Tryon, Could temporal changes in fluid expulsion patterns from cold seep regions located on faults be used to monitor transient stress changes in the seismogenically coupled region of the subduction thrust?, Special Paper – Oregon, Department of Geology and Mineral Industries, 33, 33-34, 2000.

Brown, A. K.M., Kopf, M. Underwood, J. Weinberger and J. Steurer: Frictional Coefficients of Multi-Component Sediments: Implications for the Aseismic to Seismic Transition Zone, W. Nankai: Eos, (Transactions, American Geophysical Union), 82, xxxx, 2001.

Brown, K.M, Kopf, A., Underwood, M.B. Weinberger, J.L.: Compositional and Fluid Pressure Controls on the State of Stress on the Nankai Subduction Thrust: Eos, (Transactions, American Geophysical Union), 83, xxxx, 2002.

Kevin M. Brown, Earthquakes and Transient Hydrologic Processes in Convergent

and other Plate Boundary Environments, Snowbird TEI, NSF Margins Program, 2003.

Tryon, M.D., Brown, K.M., Long-term fluid flow measurements from widely varied oceanic settings elucidate near-surface hydrologic environments, Eos, (Transactions, American Geophysical Union), 84 (46), 846, 2003.

Brown, K.M., DeShon, H., Tryon, M.D., Dorman, L., and Schwartz, S., Transient fluid pulsing and noise in the Costa Rican subduction zone: Nearly silent slip events?, Eos, (Transactions, American Geophysical Union), 84 (46), 1420, 2003.

Brown. K. M., M. Tryon, Heather DeShon, LeRoy Dorman[1], and Susan Schwartz:, Transient fluid flow processes in margin settings: Earthquakes and Pulsing in the Costa Rican Subduction Zone: Ocean Margin Research Conference, Paris, 2003.