OCE-0203830 - Hydrologic Controls on the Initial State of the Incoming Plate: Costa Rica
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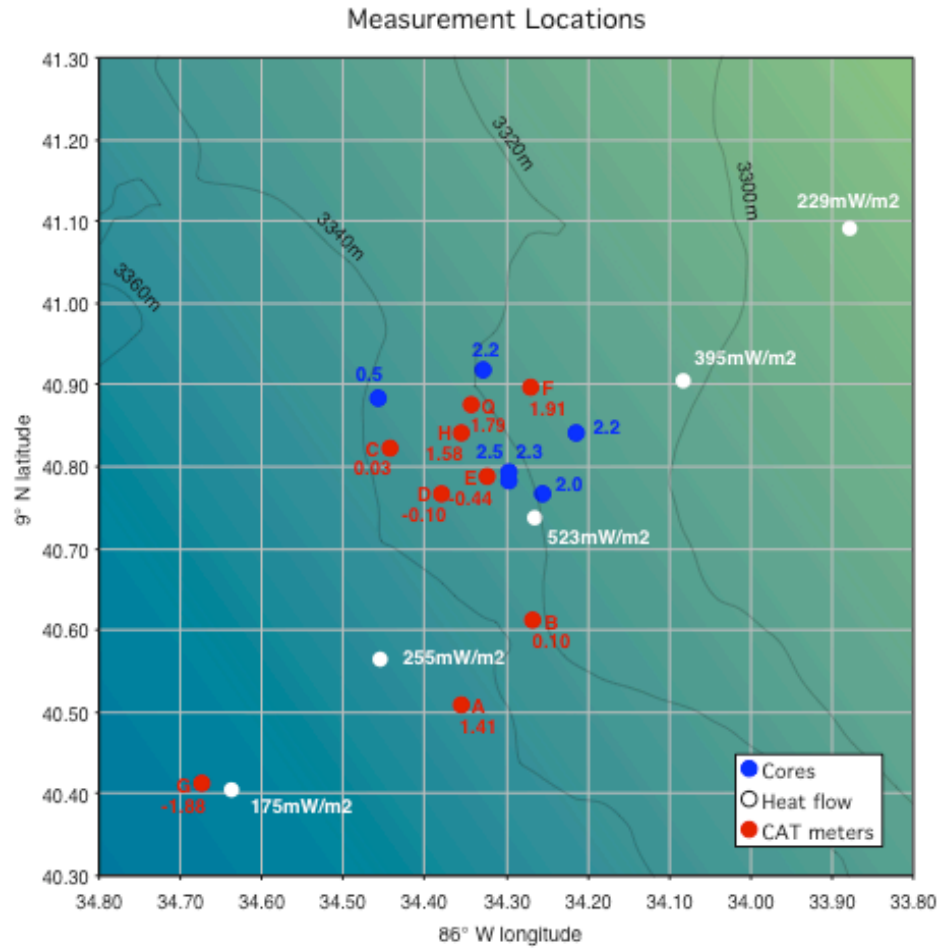
Understanding the processes involved in the thermal, and chemical aging of oceanic crust in off ridge-axis locations has long been of great interest to the general ocean geological/geophysical communities. There is now substantial and growing evidence from heat flow and coring investigations that the oceanic plate off Costa Rica is highly hydrologically active and that this activity is responsible for one of the most anomalously cold thermal environments encountered in the oceanic environment. Recent work has additionally identified limited regions above certain topographic highs with extremely high heat flows. Pore water profiles derived from cores above these thinly sedimented basement highs are suggestive of up-ward flow on the order of ~1-2 cm/yr. These highs may be the principal regions of out-flow from the basement in this region and, thus, can potentially be used to constrain the general level of hydrologic activity.

The nine Chemical and Aqueous Transport (CAT) meters we deployed in the area of one of the highest heatflow sites are highly sensitive to both in-flow and out-flow of aqueous fluids at rates of 0.1 mm/yr to 10 m/yr. Our objective was to provide an independent and direct measurement of long term flow rates along a critical representative hydrologic transect to address the following questions: (1) What are the characteristic fluid fluxes at basement highs and surrounding regions of the low heat flow region of the northern Costa Rican incoming plate, (2) by what paths does water enter and exit the area, and (3) is this flow temporally variable? The data from instruments deployed during this cruise, when combined with those of the previous TicoFlux expeditions, will supply us with co-located temperature, chemical gradient, and direct fluid flux data sets that will ultimately build upon each other to generate a more complete hydrologic picture of the surface (i.e. sea bed) boundary flux distribution across the incoming plate.

The results of the instrument deployments is shown in the accompanying figure. The map shows the locations of the heat flow, coring, and instrument deployments. The values at the core sites are the modeled flow rates in cm/yr based on chemical profiles collected during the TicoFlux expedition (Fisher, et. al). The CAT meter site rates are averages for the deployment period. These results agree quite closely in general in that rates are on the order of 2 cm/yr or less. There are, however, considerable differences in detail. Temporal variability and periods and sites of downflow are evident. Both of these results are somewhat surprising. An area of high temperature gradients and heat driven advection may also drive convection, causing areas of downflow to exist. Temporal variability is more puzzling, however. Variability can sometimes be attributed to oceanographic effects (tides, currents, etc.) but not in this case because the nature of the variability does not correlate across the array of instruments. Very small scale tectonic effects are a more likely source. While this is certainly not an area of major tectonic activity, the basement high at this site appears on seismic images to be due to action along a fault. The CAT meters are capable of detecting minute strain events in the underlying sediments and therefore may be detecting small localized strain events.

While no widespread correlation of flow "events" was seen, there is some degree of local correlation between instruments. Surprisingly, two instruments located 100 m apart indicated two short periods of downflow that are well correlated. We are currently modeling the spatial and temporal variability to reveal what may be driving the temporal variability and to look for any propagating events that may have occurred.



Publications:

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