Composition of Subduction Inputs and Its Influence on Subduction Zone Hydrogeology

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Compositional analyses of cores recovered during the TicoFlux expeditions show three principle types of near-surface sediment seaward of the Middle America Trench, offshore Costa Rica (Spinelli and Underwood, 2004; Underwood, 2007). Nannofossil chalk, which occurs on the flanks of seamounts, is nearly pure calcium carbonate, with an average opal content of 2 wt %. Hemipelagic mud is the most common lithology and has the highest content of biogenic opal (mean = 10 wt %). Mixed clay-carbonate sediment is intermediate in opal content (mean = 5 wt%). Bulk percentages of total clay minerals in the hemipelagic mud range from 59 to 88 wt %. Percentages of smectite in the clay-size fraction (relative to illite and kaolinite) average 86% and range from 75 to 97%. These data are important for two reasons. First, the unusually high content of smectite reduces the mud's coefficient of internal friction (Brown et al., 2003). Second, smectite diagenesis probably triggers an increase in pore fluid pressure as depth increases down the plate boundary fault. Volumetric fluid production can be tied to a combination of compaction plus smectite dehydration. Numerical simulations of fluid pressure, therefore, need to consider the absolute abundance of smectite in subducting sediments, as well as variations along strike in the thermal structure of the subduction zone (Spinelli et al., 2006). The same is true in the Nankai Trough, where along-strike changes in temperature at the subduction front cause significant shifts in the down-dip position of smectite dehydration (Saffer et al., 2008).

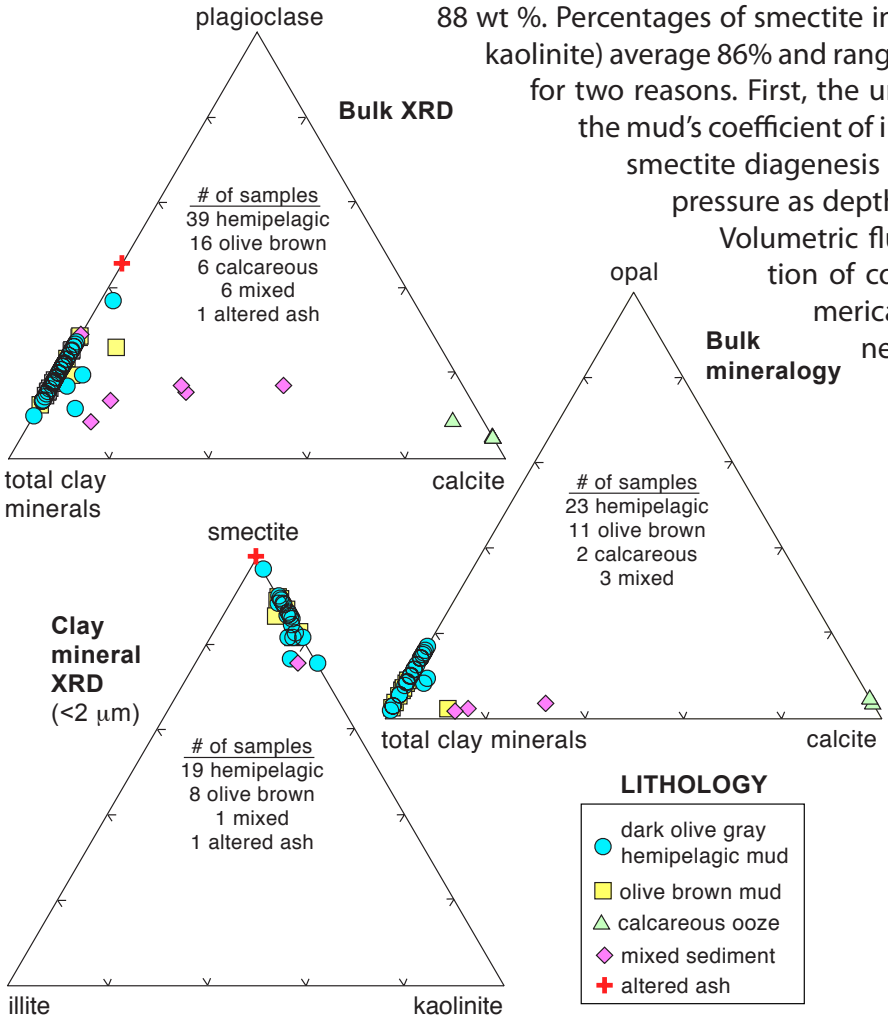

Figure: Ternary diagrams showing compositional modes for near-surface sediments seaward of the Costa Rica subduction front. Data are based on bulk-powder X-ray diffraction, alkaline leaching for opal, and clay-fraction XRD. See Spinelli and Underwood (2004) for data tables and thorough discussion.

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