Estimates of the geothermal gradient in the deep Nankai accretionary prism, Site C0002, Expedition 348

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Knowing the rate of temperature increase in deep accretionary prisms is critical for understanding changes in physical properties related to clay diagenesis and modes of stress release at the megasplay. We present data constraining temperature at depths of 2000-3000 mbsf in Site C0002. The sediments comprise steeply tilted, hemipelagic mudstone. Direct temperature measurements are only available in the Kumano forearc basin to depths of 900 mbsf. Thermal models of the prism suggest temperatures anywhere from 100˚C to 150˚C on the megasplay (Harris et al., 2011; Spinelli and Harris, 2011; Sugihara et al., 2014). We sampled carbonates from cuttings and cores with the objective of determining temperatures of carbonate formation. Most are calcite veins from 1-8 mm thick. Cements from the cored interval were also sampled. Traditional IRMS d values of oxygen and carbon isotopes (-12 to 0‰ VPDB) are consistent with carbonate formation at variable times during burial. Matrix cements in the cored interval have high $d^{18}O$ values relative to a $d^{18}O$ minimum in the fault zone at 2205 mbsf. Carbon isotopes are only slightly ^{13}C-depleted until the bottom 200 m of the section. The lightest $d^{13}C$ value was measured in the fault-zone sample with the lowest $d^{18}O$ value, suggesting the fault was a conduit for deeper, warmer fluid. The variation in $d^{13}C$ is narrow compared with Nankai input sites and other accretionary prisms. The dominant carbon source may have been recrystallization of biogenic marine carbonate in the sediment. For clumped isotope analysis we focused on samples with the greatest ^{18}O depletions, which are most likely to record maximum temperatures during burial. The amount of “clumping” of the rare isotopes ^{13}C and ^{18}O in carbonate bonds varies inversely with temperature. U-series ages from carbonate veins are at least as young as 108 ka suggesting that the clumped isotope temperatures likely reflect a contemporary geothermal gradient. The clumped isotope data define steadily increasing temperature (44˚C to 70˚C) with depth from 2106 to 2996 mbsf. These results will be used in combination with new thermal models to provide improved estimates for temperatures on the megasplay.

Keywords: IODP Expedition 348, accretionary prism, geothermal gradient, carbonate isotopes, geochronology, megasplay

