Spatial distribution of heavy and carbonate minerals beneath the seafloor in the Nankai Trough and Shikoku Basin using X-ray CT data

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The movement of mineralizing fluids within oceanic crust and sediments modifies crustal-properties such as brittleness and/or permeability, and this has important consequences for deformation around subduction zones and within accretionary complexes. Knowing at which depths and stratigraphic horizons, and with which structural elements mineralization is associated is necessary to understand how newly formed mineral phases maybe effecting crustal deformation. X-ray Computed Tomography (XCT) images of sediments and rocks can be used to detect different types of mineralization and observe where it is found. In this study, we investigated the spatial distribution of mineralization assemblages under the seafloor at the Nankai Trough off Muroto, Japan using XCT data of geological cores collected by Ocean Drilling Program (ODP) at sites 808, 1173, and 1174 and International Ocean Discovery Program (IODP) at site C0023. Site 1173 is located on the ocean side of the Nankai Trough (a reference site) and the others are at the toe of the Nankai Accretionary complex. The main lithologies are post-middle Miocene hemipelagic and trench-fill sediments, and some of them, basalt at the base.
Depth profiles of the mean CT-numbers show similar patterns for all four sites. CT-numbers basically represent density with respect to inhibiting the transmission of X-rays; for air the CT-number is -1000 and for water it is 0. The mean CT-numbers of the sediments gradually increase from about 1100 to 1800 with depth. Against this background positive spikes with mean CT numbers ranging from 2000 to 9000 are observed in three intervals: 1) the interval from the trench-to-basin to top of the upper Shikoku Basin facies, 2) an interval from the top of the lower Shikoku Basin facies to the décollement or proto-dé collement, and 3) an interval within the lower sections of the lower Shikoku Basin facies.
Once anomalous intervals were identified the geological cause of the anomalies were investigated using 3D XCT images and from visual observation: ellipsoidal calcite concretion and pyrite-filled or -replaced trace fossils with high CT numbers account for the anomalous values. Much higher CT numbers exceeding 20,000 are seen in very calcareous areas with pervasive cementation or fracture-filled minerals. At sites 808 and C0023, these features are seen in sediments that have been hydrothermally altered where barite ($BaSO_4$), anhydrite ($CaSO_4$), and rhodochrosite ($MnCO_3$) mineralization is present around and below the décollement (Alexander et al., 1999; Tsang et al., 2020). The presence of anomalous CT numbers at the same stratigraphic intervals at all four sites attests to similar mineralization processes occurring across the most seaward part of the Nankai Accretionary complex. Therefore, our results show that both calcareous concretions and hydrothermal alternation zones are strata-bound and found throughout the study area. Because these mineralization processes effect mechanical and rock physics processes they could potentially be impacting deformation processes within the accretionary complex itself.

Keywords: Nankai Subduction Zone, Calcite, Barite, X-ray Computed Tomography, Ocean Drilling Program, International Ocean Discovery Program

