Lithostratigraphic Evolution of the Shikoku Basin, Inputs to the Nankai Trough Subduction Zone

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The Shikoku Basin (Philippine Sea plate) hosts inputs of sediments and igneous crust to the Nankai Trough subduction zone of SW Japan. After five decades of scientific ocean drilling (DSDP, ODP, IODP), and three successful transects across the margin (Ashizuri, Muroto, Kumano), we are beginning to recognize and understand the complexities and idiosyncrasies of the basin’s evolution. This presentation will focus on three elements of that evolution: (a) time-transgressive facies changes; (b) an enigmatic interval of anomalously high porosity; and (c) systematic, gradual changes in detrital clay mineral assemblages over time.
Perhaps the most noteworthy of several time-transgressive facies changes occurs at the base of the uppermost lithostratigraphic unit (hemipelagic-pyroclastic facies). The base of that unit (otherwise known as Upper Shikoku Basin facies) coincides with the deepest discrete layer of volcanic ash. The age of the unit boundary changes considerably along strike, from 3.9 Ma at ODP Site 1177, to 3.3 Ma at ODP Site 1173, to 7.6-7.8 Ma at IODP Sites C0011 and C0012. Those temporal-spatial differences in the onset of substantial pyroclastic influx might be related to a NE-directed migration of the triple junction that joins the Japan, Izu-Bonin, and Nankai subduction boundaries; that migration should have triggered along-strike changes in explosive arc volcanism.
Mudstones within the zones anomalously high-porosity contain unusually large proportions of dispersed volcanic ash (glass shards and pumice). Temperatures at the base of the zones vary from site to site, so thermally driven diagenesis alone cannot account for the anomaly. Instead, dispersed ash affects mudstone microstructure by forming cohesive aggregates that inhibit collapse of intergranular pore space. Partial dissolution of glass shards also contributes silica for precipitation of weak cement. Deeper stratigraphic intervals with smaller amounts of dispersed ash show no such effects, regardless of temperature or depth.
The clay mineral assemblages of Shikoku Basin show consistent temporal changes, particularly over the last 10 Myr, with gradual reductions of detrital smectite and gradual increases in illite and chlorite (moving up-section). At IODP Sites C0011 and C0012, percentages of smectite within bulk mudstones decrease by roughly 3 wt-% for every 1-million-year reduction in age. Causes of this trend are multi-faceted but probably include: (1) intensification of the Kuroshio Current after closure of the Isthmus of Panama (at about 3 Ma); (2) blockage of transport routes from the East China Sea by rifting of the Okinawa Trough and subaerial buildup of the Ryukyu Arc (peaking at about 7 Ma); and (3) progressive uplift and denudation of detrital source rocks in the Outer Zone of Japan, which gradually stripped away the near-surface products of anomalous near-trench magmatism and exposed deeper plutonic roots and surrounding meta-sedimentary strata of the Shimanto Belt. These systematic changes in clay mineral assemblages are important because they modulate friction properties, consolidation behavior, and fluid production from dehydration reactions as the strata move deeper into the subduction zone.

Keywords: Shikoku Basin, clay minerals, anomalous porosity, time-transgressive facies

