Late Pleistocene to Holocene dynamic basin environment at the Osaka Bay: Stratigraphic expressions of tectonic deformation, sea level fluctuation, and tidal waves

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The Osaka Bay and Osaka Basin hosts a sedimentary sequence up to 3000 m thick Late Pliocene and Quaternary sediments. The basin is bounded by major faults active since the Late Pliocene. Sedimentation is controlled by dynamic interactions between tectonics, sea level fluctuation and tidal currents. To study the distribution of seafloor sediments and recent deformation history of active faults in the Osaka Bay, we present results from high-resolution seismic profiles along 15 survey lines using a Sercel Mini-GI airgun (15/15 cu^3) and a Boomer (100/200 J) as active source, together with multi-beam bathymetry data that we acquired onboard the T/S Fukaemaru and R/V Onokoro.

In all our E-W sections, we observe tilted strata that reach shallow depths, which we interpret to represent the most recent subsurface deformation by the Osaka Bay Fault, via a forelimb of the hanging wall anticline that dips east and becomes progressively steeper with depth. Towards the eastern side of our sections, the tilted strata dips gently west, forming a syncline and syn-tectonic growth strata in the footwall.

At our northern survey area, the uppermost sequence (Unit A1) consists of a seismically-transparent package with occasional chaotic fabric and a section of abnormally high-amplitude negative polarity reflector. This unit is associated with a local topographic high and “Okinose” sand wave body imaged from bathymetry. Unit A1 is underlain by a sequence of thin, well-defined parallel seismic reflections (Unit A2). Beneath Unit A2, sequences of high-amplitude reflections with occasionally discontinuous wavy contacts are present (Unit B1). From our NW-SE sections that cross nearly parallel to the long axis of the sand dune body and the northeast strike of the shelf, we observe tilting of strata in Units A1, A2, and B1, revealing the most recent deformation by uplift on the hanging wall anticline of the Osaka Bay Fault. Here, the uplifted stratigraphy is preserved from erosion, and the surface expression of the fault is clearly observed.

By contrast, our NW-SE and NE-SW sections at our northern and central survey areas cross nearly perpendicular to the shelf east of our sections. Here, Unit A1 is absent, and we observe an onlap of Unit A2 onto Unit B1. Unit A2 is relatively undeformed and is downlapping the underlying sequence above Unit B1, which we assign as Unit A3. We observe tilting of strata within Unit A3, exhibiting the recent deformation by the fault.

A transition from higher backscatter intensities to decreased backscatter levels at the seafloor is observed from west to east, which is coincident with the boundary from Units B1 to Units A2 and A3 observed from the seismic sections. Based on seismic characteristics and comparisons with nearby boreholes, we interpret Units A2 and A3 as fine-grained, marine sediments of the Holocene alluvium, deposited only on the eastern side of our sections, and Unit B1 as coarser-grained, fluvial sediments of the Late Pleistocene

colluvium.
The stratal termination and onlap of Units A2 above B1 suggest a major sequence boundary. The geometry is wavy, indicating an erosional contact. The younger strata containing distal facies of marine clay indicate transgression, while the underlying proximal facies of colluvium, indicate retrogradation. We interpret this sequence boundary to represent a maximum regressive surface at the beginning of transgression. The abrupt landward shift to marine systems suggests that rise in sea level occurred rapidly. Here, sediments have likely onlapped in the direction of advancement of the sea, perpendicular to the shelf, as sediment accommodation space increased. Within the Holocene alluvium, we observe a downlap surface indicating a switch to progradation. We interpret this boundary to represent the sea level highstand. Along strike, these surfaces are likely diachronous. At our northern survey area, we also observe erosional surfaces that have likely formed by wave scouring and high-energy tidal currents.

Keywords: Osaka Bay Fault, Seismic reflection survey・Bathymetry survey, Sequence stratigraphy

