IODP Expedition 346: Asian Monsoon

Site U1424 Summary

Background and Objectives

Site U1424 is located in the eastern part of the Sea of Japan/East Sea at 40°11.40′N, 138°13.90′E and a water depth of 2808 m. The site is at the same location as ODP Site 794 and ~200 km to the southwest from the entrance of the Tsugaru Strait. Site U1424 is located near the boundary between the Japan Basin and the Yamato Basin and ~10 km to the west of the submarine Toyama Channel that extends from the central part of Honshu Island. The site is mainly under the influence of the second branch of the Tsushima Warm Current (TWC), and close to the present position where the third branch merges with the second branch of the TWC during the present summer. The results of previous drilling at Site 794 revealed that the site is characterized by very slow (~30 m/m.y.) yet continuous sedimentation during the last 4 Ma, which is ideal to detect the contribution of eolian dust from the Asian continent. Preliminary examination of the Pleistocene sediments suggests possible occurrence of ice rafted debris (IRD), suggesting its potential utility for the study of IRD.

Site U1424 comprises the southernmost site of the northern half of the latitudinal transect targeted by Expedition 346, as well as the second deepest site of the depth transect. The location of Site U1424 was selected specifically to identify the southern limit of IRD events. Together with the results from Sites U1422 and U1423, identification of IRD events at this site and correlation with previous sites will allow us to reconstruct temporal changes in the southern limit of sea ice in the Sea of Japan/East Sea during the last 4 Ma.

Site U1424 is also ideal for reconstruction of eolian dust flux, grain size, and provenance changes since 4 Ma, considering the very slow sedimentation rate observed at Site 794. Although IRD may contribute to the total terrigenous flux in several intervals, the grain size range of eolian dust (4–32 μm) may allow differentiation of the eolian dust component from other terrigenous components.

The site is also useful to reconstruct changes in deep water oxygenation and calcium carbonate compensation depth (CCD) during the last 4 Ma, particularly because Site U1424 is the second deepest site in the Sea of Japan/East Sea drilled during

Expedition 346. At the deepest site previously drilled during this expedition, Site U1422, this objective was negatively impacted by the presence of numerous turbidites in the interval older than ~2.5 Ma.

Principal Results

Three holes were cored at Site U1424. Coring reached a maximum depth in Hole U1424A, which penetrated to 158.8 m and recovered 161 m of sediment (101%). Hole U1424B cored to 154.7 m and recovered 155.4 m of sediment (100%). Hole U1424C cored to 63.9 m and recovered 64.4 m (101%).

The sedimentary succession recovered at Site U1424 closely follows that previously identified in the upper part of ODP Site 794, and extends from the Pliocene to Holocene. Lithofacies are dominated by clays, silty-clays and diatomaceous ooze, revealing the predominance of both pelagic and hemipelagic sedimentation. Volcaniclastic material represents a minor component throughout the sediment succession, except in tephra (volcanish ash) layers. The section is divided into two major lithologic units (Units I and II), distinguished on the basis of sediment composition. Unit I (Lower Pleistocene–Holocene) consists of clay and silty-clay with small amounts of diatom-bearing, diatom-rich, and foraminifera-bearing clays. Unit I is further subdivided into two subunits (Subunits IA and IB) based on the frequency of alternating dark brown (organic-rich) and light greenish gray (organic-poor) clay intervals. Unit II (Pliocene–Lower Pleistocene) is distinguished from Unit I based on the significant increases in diatom content and bioturbation, and is further subdivided into Subunits IIA and IIB. Subunit IIA is composed of heavily bioturbated diatom-bearing and diatom-rich clays, while Subunit IIB is predominantly composed of moderate to heavy bioturbated diatom ooze. A few turbidite deposits are observed in Subunit IIA and in the upper part of Subunit IIB.

Calcareous nannofossils occur intermittently between 5 and 30 m CSF-A. Planktic foraminifers are mainly common to abundant in core catcher samples and thin carbonate layers above 40 m CSF-A, but are rare to absent, with moderate to poor preservation below 40 m CSF-A. Benthic foraminifers are absent above 33 m CSF-A, and occasionally present below this depth, generally showing poor preservation. The overall assemblage composition indicates lower bathyal to abyssal paleodepths. The

sporadic occurrence of calcareous microfossils below 30 m CSF-A most likely reflects dissolution.

The radiolarian assemblages show good preservation (except between 54 and 64 m CSF-A) and their biostratigraphic zonation ranges from the *Larcopyle pylomaticus* Zone (Pliocene) to the *Botryostrobus aquilonaris* Zone (late Pleistocene). Diatom preservation is good throughout the cored interval. Diatom abundance is low in most of the upper part of the succession and increases downhole below 83 m CSF-A. The diatom stratigraphy spans the interval from Zone NPD 12 (Pliocene) to Zone NPD7 (late Pleistocene). The presence of freshwater diatom species and phytoliths might be related to freshwater input and/or wind transportation.

Paleomagnetic investigations focused on the measurement of natural remanent magnetization (NRM) of archive split core-halves. NRM of archive-half core sections of 17 APC cores from Hole U1424A was measured before and after 20 mT alternating field (AF) demagnetization. Due to increased core flow through the paleomagnetism station, NRM of the 17 APC cores from Hole U1424B and four APC cores from Hole U1424C were only measured after 20 mT AF demagnetization. The FlexIt tool was successfully deployed to orient 16 APC cores in Hole U1424A starting from Core 2H. We measured seven discrete samples collected from varying depths in Hole U1424A before and after stepwise AF demagnetization with peak fields up to 60 mT, to verify the archive-half core section measurements and to determine the demagnetization behavior of the recovered sediments. NRM intensity of the archive-half core section measurement after 20 mT AF demagnetization in all three holes is similar in magnitude for overlapping intervals, mostly ranging from ~10^{-4} to 10^{-2} A/m. For the top ~25 m of sediment, NRM intensity is on the order of 10^{-2} A/m. From ~25 m CSF-A until the bottom of the holes, NRM intensity is on the order of 10^{-4} to 10^{-3} A/m. Inclination and orientation corrected declination data from the measured holes indicate that Site U1424 recorded almost all major reversals during the Pliocene and Pleistocene. The top and bottom of the Jaramillo (0.988–1.072 Ma) and the Olduvai (1.778–1.945 Ma) subchrons are recorded in all three holes. In Holes U1424A and U1424B, we identified the Brunhes/Matuyama boundary (0.781 Ma), the Matuyama/Gauss boundary (2.581 Ma), and the Gauss/Gilbert boundary (3.596 Ma) as well as the Mammoth subchron (3.207–3.33 Ma).

A composite section and splice were constructed for Site U1424 to establish a continuous sediment sequence using Holes U1424A, U1424B, and U1424C that were cored to 158.8, 154.7, and 63.9 m CSF-A, respectively. In Hole U1424C, only Cores U1424C-4H to -7H were subject to stratigraphic correlation, since Cores U1424C-1H to -3H were fully sampled for optically stimulated luminescence (OSL) dating and no onboard measurements were conducted. Splicing among these holes enabled us to construct a continuous stratigraphic sequence for the entire interval. Estimated sedimentation rates, based on biostratigraphy, paleomagnestratigraphy, and preliminary tephra identification, range from 14 to 41 m/m.y., with the highest sedimentation rates being characteristic of Units IA and IB.

The lower flux of organic material to Site U1424 distinguishes it from other sites drilled in the Sea of Japan/East Sea during Expedition 346. Microbially mediated oxidation of organic material is one of the main controls on the geochemical profiles. There is no sulfur-methane transition boundary at this site and methane is orders of magnitude lower than at other sites. Sulfate concentrations decrease but sulfate is still present at depth, implying that sulfate is the final electron acceptor to oxidize organic material. Near the seafloor, Mn and Fe concentrations increase as their oxide forms are reduced to degrade organic material, but other processes such as authigenic clay formation may also be influencing the Fe profile. Phosphate and alkalinity increase with depth, but their maximum concentrations never exceed ~65 μM and ~14 mM, respectively. The presence of carbonates is minimal, but alteration of volcanic ash layers and basement basalt influence the Ca, Mg, and Sr profiles. These processes could also impact the concentrations of Si and Li in the sediment, although Si and Li seem to respond more to the dissolution of diatoms throughout the sediment column. Interstitial water analyses for samples obtained by squeezing whole-rounds and Rhizon syringes agree well for most, but not all, elements and provide higher resolution at shallow depths.

Physical properties at Site U1424 are largely similar to Sites U1422 and U1423, with the possible exception of a potential hiatus near the bottom of Subunit IIB. Physical properties display the pattern typical of much Sea of Japan/East Sea sediment, with Unit I (Pleistocene to Holocene) exhibiting cyclical variability driven by alternating organic-rich and organic-poor layers, and which transitions into Unit II (Pliocene),

which has a more subdued variability largely due to alternating hemipelagic and biogenic silica-rich sediments. Compared to previous Expedition 346 sites, at Site U1424 magnetic susceptibility is less influenced by redox processes, while *P*-wave velocity and shear stress data show consistent increasing trends downhole due to less degassing. Reflectance data capture well the lithological and diagenetic variability at the decimeter- to centimeter-scale.

Downhole temperature measurements were made at the seafloor and at 35 m CFS-A using the APCT-3 tool. The measurements are in good agreement with the in situ temperature data acquired at the same location during ODP Leg 127, confirming a geothermal gradient of 125°C/km.