IODP Expedition 346: Asian Monsoon

Site U1426 Summary

Background and Objectives

Site U1426 is located in the south central part of the Sea of Japan/East Sea at 37°2.00′N, 134°48.00′E, and a water depth of 903 m. The site is situated near the top of the Oki Ridge, which extends southwest-northeast, and bounds the southern margin of the Yamato Basin. Site U1426 is at the same location as ODP Site 798, approximately 150 km to the north of Honshu Island. The bathymetric setting of Site U1426 was chosen to minimize the influence of turbidites.

Site U1426 is under the influence of the second branch of the Tsushima Warm Current (TWC), which is a highly meandering current characterized by eddies. Previous results from ODP Site 798, as well as from a piston core retrieved from almost the same location as Site U1426 during the site survey cruise, suggest an average sedimentation rate of ~80 m/m.y. These rates are slightly higher than found at previous Sites U1423, U1424, and U1425, but still low enough to detect the contribution of eolian dust from the Asian continent, considering the relatively large contribution of biogenic materials at this site. Based on a moderate geothermal gradient of ~110°C/km (as observed at Site 798), the opal-A/opal-CT boundary at Site U1426 was predicted to be at ~400 m. We expected this to allow recovery of unconsolidated sediment back to at least 4 Ma permitting reconstruction of eolian dust flux and provenance over this period in the southern part of the Sea of Japan/East Sea. The relatively shallow depth of Site U1426 was also expected to provide better preservation of calcareous microfossils.

Located in the middle of the southern half of the Expedition 346 latitudinal transect, Site U1426 lies at a relatively shallow depth in the expedition depth transect. Together with results from Sites U1423–U1425, Site U1426 will enable us to reconstruct changes in the position of the atmospheric Westerly Jet axis during the last ~5 Ma, and sea surface temperature changes associated with the north-south movement of the subpolar front, as it is related to the strength of the TWC. Finally, we will reconstruct changes in deepwater oxygenation and calcium carbonate compensation depth during the last 4 Ma by combining the results from the

Expedition 346 depth transect sites.

Principal Results

Four holes were cored at Site U1426 using the full- and half-length advanced piston corer (APC) and the extended core barrel (XCB) systems. Holes U1426A and U1426C were cored to 396.7 and 204 m CSF-A, and recovered 418.8 m (106%) and 211.9 m (104%) of core, respectively. Hole U1426B was cored to only 34.7 m because this hole was dedicated for high-resolution geochemical analyses. Hole U1426D was cored to only 99.4 m CFS-A to recover additional material from the upper part of the section. A total of 95 APC and 2 XCB cores were obtained with a recovery of 770.2 m of sediment (105% core recovery). Four formation temperature measurements were performed in Hole U1426A.

The sediment succession at Site U1426 extends from the Pliocence to the Holocene, and consists of clay and silty clay, with varying content of biogenic silica, foraminifera and calcareous nannofossils, and diatom-, biosiliceous- and nannofossil ooze. These lithologies are interbedded with tephra layers. The sediment succession is divided into two lithological units based on sedimentary structures and sediment composition and is similar to that observed at Sites U1422 through U1425. At Site U1426, Unit I shows alternations of clay and diatom-rich clay to diatom-ooze. Subunit Ia shows characteristic cm- to dm-scale alternations of diatom-rich clay and clay with a distinct dark-light color banding. These alternating layers are somewhat less pronounced than at Site U1425. In contrast, Subunit Ib is characterized by 3 to 5 m-scale alternations of clay with diatom- and nannofossil-oozes; there are only subtle color changes between major lithologies. Unit II is characterized by thick intervals of diatom-ooze and clay and shows less frequent lithologic variation.

Nannofossils are present shallower than 182.3 m CSF-A, but are absent or rare in deeper sediment. Planktic foraminifers are mainly confined to the upper part of the succession (above ~172 m CSF-A), exhibiting good preservation above ~99 m CSF-A and moderate to poor preservation from ~172 to ~170 m CSF-A. Planktic foraminiferal assemblages above ~172 m CSF-A generally indicate temperate to subarctic environments with intermittent incursions of subtropical species. Benthic foraminifers occur intermittently throughout the succession, showing marked variations in abundance and preservation. The overall assemblage composition

indicates bathyal paleodepths. The highly variable composition of the assemblages suggests fluctuating organic fluxes to the seafloor with episodic oxygen depletion and intense carbonate dissolution, particularly during the Pliocene. Radiolarians are generally common to abundant in the sequence, except deeper than ~289 m CSF-A where they are rare or absent. Diatom preservation is good throughout the succession, although extreme diatom dissolution occurs below 392.1 m CSF-A. Overall, diatom abundances are high at this site and include few or rare warm water diatom species. Twenty-six datums are documented (six nannofossil, four planktic foraminifer, 10 radiolarian, six diatom). These datums generally agree with only some minor inconsistencies.

Stratigraphic correlation produced a complete splice spanning the entire length of overlap between the two deep holes drilled (Holes U1426A and U1426D). The splice covers 0 to 236.2 m CCSF-D (0 to 210.5 m CSF-A). Cores not used in the splice, including cores from Hole U1426B (which was dedicated to geochemical analyses), and some cores from Hole U1426D (drilled to recover additional sediments from the upper 100 m CSF-A), were also mapped into the splice at cm-scale resolution. A preliminary age model was produced using micropaleontological, tephra, and paleomagnetic datums. Sediments at ~400 m CSF-A approach ~5 Ma in age. Sedimentation rates vary from ~90 to 115 m/m.y. and are consistent with changes in lithology; Subunit Ib (~125 to 281 m CSF-A) has slightly higher rates than Subunits Ia and IIa, most likely due to the increased biological productivity or enhanced preservation.

Physical properties are significantly different from the previous deep-water sites of Expedition 346, except that sediments in Unit I show a similar high variability in lithological composition and thus physical properties. In Unit I, cyclical physical properties appear to be driven not only by the binary mixture of organic matter and hemipelagic sediments but also by the addition of carbonate and possibly a reduction in the formation in authigenic pyrite. Compared to Sites U1422–U1425, the more abundant clay appears to overtake organic matter as the main factor influencing NGR variability. Magnetic susceptibility is low, but magnetic carriers appear sturdy enough to preserve a good paleomagnetic signal. Four formation temperature measurements were made using the APCT-3 tool down to 116.5 mbsf in Hole U1426A. The

geothermal gradient was 115°C/km and the heat flow 94 mW/m^2.

Paleomagnetic studies focused on the measurement of natural remanent magnetization of archive-half split-core sections. NRM of archive-half core sections from Hole U1426A was measured before and after 20 mT alternating field (AF) demagnetization. Due to increased core flow, NRM of core sections from Holes U1426B, U1426C, and U1426D were only measured after 20 mT AF demagnetization. The FlexIt tool was successfully deployed to orient 25 APC cores in Hole U1426A beginning with Core U1426A-2H. NRM intensity of the measured core sections after 20 mT demagnetization mostly ranges between ~10^{-4} and 10^{-2} A/m; values are close to ~10^{-2} A/m for the top ~90 m CSF-A, except from ~60 to 80 m CSF-A it decreases to 10^{-4} to 10^{-3} A/m. The Brunhes/Matuyama boundary (0.781 Ma) is recorded at 81.5 m CSF-A in Hole U1426A, 74.9 m CSF-A in Hole U1426C, and 80.5 m CSF-A in Hole U1426D. Both the Jaramillo (0.988–1.072 Ma) and Olduvai subchrons were identified in Holes U1426A and U1426C. The Matuyama/Gauss boundary (2.581 Ma) is recorded at ~254.6 m CSF-A in Hole U1426A. Sediments recovered from deeper than ~260 m CSF-A at Site U1426 have mostly positive inclinations that are apparently steeper than the expected normal polarity dipole value. Increased coring disturbance, a strong drilling overprint, the lack of core orientation, and the large scatter in paleomagnetic declinations makes magnetostratigraphic interpretations difficult deeper than ~260 m CSF-A.

Site U1426 is characterized by relatively high contents of organic carbon (~2 wt%) and carbonate (up to 25 wt%) compared to the previous Expedition 346 sites. A rapid decrease of dissolved Fe and Mn near the seafloor indicates reactions between organic matter and metal oxides, leading to increases in alkalinity, ammonium, and phosphate. The shallow sulfate-methane transition (SMT) boundary occurs at ~8 m CSF-A. A marked change in the slope of the alkalinity profile, constant concentration of dissolved NH_4^+, and maximum in dissolved sulfide (HS^-) at the SMT boundary are indicative of shallow anaerobic oxidation of methane (AOM). The degradation of the large amount of organic carbon at depth drives methanogenesis. The upward flux of methane toward the seafloor reacts with sulfate during AOM. The low values of the methane to ethane ratio, with the occurrence of propane at depth, suggest the possibility of thermogenic methane near the bottom of the recovered sequence.