IODP Expedition 346: Asian Monsoon

Site U1427 Summary

Background and Objectives

Site U1427 is located in the southernmost part of the Sea of Japan/East Sea at 35°57.92′N, 134°26.06′E and a water depth of 337 m. The site is situated on the outer margin of the SE–NW trending continental shelf ~35 km from the northern coast of Honshu Island and ~110 km south of Site U1426. Today, this site is under the influence of the first branch of the Tsushima Warm Current (TWC), which is flowing along the outer margin of the continental shelf of Honshu Island. A piston core obtained during site a pre-expedition site survey cruise suggests an average sedimentation rate of ~300 m/m.y. This is significantly higher than any other sites drilled in the Sea of Japan/East Sea and coring at this site should provide an extremely high-resolution record spanning the most of the Pleistocene. In addition, the proximity to the southwestern portion of Honshu Island will provide a rare opportunity to examine the interrelationship between terrestrial climate and oceanography in the southern part of the Sea of Japan/East Sea.

Site U1427 is the southernmost site of the Expedition 346 latitudinal transect and is also the shallowest of the depth transect. The location of Site U1427 was selected to obtain a high-resolution record of changes in the intensity of the influx of the first branch of the TWC during the last 2 Ma. We anticipate that this site will allow a high-resolution and continuous reconstruction of the oxygen isotope record because the shallow depth of U1427 assures that the site has always been located above the calcium carbonate compensation depth (CCD). Accordingly, benthic foraminifera have likely survived burial and resisted corrosion even during glacial maxima climate stages when euxinic deep water condition prevailed below the depth of 500 m. Together with the results from Sites U1425 and U1426, Site U1427 will enable us to reconstruct sea surface temperature changes associated with the north–south movement of the subpolar front that is considered to be related to the strength of the TWC.

Principal Results

Two holes were cored at Site U1427 using the full and half-length advanced piston

corer (APC) and the extended core barrel (XCB) systems. Hole U1427A was cored to 548.6 m CSF-A (81 cores), and recovered 515.1 m (105%). Hole U1427B was cored to 405.6 m CSF-A (65 cores), and recovered 422.41 m (105%). In Hole U1427A, four formation temperature measurements were performed and downhole wireline log data was obtained to 548.5 m WSF.

The sedimentary succession recovered at Site U1427 extends from the early Pleistocene to the Holocene and is dominated by clayey silt and nannofossil-rich or biosiliceous-rich clayey silt. Numerous tephra beds are interbedded with these major lithologies and volcaniclastic material represents a minor component throughout. The complete succession of Site U1427 is assigned to a single unit "Unit A," based on sedimentary structures and sediment composition. We refer to this unit as "Unit A" (instead of "Unit I") to reinforce that this unit is lithologically distinct from the first unit described at other Sea of Japan/East Sea sites occupied during Expedition 346.

Lithologic Unit A is characterized by tens of meters scale alternations of biogenic component-rich clayey silt and clayey silt and shows a gradual color change from olive gray to grayish green. The sediments are generally highly bioturbated and fairly homogeneous. Dispersed tephra and shell fragments are present throughout. Some intervals in the upper 120 m CSF-A show very dark gray colors with heavy bioturbation. Laminated intervals are found between 150 and 350 m CSF-A. The downcore variation of maximum grain size shows a coarser size in clayey silt intervals for the upper ~120 m CSF-A, with finer material in the clayey silt intervals deeper than ~120 m CSF-A.

Nannofossils are generally common to abundant and exhibit moderate to good preservation. Six calcareous nannofossil datums are documented. Planktic foraminifers are generally abundant, except for a few barren horizons and rare occurrences deeper than 511.8 m CSF-A. Planktic foraminiferal assemblages are characteristic of temperate to subarctic environments with intermittent incursions of subtropical species. Benthic foraminifers and ostracods are generally abundant and moderately to well preserved, except for a few samples which are either barren or contain impoverished assemblages. The overall composition of assemblages indicates shelf to upper slope paleodepths. However, downhole changes in assemblage composition appear to reflect changing paleoenvironmental conditions, probably

related to distinct phases of Pleistocene climate evolution. Radiolarians are generally rare throughout the cored section, except for at the base of the succession where they are abundant. Four radiolarian markers are documented in Hole U1427A from the *Stylatractus universus* Zone (middle Pleistocene) and the *Botryostrobus aquilonaris* Zone (late Pleistocene). Diatoms are generally abundant and exhibit excellent preservation throughout the sedimentary sequence. No biostratigraphically useful diatom marker species were documented. High abundances of *Chaetoceros* spores and *Paralia sulcata* throughout the succession indicate a productive coastal environment. Freshwater diatom species differing from those at previous sites were also recognized. Phytoliths were present in all samples. All calcareous and siliceous microfossil datums generally agree, with only minor inconsistencies.

Stratigraphic correlation of Holes U1427A and U1427B produced a complete splice extending from the sea floor to the bottom of Core U1427A-63H (407.3 m CSF-A). From that depth downward, only sediment from Hole U1427A was recovered. Although the cores below Core U1427A-63H were not included in the spliced section, comparing the cores' natural gamma radiation (NGR) profiles to the Hostile Environment Natural Gamma Ray Sonde (HSGR) profiles from the wireline measurements suggests that there are no significant core gaps. Sedimentation rates in the single lithologic unit established at this site vary little over the ~500 m record, and averages ~36 cm/k.y.

Physical properties measured at Site U1427 generally show trends that follow the alternating darker clay-rich and light biogenic component-rich sediments. Bulk density, NGR, and magnetic susceptibility show higher values in clay-rich sediment intervals, whereas lower values occur in biogenic-rich intervals. Porosity and water contents show opposite trends. Color reflectance also reflects these lithologic changes. Color reflectance (b*) representing the yellow-blue ratio is a good indicator to discriminate the clay-rich from the biogenic-rich sediments and correlates well with the trends of bulk density and NGR.

Paleomagnetic studies focused on the measurement of natural remanent magnetization of archive-half split-core sections. NRM of archive-half core sections from Hole U1427A was measured before and after 20 mT alternating field (AF) demagnetization. Due to increased core flow, NRM of core sections from Hole U1427B was only

measured after 20 mT AF demagnetization. The FlexIt tool was successfully deployed to orient Cores U1427A-2H to -25H. We measured 12 discrete samples collected from Hole U1427A 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 measured core sections after 20 mT demagnetization mostly ranges between ~10^{-4} and 10^{-3} A/m. For the top ~280 m of the recovered sediments, NRM intensity of the measured core sections after 20 mT demagnetization is mostly on the order of 10^{-3} A/m. Below ~280 m CSF-A until the bottom of the holes, NRM intensity decreases to the order of 10^{-4} A/m and the trend appears to be noisier than that from sediments found shallower than ~280 m CSF-A. The increase in scatter in the NRM intensity data from ~280 m CSF-A until the bottom of the holes is accompanied by increased scatter in paleomagnetic directional data.

The Brunhes/Matuyama boundary (0.781 Ma) was recorded at ~295.3 m CSF-A in Hole U1427A, and at ~293.7 m CSF-A in Hole U1427B. Below ~280 m CSF-A, NRM inclinations of the holes after 20 mT AF demagnetization show mostly positive values that are apparently steeper than the expected normal polarity dipole inclination, and scattered intervals with shallow and negative inclinations. Increased coring disturbance, strong drilling overprint, the lack of core orientation, and the large scatter in paleomagnetic declinations makes magnetostratigraphic interpretations difficult for the deep part of sediments recovered at Site U1427 (>~280 m CSF-A).

We also conducted a short experiment to study changes in NRM as a function of core oxidation. Repeated measurement of NRM after 20 mT demagnetization of core sections from the dark intervals in the upper ~120 m of the holes at varying times indicates that NRM appears to decay through time possibly due to magnetic mineral alteration caused by oxidation after the cores are split. The light intervals were not nearly as affected as the darker intervals.

The geochemistry at Site U1427 typifies that of continental margin sequences with extreme decomposition of organic matter. Organic carbon contents are relatively high with a mean of 1.2 wt% from the seafloor to a depth of ~550 m CSF-A. Combined with a very high sedimentation rate (~36 cm/k.y.), large quantities of organic matter are buried, which facilitates intense microbially-mediated organic matter degradation

processes including fermentation and methanogenesis. As a consequence, interstitial waters are yellow, and certain dissolved species have very high concentrations. In particular, alkalinity, ammonium, phosphate, and bromide are all much higher than at other sites drilled during Expedition 346.

The considerable organic matter decay also results in very high methane concentrations, which caused numerous gas voids beginning at ~18 m CSF-A. A very shallow and sharp sulfate-methane transition (SMT) occurs at ~5 m CSF-A. This SMT is caused by anaerobic oxidation of methane (AOM) where a high upward flux of methane reacts with downward diffusing sulfate. This is shown by analyses of high-resolution water samples, collected using a combination of whole-rounds and Rhizons. Dissolved silica concentrations increase with depth, but much more slowly than at other Expedition 346 sites, probably because of the low geothermal gradient (70°C/km) at Site U1427 compared to that at other locations. Calcium carbonate varies between 2.6 and 25.1 wt%, and is well preserved over the entire depth of Site U1427, perhaps in part due to the very high interstitial water alkalinity.

Downhole wireline log measurements were made in Hole U1427A to 548.5 mbsf using the Paleo-combo tool string, which recorded spectral gamma ray, caliper, magnetic susceptibility, resistivity, lithologic density logs, and the FMS-sonic tool string, which recorded resistivity images of the borehole, sonic velocities, and natural gamma data. Each logging tool string was run twice in the hole to ensure the quality of the logging data. The logs do not show major steps in the base levels and the entire logged interval was assigned to one Logging Unit (Log Unit 1) corresponding to lithostratigraphic Unit A. Preliminary inspection of the data revealed cyclicities that mainly reflect variations in biogenic content relative to terrigenous clays and are consistent with lithological changes in the recovered cores. Intervals with high gamma ray values, high density, and high resistivity generally reflect terrigenous clay rich intervals. The measured geothermal gradient was 70°C/km and the calculated heat flow value was 71 mW/m^2.