**IODP Expedition 346: Asian Monsoon**
**Site U1428/U1429 Summary**

## Background and Objectives

Site U1428 is located in the northernmost part of the East China Sea (ECS) at 31°40.64′N, 129°02.00′E, and a water depth of 735 m, while Site U1429 is located only 7.4 km away at 31°37.04′N, 128°59.85′N and a water depth of 744 m. The sites are situated in the southern part of Danjo Basin, which is located in the northern tip of the Okinawa Trough. Danjo Basin is a depression ~80 km wide and ~800 m deep with a sill depth at ~700 m, and is surrounded by continental shelves to its west, north, and east. Only its south side is open to the Okinawa Trough.

At present, the more than 500 km wide continental shelf of the ECS spreads to the west of Danjo Basin, and also extends further to the northwest to the Yellow Sea. Because the two large Yangtze and Yellow Rivers drain into the Yellow Sea, there is expected to be a significant contribution of fine detrital material from the west. During glacial lowstands, approximately one half of the shelf was subaerially exposed and the mouth of Yellow River advanced southeastward toward Danjo Basin. Thus, the mouth of the Yellow River was perhaps located only ~150 km to the northwest of Sites U1428 and U1429 during glacial maxima. At other times during glacial periods, the mouth of the Yangtze River instead advanced to the southeast and was located ~400 km to the southwest.

Sites U1428 and U1429 lie beneath the Tsushima Warm Current (TWC), which branches from the Kuroshio Current ~250 km to the south. The sites are also under the influence of East China Sea Coastal Water (ECSCW), which expands eastward from the continental shelf of the northern ECS due to the larger discharge of the Yangtze River during summer. Studies on piston cores retrieved from nearby locations suggest fast sedimentation rates of ~300–800 m/m.y., which should allow for high-resolution paleoceanographic reconstruction of the northern ECS.

One of the major objectives of Expedition 346 is to reconstruct high-resolution changes in East Asian summer monsoon (EASM) intensity since the Pliocene. The location of Sites U1428 and U1429 was selected to explore high-resolution changes in Yangtze River discharge through reconstruction of sea surface salinity. Since the

Yangtze River drainage basin occupies the portion of southern China where EASM precipitation is most intense, it is reasonable to consider that Yangtze River discharge reflects the intensity of EASM precipitation.

The influx of water through the Tsushima Strait is the major source of nutrients as well as freshwater to the Sea of Japan/East Sea. Therefore, data from Sites U1428 and U1429, will constrain the history of surface water salinity and nutrient concentration of water that flows into the Sea of Japan/East Sea.

The difference in salinity of the surface water relative to that of the deep water is one of the major controls of deep water ventilation in the Sea of Japan/East Sea. The nutrient influx together with the deep water ventilation rate is the major control of biological productivity in the surface as well as of bottom water oxygenation. Therefore, it is important to document the fresh water and nutrient budgets of the Sea of Japan/East Sea to best understand the origin of the dark and light layers in the sedimentary record as well as the overall paleoceanographic evolution of the Sea of Japan/East Sea.

**Principal Results**

Two holes were cored at the primary Site U1428 and three holes at the alternate Site U1429 using the full- and half-length advanced piston corer (APC) and the extended core barrel (XCB) systems. At both sites non-magnetic core barrels were used with the APC system. Only full-length core barrels were oriented. In Hole U1428A, twenty-six cores extended from the seafloor to 211.5 m CSF-A, including seven drilled intervals (totaling 37.6 m) through thick sand beds. The cored interval in Hole U1428A was 173.9 m with a recovery of 178.86 m of core (103%). After completing Hole U1428A, we moved to Site U1429, which was estimated to have higher linear sedimentation rates and therefore an expanded late Pleistocene section.

APC coring at Site U1429 was uneventful. Hole U1429A penetrated to 188.3 m CSF-A, including two drilled intervals totaling 4.1 m. Core recovery for Hole U1429A was 190.3 m (103%). Hole U1429B penetrated to 186.2 m CSF-A with a recovery of 200.9 m of core (108%). Hole U1429C penetrated to 179.2 m CSF-A, including two drilled intervals totaling 4.9 m. Core recovery for Hole U1429C was 180.7 m (104%).

After completing Site U1429, we returned to Site U1428 to drill an additional hole

that provided material to build a complete spliced section at this site spanning at least the last ~0.3 Ma, and to provide additional material for high resolution paleoceanographic studies. Hole U1428B was subsequently APC cored to 143.3 m CSF-A (16 cores) with a recovery of 145.85 m (102%).

The sedimentary succession recovered at Sites U1428 and U1429 extends from the Middle Pleistocene to the Holocene, and is divided into two lithologic Units, Unit A and Unit B, based on sedimentary structures and composition. Unit A at Sites U1428 and U1429 is equivalent to Unit A at Site U1427 in the southern Sea of Japan/East Sea. Unit A is composed mainly of calcareous nannofossil ooze and calcareous nannofossil rich clay. Meter scale color variations from olive gray to greenish gray and light greenish gray is visible but subtle, and appear to respond to glacial-interglacial variations of paleoceanographic change. Tephra layers with thickness ranging from decimeters to half a meter occur throughout. Unit B is a sand unit, consisting of fine- to medium-grained, rounded to sub-rounded massive sand up to 70 m in thickness. Little sedimentary structure is preserved in this unit. Given the sand is well sorted and rounded, it is strongly suggested that the unit was deposited by strong along-slope currents, rather than gravity flow as in the case of turbidite formation.

Nannofossils are generally abundant and exhibit good preservation through the upper Pleistocene succession, except in the sand intervals. One calcareous nannofossil datum, the FO of *Emiliania huxleyi*, is documented. Diatoms are generally common and exhibit good preservation. No biostratigraphically useful marker species are recorded. Variable abundances of Chaetoceros spores and *Paralia sulcata* indicate the occasional presence of a biologically productive coastal environment. Freshwater diatoms show significant abundance peaks throughout the succession. Planktic foraminifers are abundant and well preserved, except in the sand horizons, which are barren. Planktic foraminiferal assemblages are diverse and typical of subtropical environments. The LO of *Globigerinoides ruber* (pink) is consistent with the calcareous nannofossil datum. Benthic foraminifers vary markedly in abundance, but are generally well preserved. The overall assemblage composition indicates upper bathyal paleodepths. Ostracods are common to abundant, and well preserved, in the upper ~130 m CSF-A, but absent in the sand horizons of the lower part of the section.

Downhole changes in assemblage composition reflect variations in organic export fluxes to the seafloor and bottom water ventilation that are probably linked to glacial-interglacial oscillations in biological surface productivity and ocean circulation.

Calcium carbonate contents display a cyclic pattern, alternating between ~15 and ~35 wt%. These changes probably relate to glacial/interglacial oscillations. Carbonate profiles at both sites correlate well with each other, once different sedimentation rates between the two sites have been taken into account. The organic carbon content varies from a relative high in the uppermost sample at Hole U1428A (TOC ~1.5 wt%) to almost zero in the basal sand layers. This change is a gradual decrease with depth but does display a saw-tooth pattern with up to a 0.20 wt% variance. At ~90 m and 110 m CSF-A, TOC values decrease due to the presence of tephras. Total Nitrogen (TN) content is low, as observed at previous sites. However, it closely follows the TOC pattern, decreasing over depth, from ~0.3 wt% at the top to ~0.12 wt% at the bottom. The C:N ratio is low, but follows the TOC trend.

Interstitial waters were collected using traditional whole-round samples and and Rhizons. Results from both techniques show very unusual profiles. In particular, a sharp change in several constituents at ~46 m CSF-A at both sites shows that uppermost sedimentary section contains porewaters with a very different chemistry compared to underlying sediment. The abrupt interface coincides with a very porous tephra horizon at both sites at similar depths. The interface also corresponds with a sulfate-methane transition (SMT). Sub-horizontal fluid flow may be occurring within the abundant tephra horizons and driving microbial activity at these sites.

Physical properties measured at Sites U1428 and U1429 generally show similar trends that follow the sediment lithology. Bulk density and NGR gradually increase with depth in lithologic Unit A and the highest values occur in the sands of lithologic Unit B. Porosity and water content show an opposite trend. Magnetic susceptibility shows high values in the tephra layers and also largely increases downhole in Unit B. At both sites, the color reflectance profiles agree well with changes in the content of calcium carbonate and other physical properties related to tephra and sand layers. Color changes at these two sites are mainly controlled by calcium carbonate content, the color of tephra layers, and the presence of the sands.

Paleomagnetic measurements indicate that the entire sections at Sites U1428 and U1429 correspond to the Brunhes age. This interpretation is consistent with biostratigraphic results for the site.

Five formation temperature measurements, including the mudline, were performed in Holes U1428A and U1429A using the APCT-3 tool. The measured geothermal gradients were 116°C/km and 94°C/km, and heat flows were 126 mW/$m^2$ and 88 mW/$m^2$ in in Holes U1428A and Hole U1429A, respectively.

Stratigraphic correlation at both Site U1428 and Site U1429 benefited from calm seas and minimal gas expansion. Although the sites are only 7.4 km apart, sedimentation rates were sufficiently different to merit generation of separate splices. The Site U1428 splice reaches ~145 m CCSF-D with one gap, from 88.7 to 93.8 m CCSF-D. The U1429 splice reaches ~188 m CCSF-D with two gaps, the first from 50 to 53.1 m CCSF-D and the second from 123 to 125.8 m CCSF-D. Preliminary correlation among the two splices indicates that the shallower gap in the U1429 splice was successfully recovered at Site U1428, but that the deeper gap is likely in the same interval as the gap at U1428. All three of these gaps stem from strong coring disturbance and poor core recovery associated with the unsuccessful coring of unconsolidated coarse (sand and ash) layers. Preliminary age models based on a very limited number of datums (two to three at each site) indicate sedimentation rates of ~42 cm/k.y. at Site U1428 and ~50 cm/k.y. at Site U1429.