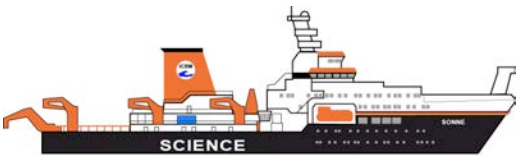
SO-249 Leg 1
BERING

Weekly Report No. 3
(20.06. – 26.06.2016)



R/V SONNE
51° N / 172° E

An important goal of the two SO249 cruise legs is to determine if the Aleutian Volcanic Front can be traced continuously from the Ingenstrem Trough, west of Buldir Island (US), to Piip Volcano, north of Bering Island (Russia) in the westernmost Aleutians. From June 19 to June 20, we added to previous mapping looking for young submarine volcanic centers west of the Ingenstrem Trough, but found no new centers until we approached the Western Cones Region, which was discovered on the R/V SONNE 201/1b KALMAR Expedition. There we found several new cones aligned in a perfect linear array along a young fault cutting the uppermost sedimentary sequence and recovered largely rhyodacites, presumably melts of the subducting Pacific Plate. We then proceeded southwards to the Kresta Ridge, which is a steep fault scarp bounding the northern side of a deep graben with a relief of up to 1.7 km. The fault appears to be an extension of the Bering Fault system that forms the northern margin of the plateau on which the Komandorksy Islands (Bering and Medny) are located and is believed to have a large right-lateral strike-slip component of movement, due to the highly oblique subduction of the Pacific Plate beneath the westernmost Aleutians. Here we carried out three successful dredges recovering volcaniclastic rocks, a variety of lavas, and gabbroic rocks cut by small basaltic dikes. Age dating and geochemical analyses of these rocks will clarify if they preserve information about the early history of the Aleutian arc.

On June 21, we returned to the Aleutian forearc and carried out several deep dredges to depths of up to 6.7 km at the nose of the forearc, largely recovering volcaniclastic material and sedimentary rocks. We then crossed the trench to the northwestern tip of the Stalemate Fracture Zone and mapped the large fault block that had been previously sampled at its southern end during the SO201/1b cruise. The mapping revealed evidence for a complex history of faulting of this block and showed that this block forms a barrier in the Aleutian Deep-Sea Trench, separating sedimentary material derived from North America from that derived from Siberia. On the previous SONNE cruise, dunitic rocks (primarily consisting of >90% olivine) were recovered and were interpreted to have been previously exposed to subaerial conditions, based on their alteration style. The proposed large-scale vertical tectonic movements of “several thousand meters” were met with much skepticism. Subaerial exposure, however, has now been confirmed, as will become evident below. Our first dredge June 23 was half full and contained a wide array of rocks ranging from ultramafic samples (olivine orthopyroxenites to harzburgites) to plutonic rocks (gabbros, diorites and possibly plagiogranites) to basaltic volcanic rocks. These rocks, present in a single dredge, represent a cross-section through the entire ocean crust into the uppermost mantle, providing invaluable information about the composition of the entire crustal and upper mantle input into the subduction zone, one of the major goals of the Bering project. A quarter-full dredge from the top of the tectonic block was even more exciting than the first dredge. Although we expected to sample pillow basalts, representing the uppermost portion of the ocean crust, we again recovered the complete section through the ocean crust and upper mantle (see photo), with many of the rocks being rounded river/beach cobbles (see photo) and coarse-grained sandstones of the major rock types in the dredge. The cobbles and sandstones provided direct confirmation that this block had indeed undergone major tectonic uplift, such that even lower crustal and upper mantle rocks were emergent and formed, at some point in their history, part of an island. If we use an average oceanic crustal thickness of 6-7 km and add this to the water depth of similar aged seafloor of ~5 km, then the vertical tectonic uplift has to have been ≥11 km followed by down-dropping of ~5 km (present-day depth) of this ~70 km long by ~25 km wide tectonic block.

After carrying out more dredging in the forearc of the Aleutian subduction zone on June 24-25, we again crossed over to the Pacific Plate and mapped the remaining portion of the Stalemate Fracture Zone and began dredging again late in day on June 26. The long mapping exercise provided the first day off for the scientists since the beginning of the cruise and allowed a shift

rotation, such that the scientists working at night are now working during the day and vice versa. It also provided an excellent opportunity for the midway party, enjoyed by both crew and scientists.

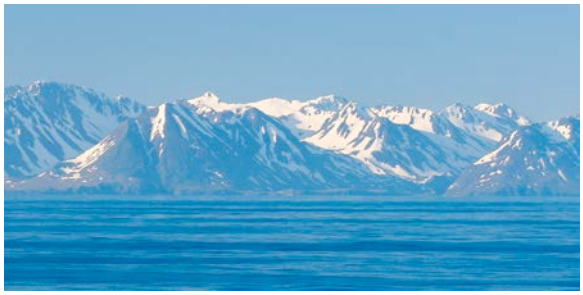
Biological sampling in the third week of the cruise resulted in about a dozen new sediment samples with associated meiofauna from various stations surrounding the island of Attu. As in the previous two weeks, the bathymetric range of the sampling (2,000-7,000 m) was impressive and is certainly bound to lead to one or the other new discovery. In addition, a large variety of macrofaunal organisms was found, including echinoderms (Echinodermata), crustaceans (Crustacea), sponges (Porifera), bristle worms (Polychaeta), moss animals (Bryozoa), corals (Cnidaria), lamp shells (Brachiopoda), and sea squirts (Tunicata). One of the notable specimens was a sea cucumber found at about 3,500 m depth on one of the submerged cones NW of the island of Attu (see photo). Another interesting specimen was found at about 6,500 m depth and is likely to be a representative of a group of sea squirts (Tunicata) called Stolidobranchiata - it might actually be one of the few members of this group that evolved a predatory lifestyle (see photo). Further analyses at the Museum für Naturkunde in Berlin, where all biological samples will be sent, will reveal more details about all the biological specimens.

On Saturday June 25, while dredging south of snow-covered Attu Island (see photo) and west of the barren Agattu Island, we passed out of the fog for several hours and were able to bask in the sun with gorgeous views of the islands before returning to the fog and cold. The seas have remained amazingly calm and the exciting work, beautiful island views, midway party with gorgeous sunset (see photo), and day off (at least for most scientists) have assured that everyone on board continues to do well and remain cheerful.

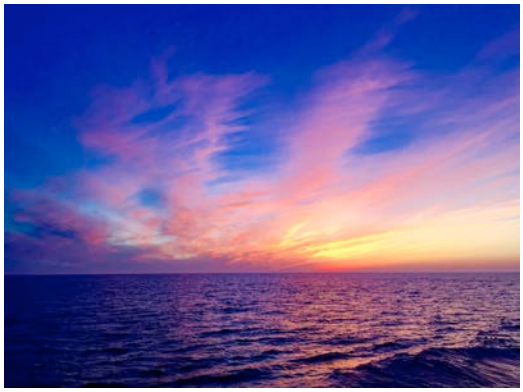
Kaj Hoernle (chief scientist SO249) and the cruise participants

Russian colleagues are excited about recovering an entire cross section from the upper mantle (foreground) through the lower crust (middle) to the top of the ocean crust (background) from the Stalemate Fracture Zone. (Kaj Hoernle)

Olivine (altered to orange) orthopyroxenite (bottom) and gabbro (top) from the lower ocean crust. Samples on left are river/beach cobbles, providing evidence that the top of the Stalemate Fault block once formed an island. (Kaj Hoernle)



A rare view of the snow-covered Attu Island on the nicest evening of the cruise thus far (Gene Yogodzinski)



Gorgeous sunset to accompany the midway party. (Kaj Hoernle)

This ca. 25 cm long sea cucumber was brought up from a depth of about 3,500 m. As a defensive reaction, the animal has expelled part of its intestines. (Alexander Ziegler)

This stalked colonial tunicate was dredged at about 6,500 m depth in the Stalemate Fracture Zone. (Alexander Ziegler)