ARK-XXVIII/4

05 August 2014 - 08 October 2014

Tromsö - Bremerhaven

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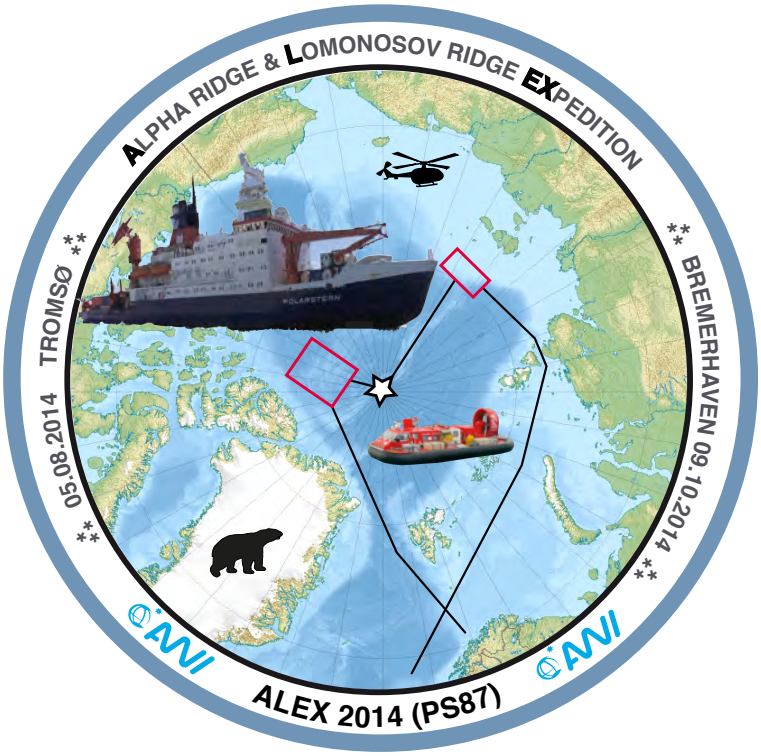

SUMMARY AND ITINARARY

The Expedition PS87 (ARK-XXVIII/4) was mainly related to geoscientific investigations in the central Arctic Ocean, to be carried out on the Alpha Ridge and the Lomonosov Ridge (Fig. 1.1). The overall goal of the research program was the detailed reconstruction of the short- and long-term climate history as well as the tectonic evolution of the Arctic Ocean. As too strong ice conditions did not allow to reach the Alpha Ridge, we focused our work on the Lomonosov Ridge (Fig. 1.1 and 1.2). Key activities of the expedition can be summarized as follows:

- In total, 3084 km of high-quality seismic profiles were recorded, 2058 km of which are multichannel seismic lines with the 3000 m long streamer. These data are important for future more detailed planning of IODP drill sites we have proposed for the Lomonosov Ridge area.
- A detailed geological coring program was carried out on Lomonosov Ridge from the Greenland side across the North Pole towards the Siberian side of the ridge. Areas from where no material was available so far, were sampled as well as old (preglacial?) sediments having an age of probably Late-Middle Miocene and older. These sediments may give us the unique chance to reconstruct past preglacial Arctic climate intervals.
- During transit and within the main working areas, Hydrosweep and Parasound were running continuously, resulting in 10370 km of high-quality profiles. In some key areas, a detailed bathymetry profiling was carried out, and unique and impressive 3D maps of parts of Lomonosov Ridge could be obtained.
- On August 30, we dropped-off Yngve Kristoffersen and Audun Tholfsen (University of Bergen/Norway) with their hovercraft on an huge ice floe from where they started their drift experiment “FRAM-2014/15”.
- The geoscientific program was supplemented by additional activities related to sea ice physics (i.e., 1300 km of measurements of sea ice thickness, deployment of 20 drift buoys), oceanography (i.e., measurements of temperature and conductivity by 50 XCTD runs), and polar ecology (i.e., 1607 counting sessions of sea birds and marine mammals).

The outstanding event of this expedition was not the North Pole *Polarstern* reached on August 26 at 10:23 UTC for the 4th (!) time, but certainly the discovery and detailed Hydrosweep mapping of large-scale slide scars and mega-slides that occurred along the western slope of Lomonosov Ridge and exposed older in general more deeply buried sediments. Cropping-out at the seafloor, these sediments could by cored by gravity coring from Polarstern. As the coring stations at this steep slope of Lomonosov Ridge are located very close to each other (i.e., partly < half of the ship’s length!), a precise navigation and the use of a special acoustic pinger (“Posidonia“) system was needed to locate the ship and the gravity corer exactly on the spot.

Polarstern left Tromsö on August 05 around noon, onboard 44 crew members and 50 scientists and technicians from 11 nations. On our way to the central Arctic Ocean we had a first geological station with giant box corer, multicorer and gravity corer on Hovgaard Ridge west of Svalbard during the night August 07/08. From there, we steamed towards NW along the NW Greenland continental shelf. At 80°51’N/09°10’W, we met a huge sediment-laden iceberg that we sampled by using the mummy chair. Then, we continued steaming towards

the north, towards our first main target area, the Alpha Ridge. The further to the North, the denser the ice became. During these days our station work was restricted to measurements of sea-ice thickness, XCTD runs and counting activities of sea birds and marine mammals from the bridge. On August 18, we reached Lomonosov Ridge and had the first kastenlot station.

From day to day, ice conditions became worse. On August 19 we stuck in the ice. Although we tried hardly it was not possible for us crossing the Lomonosov Ridge towards the west, towards Alpha Ridge. Thus, finally we had to skip one of our main goals, i.e., reaching Alpha Ridge and sample the Cretaceous blackshales. As a consequence, we had to move all our scientific objectves to Lomonosov Ridge, where several geological stations, XCTD runs and sea-ice measurments were carried out during the coming days.

Whereas steaming towards the west was not possible, the way towards northern direction was relatively „easy“ to handle. Thus, on August 26, 10:23 UTC, we arrived at the North Pole (89°59.7'N/23°59.8'W). On August 30, we docked at a major ice floe at about 87°15'N/155°E where our Norwegian colleagues Yngve Kristoffersen and Audun Tholfsen were dropped-off with their hovercraft *Sabvabaa* (Fig. 1.3). From this location they planned to start their FRAM-2014/15 Experiment, i.e., they planned to drift within the Transpolar Drift across the entire Arctic Ocean (Fig. 1.4), doing seismic, geological and oceanographical measurements and sampling, respectively, along the drift route, before they will leave the Arctic Ocean through Fram Strait during next spring/summer.

On September 02, we reached an area with less dense sea-ice conditions, and for the first time seismic profiling could be carried out in the area of a potential location for an IODP drill site. Besides seismic profiling also a detailed Hydrosweep bathymetry survey was carried out. By this activity, an area with huge slide scars could be indentified and then sampled by gravity coring.

From September 11 to 18, we concentrated on seismic profiling using the 3000 m streamer as part of a site survey for a number of IODP drill sites proposed on southern Lomonosov Ridge. Within this area, also a detailed Hydrosweep survey was carried out. By this, large-scale slide scars were identified at the western slope of Lomonosov Ridge where older sediments of about 500 m in thickness are probably cropping-out. These sediments were sampled by means of gravity coring between September 22 and 26.

On September 27 we steamed through the Amundsen Basin towards the Gakkel Ridge where we had a last geologiocal station in the central rift valley at 81°21'N/120°31.5'E and in a water depth of ca. 5200 m, followed by a final hydrosweep survey across the rift valley. On September 28, 02:08 UTC, we switched-off all our scientific measuring devices, an hour later we entered the Russian EEZ.

After a stormy return track through the North Atlantic, we arrived Bremerhaven on September 08 at about 14:00 UTC.

Finally, we would like to thank Captain Schwarze and his crew for the excellent cooperation at any time. This cooperation was the basis for the success of Expedition PS87!

Details about the expedition are available online in the PS87 Cruise Report::

Stein, R. (Ed.), 2015. The Expedition PS87 of the Research Vessel *Polarstern* to the Arctic Ocean in 2014, *Reports on Polar and Marine Research* **688**, Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, 273 pp (http://epic.awi.de/37728/).

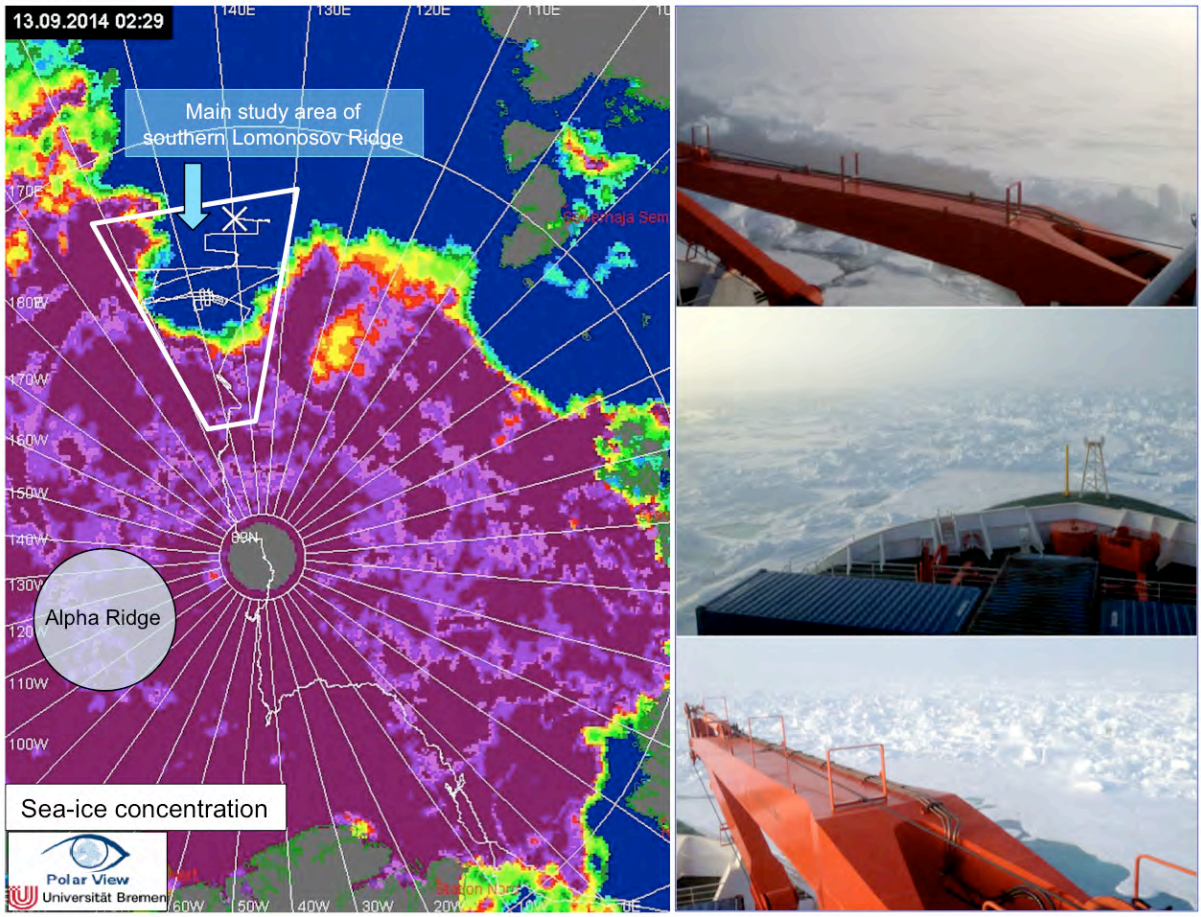

Fig. 1.1: Sea-ice concentration during Expedition PS87. The Alpha Ridge area that could not be reached due to too strong ice cover, and the main study on southern Lomonosov Ridge with optimum ice conditions is shown. Photographs are examples of central Arctic Ocean areas with heavy ice conditions.

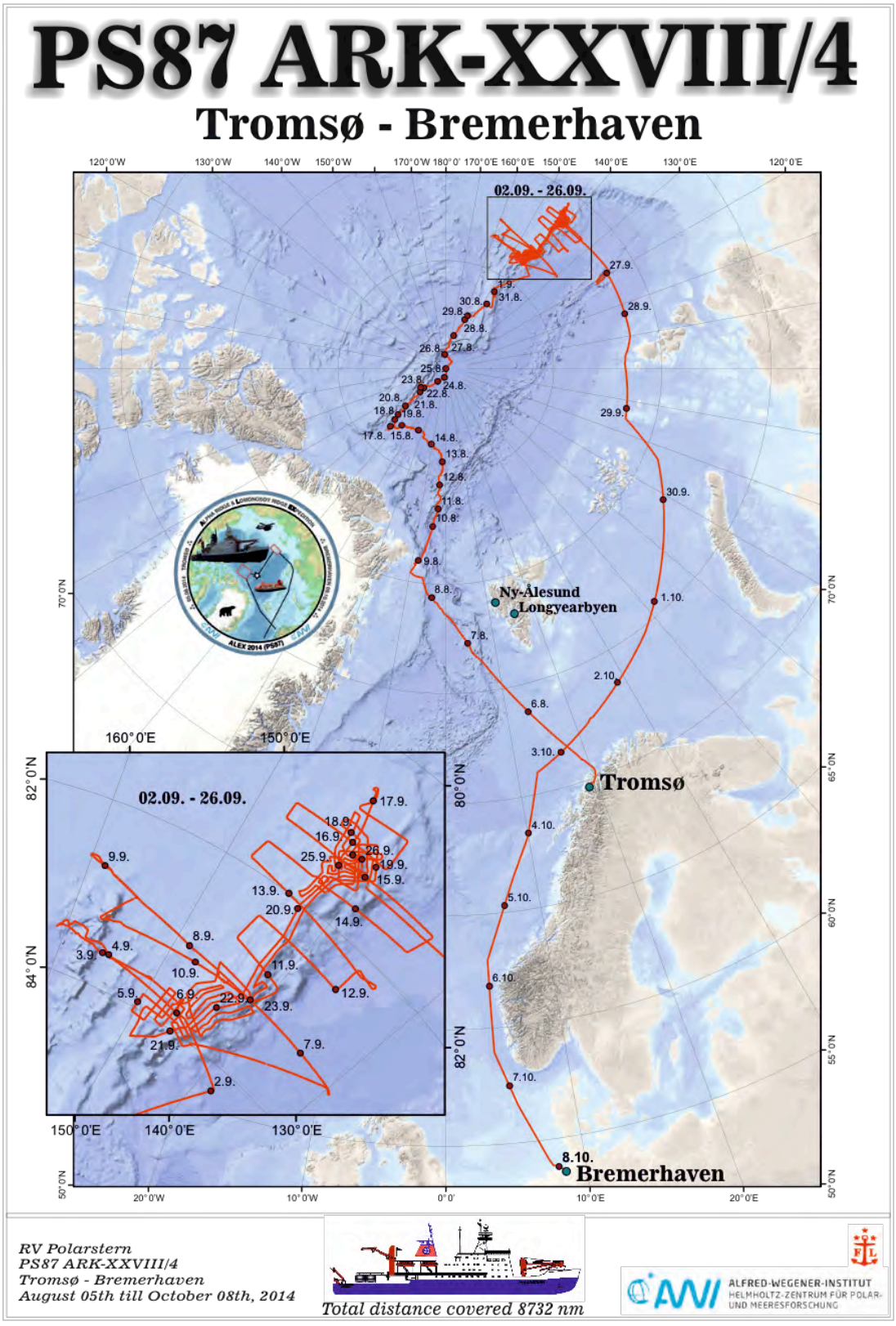

Fig. 1.2: Cruise track of Expedition PS87 (ARK-XXVIII/4)

Fig. 1.3: The hovercraft Sabvabaa and some of its equipment (Photo: Y. Kristoffersen)

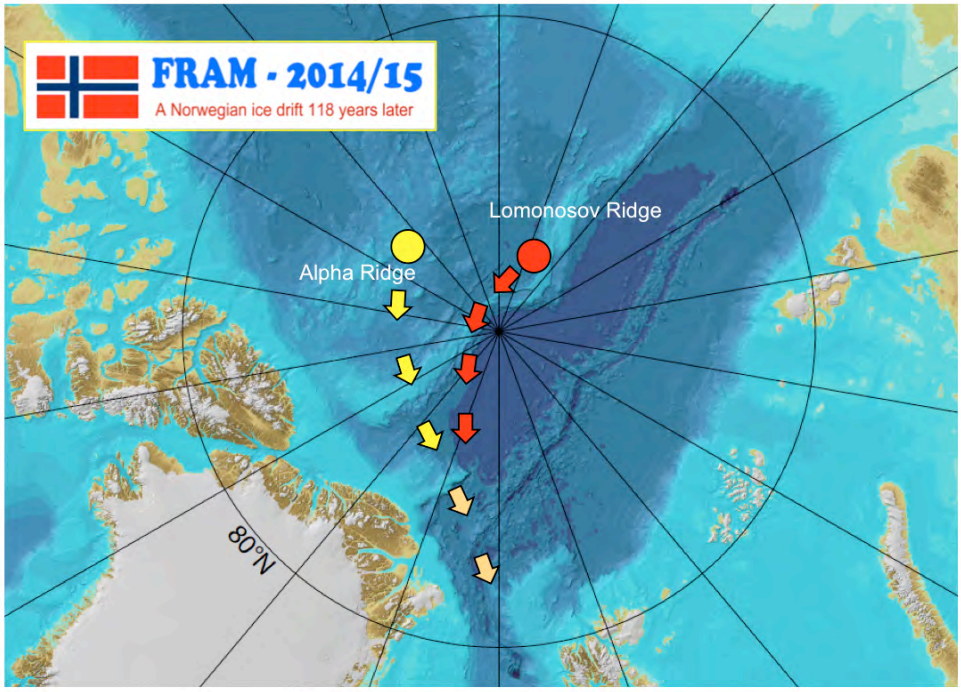

Fig. 1.4: Outline of the plan for the FRAM-2014/15 drift experiment (Proposal Y. Kristoffersen); yellow circle = originally starting point on Alpha Ridge, red circle = real starting point at 87°15'N/155°E

Tab. 1 Locations and gears of the geological stations. GC – Gravity Corer, MUC- Multicorer, GKG – Giant Box Corer, KAL – Kastenlot Corer.

Station	Gear	Latitude	Longitude	Water depth [m]
PS87/003-1	GKG	78° 24.12' N	1° 2.88' E	1170.8
PS87/003-2	GC	78° 24.08' N	1° 2.77' E	1173.2
PS87/023-1	KAL	86° 38.23' N	44° 53.98' W	2444.8
PS87/023-2	GKG	86° 37.86' N	44° 52.45' W	2439
PS87/026-1	GKG	87° 26.95' N	46° 33.95' W	3339
PS87/029-1	GKG	88° 29.01' N	48° 5.81' W	2903
PS87/029-2	MUC	88° 28.91' N	48° 4.55' W	2905.1
PS87/029-3	MUC	88° 28.73' N	48° 2.88' W	2911.9
PS87/030-1	KAL	88° 39.72' N	61° 32.52' W	1276.8
PS87/030-2	GKG	88° 39.56' N	61° 29.20' W	1278.4
PS87/030-3	MUC	88° 39.39' N	61° 25.55' W	1277.8
PS87/035-2	GKG	89° 58.97' N	19° 28.74' E	4183.1
PS87/035-3	MUC	89° 58.61' N	31° 53.17' E	4184.9
PS87/040-1	KAL	88° 59.31' N	171° 53.20' E	2614.1
PS87/040-2	GKG	88° 59.18' N	171° 44.50' E	2618.4
PS87/040-3	MUC	88° 58.96' N	171° 37.55' E	2621.4
PS87/051-1	GC	86° 26.98' N	147° 20.31' E	1190.7
PS87/055-1	GKG	85° 41.47' N	148° 59.47' E	730.7
PS87/056-1	KAL	85° 45.15' N	147° 57.24' E	835.8
PS87/056-2	GKG	85° 45.07' N	147° 55.85' E	836
PS87/067-1	GC	83° 29.47' N	160° 34.29' E	2862.3
PS87/067-2	GKG	83° 29.65' N	160° 35.36' E	2857
PS87/067-3	MUC	83° 29.90' N	160° 34.48' E	2867.1
PS87/068-1	GC	83° 37.89' N	154° 46.50' E	2708.9
PS87/068-2	GKG	83° 37.70' N	154° 46.87' E	2711
PS87/068-3	MUC	83° 37.41' N	154° 45.27' E	2712.6
PS87/070-1	KAL	83° 48.17' N	146° 7.01' E	1339.8
PS87/070-1	GKG	83° 48.16' N	146° 6.77' E	1340.4
PS87/070-3	MUC	83° 48.18' N	146° 7.04' E	1340.2
PS87/074-1	GKG	82° 43.39' N	158° 37.49' E	2816.5
PS87/074-2	MUC	82° 43.44' N	158° 37.54' E	2815.7
PS87/074-3	GC	82° 43.12' N	158° 36.88' E	2772
PS87/075-1	GC	82° 51.49' N	155° 45.19' E	2711.5
PS87/076-1	GC	82° 53.80' N	154° 57.93' E	2762.2
PS87/076-2	GKG	82° 53.81' N	154° 57.88' E	2763
PS87/076-3	MUC	82° 53.78' N	154° 57.79' E	2764.9
PS87/078-1	GC	83° 15.14' N	156° 48.17' E	784.2
PS87/079-1	KAL	83° 12.06' N	141° 22.77' E	1360.8
PS87/079-2	GKG	83° 12.09' N	141° 22.92' E	1359.6
PS87/079-3	MUC	83° 12.09' N	141° 22.54' E	1358.6
PS87/079-4	MUC	83° 12.09' N	141° 22.48' E	1360.8

PS87/080-1	GC	83° 12.26' N	141° 4.97' E	1471.8
PS87/080-2	GC	83° 12.28' N	141° 4.41' E	1508.9
PS87/080-3	GC	83° 12.27' N	141° 5.05' E	1468.8
PS87/080-4	GC	83° 12.30' N	141° 4.45' E	1512.1
PS87/083-1	GC	83° 12.26' N	141° 5.55' E	1448.6
PS87/083-2	GC	83° 12.23' N	141° 4.72' E	1486.9
PS87/083-3	GC	83° 12.24' N	141° 4.18' E	1537.8
PS87/086-1	GKG	81° 13.04' N	141° 22.99' E	901.8
PS87/086-2	MUC	81° 13.04' N	141° 22.98' E	901.7
PS87/086-3	GC	81° 13.04' N	141° 23.02' E	901
PS87/087-1	GC	81° 12.29' N	141° 15.92' E	1407.6
PS87/088-1	GC	81° 12.31' N	141° 16.40' E	1378.2
PS87/089-1	GC	81° 12.35' N	141° 16.47' E	1364.8
PS87/090-1	GC	81° 12.37' N	141° 16.87' E	1313
PS87/093-1	GC	81° 12.48' N	141° 17.62' E	1215.7
PS87/094-1	GC	81° 12.57' N	141° 18.49' E	1167.6
PS87/095-1	GC	81° 12.64' N	141° 19.21' E	1125.9
PS87/096-1	GC	81° 12.73' N	141° 20.04' E	1071.4
PS87/097-1	GC	81° 12.37' N	141° 16.88' E	1327.8
PS87/099-1	GC	81° 25.50' N	142° 14.43' E	740.4
PS87/099-2	GC	81° 25.49' N	142° 14.24' E	739.5
PS87/099-3	GKG	81° 25.48' N	142° 14.49' E	741.3
PS87/099-4	MUC	81° 25.50' N	142° 14.33' E	741.2
PS87/100-1	GKG	81° 21.42' N	142° 35.46' E	951
PS87/100-2	GC	81° 21.41' N	142° 35.56' E	951.1
PS87/102-1	GC	81° 12.86' N	141° 11.38' E	1330.6
PS87/103-1	GC	81° 12.84' N	141° 11.12' E	1369.7
PS87/104-1	GC	81° 12.80' N	141° 10.85' E	1417.8
PS87/105-1	GC	81° 12.78' N	141° 10.65' E	1448.3
PS87/106-1	GC	81° 12.76' N	141° 10.47' E	1471.8
PS87/107-1	GC	81° 12.74' N	141° 10.25' E	1496.3
PS87/108-1	GC	81° 12.79' N	141° 10.70' E	1439.6
PS87/109-2	GC	81° 7.70' N	140° 34.99' E	1306.9
PS87/109-3	MUC	81° 7.67' N	140° 34.91' E	1303.1
PS87/109-4	GKG	81° 7.69' N	140° 34.95' E	1303.3
PS87/109-5	MUC	81° 7.69' N	140° 34.94' E	1302.6
PS87/109-6	MUC	81° 7.67' N	140° 35.13' E	1304.6
PS87/110-1	GC	81° 21.02' N	120° 31.47' E	5071.9
PS87/110-2	GKG	81° 21.03' N	120° 31.48' E	5129.5

Tab. 2 Recovery and penetration of Kastenlot- and Gravity cores taken on the PS 87 expedition.

Station	Gear	Latitude	Longitude	Water depth [m]	Recov-ery [cm]
PS87/003-2	GC-10	78° 24.08' N	1° 2.77' E	1173.2	178
PS87/023-1	KAL-10	86° 38.23' N	44° 53.98' W	2444.8	698
PS87/030-1	KAL-10	88° 39.72' N	61° 32.52' W	1276.8	625
PS87/040-1	KAL-10	88° 59.31' N	171° 53.20' E	2614.1	260
PS87/051-1	GC-10	86° 26.98' N	147° 20.31' E	1190.7	495
PS87/056-1	KAL-10	85° 45.15' N	147° 57.24' E	835.8	234
PS87/067-1	GC-10	83° 29.47' N	160° 34.29' E	2862.3	516
PS87/068-1	GC-10	83° 37.89' N	154° 46.50' E	2708.9	588
PS87/070-1	KAL-10	83° 48.17' N	146° 7.01' E	1339.8	770
PS87/074-3	GC-10	82° 43.12' N	158° 36.88' E	2772	615
PS87/075-1	GC-10	82° 51.49' N	155° 45.19' E	2711.5	573
PS87/076-1	GC-10	82° 53.80' N	154° 57.93' E	2762.2	622
PS87/078-1	GC	83° 15.14' N	156° 48.17' E	784.2	223
PS87/079-1	KAL-10	83° 12.06' N	141° 22.77' E	1360.8	664
PS87/080-1	GC-5	83° 12.26' N	141° 4.97' E	1471.8	454
PS87/080-2	GC-10	83° 12.28' N	141° 4.41' E	1508.9	350
PS87/080-3	GC-10	83° 12.27' N	141° 5.05' E	1468.8	460
PS87/080-4	GC-10	83° 12.30' N	141° 4.45' E	1512.1	485
PS87/083-1	GC-10	83° 12.26' N	141° 5.55' E	1448.6	479
PS87/083-2	GC-10	83° 12.23' N	141° 4.72' E	1486.9	465
PS87/083-3	GC-10	83° 12.24' N	141° 4.18' E	1537.8	401
PS87/086-3	GC-10	81° 13.04' N	141° 23.02' E	901	629
PS87/087-1	GC-10	81° 12.29' N	141° 15.92' E	1407.6	594
PS87/088-1	GC-10	81° 12.31' N	141° 16.40' E	1378.2	586
PS87/089-1	GC-10	81° 12.35' N	141° 16.47' E	1364.8	294
PS87/090-1	GC-10	81° 12.37' N	141° 16.87' E	1313	439
PS87/093-1	GC-10	81° 12.48' N	141° 17.62' E	1215.7	673
PS87/094-1	GC-10	81° 12.57' N	141° 18.49' E	1167.6	712
PS87/095-1	GC-10	81° 12.64' N	141° 19.21' E	1125.9	478
PS87/096-1	GC-10	81° 12.73' N	141° 20.04' E	1071.4	523
PS87/097-1	GC-10	81° 12.37' N	141° 16.88' E	1327.8	578.5
PS87/099-1	GC-10	81° 25.50' N	142° 14.43' E	740.4	447
PS87/099-2	GC-10	81° 25.49' N	142° 14.24' E	739.5	464.5
PS87/100-2	GC-10	81° 21.41' N	142° 35.56' E	951.1	483
PS87/102-1	GC-10	81° 12.86' N	141° 11.38' E	1330.6	678
PS87/103-1	GC-10	81° 12.84' N	141° 11.12' E	1369.7	353
PS87/104-1	GC-10	81° 12.80' N	141° 10.85' E	1417.8	317
PS87/105-1	GC-10	81° 12.78' N	141° 10.65' E	1448.3	88
PS87/106-1	GC-10	81° 12.76' N	141° 10.47' E	1471.8	486

PS87/107-1	GC-10	81° 12.74' N	141° 10.25' E	1496.3	556
PS87/108-1	GC-3	81° 12.79' N	141° 10.70' E	1439.6	129
PS87/109-2	GC-10	81° 7.70' N	140° 34.99' E	1306.9	617
PS87/110-1	GC-10	81° 21.02' N	120° 31.47' E	5071.9	517