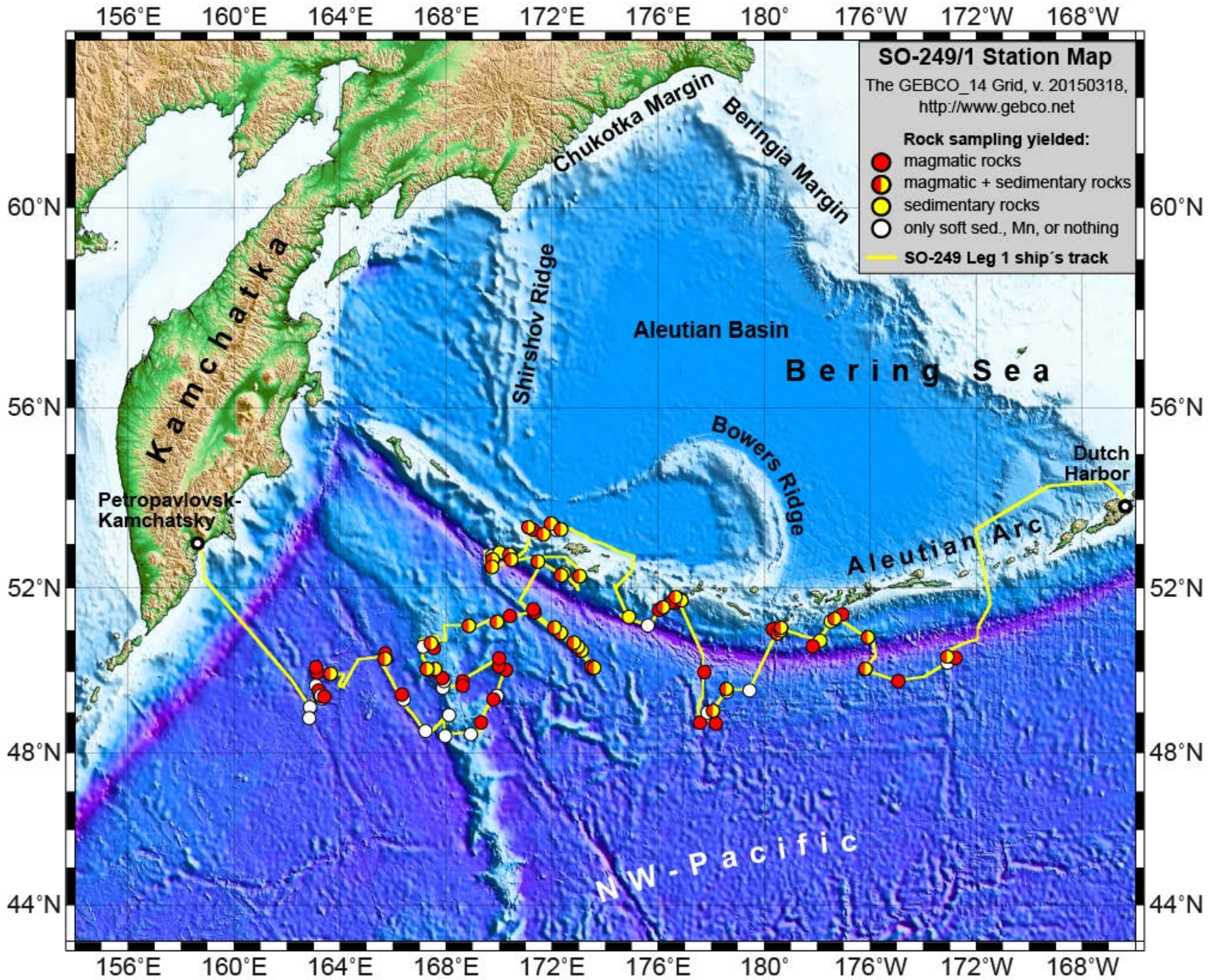
Prof. Dr. Kaj Hoernle
GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel
Wischhofstr. 1-3
24148 Kiel
Germany

Tel.: +49 431 600 2642
Fax: +49 431 600 2624
email: khoernle@geomar.de

Short Cruise Report
R/V SONNE cruise SO-249 Leg 1

Dutch Harbor (U.S.A.) - Petropavlovsk-Kamchatsky (Russia)
05.06.2016 - 15.07.2016
Chief Scientist: Prof. Kaj Hoernle
Captain: Lutz Mallon



Objectives

The BERING project is a long-term international collaboration between German, Russian, and U.S. American scientists. The project encompasses two legs: (1) from Dutch Harbor, Alaska to Petropavlovsk-Kamchatsky, Russia, and (2) from Petropavlovsk to Tomakomai, Japan. The overall goal of the SO-249 BERING cruises is to study the geodynamic evolution of the southern and western margins of the Bering Sea, formed by the Aleutian Subduction Zone and Chukotka-Beringian continental margin respectively, and the northwestern Pacific seafloor, being subducted beneath the Aleutian and Kamchatka arcs. The ship-based mapping, sediment profiling and rock sampling of seafloor structures by dredging, combined with planned shore-based evaluation of the mapped seafloor morphology and petrographic, petrological, geochemical and geochronological studies of the obtained samples, will contribute to an improved understanding of the origin of marginal seas, the initiation and geodynamic evolution of subduction zones, the affect of variation in the composition and structure of the subduction input on the output at the volcanic arc, as well as the causes and effects of natural hazards, such as explosive volcanic eruptions.

More specific scientific questions of SO-249 Leg 1 include:

1) *Aleutian arc inception and evolution*: What is the age and composition of the oldest rocks in the western Aleutian Arc? Can the inception of the arc be linked to other key tectonic events in the Pacific such as the Hawaiian-Emperor Bend at ~50-47.5 Ma, inception of the IBM and Tonga Arc at 50-52 Ma, or collision of the Olyutorsky Arc with Kamchatka at ca. 51-54 Ma?
2) *Modern Aleutian arc system*: What is the origin and occurrence of recent magmatic activity in the Western Aleutian Arc? Is there a continuous volcanic front in the western Aleutians west of Buldir Island? How is the distinctive geochemical character of western Aleutian volcanic rocks related to volcanism in the central and eastern Aleutians and in island arcs globally?
3) *Arc Input*: What are the ages and the spatial-temporal variability in composition of the subducting Pacific lithosphere offshore the Aleutian Arc and Kamchatka? To what extent is the chemistry of the volcanic arc output related to the subduction input? Do subducted oceanic Fracture Zones deliver particularly large amounts of volatile and fluid-mobile elements to the mantle wedge, causing enhanced partial melting of the wedge and enrichment in fluid-mobile elements in arc magmas?

The SO-249 cruises also included a minor biology program which aims at collecting marine fauna from both hard rocks and sediments yielded by dredging to determine the benthic biodiversity south of the Aleutian Islands and of the incoming Pacific Plate.

Integration of the results of studies conducted by the SO-249 BERING project with those of previous investigations (in particular KOMEX and KALMAR), and of the work being carried out in the GeoPRISMS initiatives will substantially improve our understanding of the magmatic and tectonic evolution of the Aleutian-Kamchatka-Junction and arc systems in general. Combined with the results from recent IODP drilling into the IBM forearc and backarc and with those from the complementary SO-255 VITIAZ SONNE cruise to investigate the Vitiaz-Kermadec Arc/Backarc System, scheduled for the beginning of 2017, we should gain additional important new insights into the workings of subduction systems and the origin of marginal basins.

Narrative

After a long journey from Germany halfway around the world to Dutch Harbor, Alaska, the German and Russian scientists met up with their American colleagues on June 4. On the next day the scientists boarded R/V SONNE, unpacked the sampling equipment and set up the laboratories. At 9:00 a.m. on June 6, R/V SONNE left Dutch Harbor. After a day of transit, we reached our study area and began dredging on the Amlia Fault (Fracture) Zone that extends southward along the Pacific Plate south of the Central Aleutians. Here we recovered an interesting variety of rocks from a fault-bounded block in the fracture zone. On the third day of the cruise, we sampled fresh basaltic rocks from the Pacific Plate along a fault running parallel to the Aleutian deep-sea trench.

We then dredged Adams Seamount being located directly outboard of the Aleutian deep-sea trench. On June 10, R/V SONNE crossed the Aleutian trench once again and we carried out several successful dredges on the lower slopes of the subduction-zone forearc and the deepest parts of the walls of Adak and Amchitka Canyons at the southern side of the Aleutian Arc. The samples included a wide variety of rocks typical for arc volcanoes. On board R/V SONNE, we skipped the next Monday after crossing the 180° meridian. On board, however, we used UTC (Coordinated Universal or Greenwich Time), so the missing day does not show up in any of the cruise-related reports.

On June 13, R/V SONNE left Amchitka Canyon and crossed the Aleutian deep-sea trench onto the Pacific Plate where we attempted to sample three seamounts south of the trench but recovered magmatic rocks only at one of them. On June 14, we reached the Rat Fracture Zone, oriented north-south and thus perpendicular to the trench. Four dredges along the Rat Fracture Zone brought up a variety of volcanic (basalts and volcaniclastic rocks) and plutonic (diorites) rocks. On June 16, we crossed the trench again and began dredging in Murray Canyon, located southwest of Kiska Island. We conducted eight dredge hauls in that area, six of them were carried out along the base of the western, northern and southern canyon walls. A wide variety of volcanic rocks, dioritic to gabbroic intrusive rocks, and a variety of sedimentary rocks were recovered with many very fresh samples. Unfortunately our deepest dredge track thus far at the base of the forearc slope, just above the sediment fill in the trench, brought up a third a dredge of consolidated mud.

An important goal of the two SO-249 cruise legs was 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 SO-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. R/V SONNE 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. Here we carried out three successful dredges recovering volcaniclastic rocks, a variety of lavas, and gabbroic rocks cut by small basaltic dikes.

On June 21, we returned to the Aleutian forearc and carried out several deep dredges to depths of up to 6.7 km, largely recovering volcaniclastic material and sedimentary rocks. We then crossed the trench to the northwestern tip of the Stalemate Fracture Zone and mapped a large fault block that had been previously sampled at its southern end during the SO-201/1b cruise. 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 on June 23 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. A 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, with many of the rocks being rounded river/beach cobbles 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. After carrying out more dredging in the forearc of the Aleutian subduction zone on June 24 - 25, R/V SONNE 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 most scientists since the beginning of the cruise and allowed a shift rotation, but also provided an excellent opportunity for the midway party, enjoyed by both crew and scientists.

The fourth week of the cruise focused on the northwest Pacific Plate. We continued our multi-beam mapping of the seafloor and carried out 24 dredge hauls. We spent June 27 - 28 sampling the southeast portion of the Stalemate Fracture Zone. The dredges brought up primarily basaltic rocks. These included both pillows, some with glassy rinds, and subvolcanic rocks. Dioritic to gabbroic rocks and a variety of sedimentary rocks were also recovered. Thereafter we proceeded to a seamount province between the Stalemate FZ and the Emperor Seamounts. Nothing was known about this fairly dense province of large seamounts before SO-249, which in contrast to the nearby Emperor Seamounts, don't appear to form part of a hotspot track, but are randomly distributed and include conical-shaped and ridge-like structures. We successfully sampled three seamounts, recovering basaltic rocks and a hyloclastite sample, which may contain fresh glass. From June 30 on, we have mapped and sampled the Detroit, Hanzei and Suizei Seamounts, which belong to the Emperor Seamount Chain. Although sampling was extremely difficult due to the thick (up to 20 cm) manganese pavement on these Cretaceous seamounts, we recovered the first ever samples from Hanzei Seamount as well as basalts from the eastern and western flanks of Suizei Seamount.

The fifth and final full week of SO-249 Leg 1 focused on mapping and sampling of the northwest Pacific Plate subducting beneath the Kamchatka Volcanic Arc. From July 4 - 6, we continued mapping and carried out six dredge hauls on the large Tenji Seamount Complex. Late in the evening on July 6, we reached the Krusenstern Fracture Zone and recovered pillow basalts and possibly some fresh glass from the upper Pacific ocean crust at several locations. On July 9 - 10, we mapped and sampled the seafloor south of the Krusenstern Fracture Zone. This work continued through Tuesday July 12, which marked the end of our work program on SO-249 Leg 1. We completed 98 dredge hauls of which 77 (=79%) yielded volcanic, plutonic, ultramafic and/or sedimentary rocks. The biological sampling during this first leg of the cruise was unusually successful and will result in many months of further analysis, in particular with regard to obtaining fresh tissue for immunohistochemical, genomic, and transcriptomic analysis from various brachiopod and ophiuroid species. All macrofaunal specimens collected during SO-249 will be transferred to the Museum für Naturkunde (Berlin, Germany), where they will be re-assessed and then distributed to colleagues for species identification.

In summary, all of the major goals of the SO-249 Leg 1 were achieved. These included mapping and hard-rock, sediment and biological sampling of 1) the oldest, accessible parts of the Aleutian subduction zone, 2) the present-day volcanic front in the western Aleutians, and 3) the input (subducting Pacific Plate) into the Aleutian and Kamchatka subduction systems, including sediments, volcanic and plutonic ocean crust, exposed upper mantle ultramafic rocks underlying the crust and the full range of intraplate volcanic seamounts.

On July 13, we crossed into the Russian Exclusive Economic Zone (EEZ) and R/V SONNE arrived in Petropavlovsk-Kamchatsky early in the morning of July 14. Nine of the SO-249 Leg 1 scientific crew disembarked in Petropavlovsk on July 15 and were replaced on July 16 by 15 new scientists, primarily from Russia, to carry out SO-249 Leg 2 to the westernmost Aleutians and the Chukotka-Beringian margin of the Bering Sea.

Acknowledgements

We would especially like to thank Captain Mallon and the crew of R/V SONNE. Their hard work, high level of experience, great flexibility and willingness to help, as well as the pleasant working atmosphere on board, contributed directly to the success of the SO-249 Leg 1 expedition.

We thank the Government of the U.S.A. for granting permission to work within their territorial waters and we gratefully acknowledge the support of the German Foreign Office and the German Embassy in Washington in this matter.

We are also grateful to the German Federal Ministry of Education and Research for continuing support of marine research.

Cruise Participants

1.	Hoernle, Kaj	Fahrtleiter / *Chief Scientist*	GEOMAR
2.	Hauff, Folkmar	Gesteinsbeprobung / *Rock Sampling*	GEOMAR
3.	Hauff, Silke	Gesteinsbeprobung / *Rock Sampling*	GEOMAR
4.	Jensen, Owen	Gesteinsbeprobung / *Rock Sampling*	USC
5.	Koch, Steffen	Gesteinsbeprobung / *Rock Sampling*	GEOMAR
6.	Krasnova, Elizaveta	Gesteinsbeprobung / *Rock Sampling*	GEOKHI RAS
7.	Portnyagin, Maxim	Gesteinsbeprobung / *Rock Sampling*	GEOMAR
8.	Rahmsdorf, Charlotte	Gesteinsbeprobung / *Rock Sampling*	GEOMAR
9.	Schönhofen, Milena	Gesteinsbeprobung / *Rock Sampling*	GEOMAR
10.	Siebelist, Marlena	Gesteinsbeprobung / *Rock Sampling*	GEOMAR
11.	Siegrist, Max	Gesteinsbeprobung / *Rock Sampling*	USC
12.	Silantiev, Sergey	Gesteinsbeprobung / *Rock Sampling*	GEOKHI RAS
13.	Steffen, Ilona	Gesteinsbeprobung / *Rock Sampling*	GEOMAR
14.	Waldmann, Ryan	Gesteinsbeprobung / *Rock Sampling*	USC
15.	Wellschmidt, Gesine	Gesteinsbeprobung / *Rock Sampling*	GEOMAR
16.	Werner, Reinhard	Gest.-Bepr., Bathymetrie / *Rock S., Bathym.*	GEOMAR
17.	Yogodzinski, Gene	Gesteinsbeprobung / *Rock Sampling*	USC
18.	Ziegler, Alexander	Biologie / *Biology*	Univ. Bonn

Institutes

GEOKHI RAS	Vernadsky Institute of the Russian Academy of Sciences, Moscow, Russia
GEOMAR	Helmholtz-Zentrum für Ozeanforschung Kiel, Germany
USC	University of South Carolina, Columbia, U.S.A.
Univ. Bonn	Institut für Evolutionsbiologie und Ökologie, Rheinische Friedrich-Wilhelms-Universität Bonn, Germany

Stationsliste

Type	Stat.	Location	total volume	Rec. DR	Rock summary	on bottom / start* lat °N	long °	off bottom / end* lat °N	long°	depth (m) begin	end
CTD	1	East of Amlia Fracture Zone				51.001	188.000	51.000	172.000		2500
DR	2	Amlia Fracture Zone	few rocks	1	volcaniclastic rocks, Mn-crusts, and nodules	50.307	186.905	50.300	186.902	5360	4900
DR	3	Amlia Fracture Zone	few rocks	1	lava fragments, volcaniclastic and (meta)sed. rocks, Mn	50.292	186.948	50.289	186.936	5700	5200
DR	4	Amlia Fracture Zone	empty	0		50.182	186.830	50.176	186.838	4514	4030
DR	5	Bendfault west of Amlia Fracture Zone	few rocks	1	lava fragments, intrusive rocks	49.735	184.976	49.728	184.980	5460	4900
DR	6	Adams Seamount	full	1	pillow fragments, volcaniclastic and sedimentary rocks	50.032	183.732	50.024	183.732	4000	3492
DR	7	Aleuten Trench	1/4 full	1	lava fragments, intrusive, metamorphic, and sed. rocks	50.786	183.831	50.779	183.827	5000	4560
DR	8	Adak Canyon	one rock	1	meta sediment	51.233	182.620	51.241	182.622	3720	3403
DR	9	Adak Canyon	full	1	lava fragments, volcaniclastic rocks	51.340	182.866	51.346	182.878	3500	2900
DR	10	Adak Canyon	1/4 full	1	lava fragments, sedimentary rocks	51.250	182.650	51.254	182.645	3700	3400
DR	11	Adak Canyon	one rock	1	lava fragment	50.575	181.755	50.583	181.753	4812	4400
DR	12	Southern extension of Adak Canyon	1/2 full	1	sedimentary rocks, metasediments	50.709	182.029	50.714	182.020	4450	3950
DR	13	Amatignak Canyon	few rocks	1	lava fragment, solidified sediments	50.979	180.346	50.983	180.333	5426	5078
DR	14	Amatignak Canyon	few rocks	1	volcaniclastic rocks, sedimentary rocks	51.011	180.556	51.004	180.556	5130	4680
DR	15	Amatignak Canyon	1/4 full	1	lava fragments, metamorphic and sedimentary rocks	50.954	180.542	50.948	180.550	4900	4384
DR	16	Amatignak Canyon	1/4 full	1	lava f., volcaniclastic, sedimentary and intrusive (?) rocks	50.881	180.414	50.875	180.418	5523	4991
DR	17	1. Seamount east of Rat Fracture Zone	empty	0		49.510	179.373	49.515	179.381	4669	4309
DR	18	2. Seamount east of Rat Fracture Zone	few rocks	1	intrusive, volcaniclastic and sedimentary rocks	49.541	178.500	49.547	178.507	4312	3893
DR	19	3. Seamount east of Rat Fracture Zone	empty	0		49.480	178.526	49.472	178.526	4802	4479
DR	20	Rat Fracture Zone	only Mn	0	maganese crusts and nodules	48.977	177.788	48.973	177.790	5265	5057
DR	21	Rat Fracture Zone	few rocks	1	lava fragments, intrusive, voclaniclastic, and sed. rocks	49.014	177.987	49.011	177.989	5195	4946
DR	22	Rat Fracture Zone	few rocks	1	lava fragments	48.717	178.103	48.711	178.101	5659	5141
DR	23	Rat Fracture Zone	few rocks	1	volcaniclastic rocks, Mn-crusts	48.738	177.504	48.731	177.502	5088	4510
DR	24	Rat Fracture Zone	1/6 full	1	lava fragments, intrusive and voclaniclastic rocks	49.954	177.669	49.946	177.671	5419	5130
DR	25	Murray Canyon	1/4 full	1	lava fragments, intrusive and sedimentary rocks	51.691	176.757	51.685	176.753	3540	3171
DR	26	Murray Canyon	1/4 full	1	lava fragments, (meta)sedimentary rocks	51.511	176.111	51.518	176.108	4445	4067
DR	27	Murray Canyon	few rocks	1	lava fragments	51.628	176.409	51.635	176.406	4089	3683
DR	28	Murray Canyon	few rocks	1	lava fragments	51.693	176.781	51.686	176.782	3557	2978
DR	29	Murray Canyon	full	1	lava fragm,, intrusive, voclaniclastic, and sed. rocks	51.688	176.788	51.681	176.792	2894	2377
DR	30	Murray Canyon	1/4 full	1	lava fragments, intrusive and sedimentary rocks	51.679	176.799	51.673	176.802	2194	1825
DR	31	Murray Canyon	few rocks	1	lava fragments, solidifed sediments	51.619	176.555	51.613	176.559	4280	3563
DR	32	Murray Canyon	1/6 full	1	lava fragments, solidifed sediments	51.508	176.058	51.515	176.057	4197	3816
DR	33	Aleutian trench	1/4 full	0	semi-consolidated sediments (mud)	51.073	175.540	51.081	175.532	6790	6505
DR	34	Aleutian trench	1/4 full	1	sedimentary rocks	51.281	174.825	51.287	174.819	6079	5703
DR	35	Western Cones	1/3 full	1	lava fragments, intrusive, and sedimentary rocks	53.403	172.199	53.396	172.197	3549	3351

Type	Stat.	Location	total volume	Rec. DR	Rock summary	on bottom / start* lat °N	long °	off bottom / end* lat °N	long°	depth (m) begin	end
DR	36	Western Cones	empty	0		53.411	172.077	53.407	172.155	3694	3557
DR	37	Western Cones	1/5 full	1	lava fragments	53.430	172.072	53.425	172.070	3643	3340
DR	38	Western Cones	full	1	lava fragments, intrusive and (meta)sedimentary rocks	53.486	171.993	53.498	171.981	3554	3042
DR	39	Kresta Ridge	1/4 full	1	lava fragments, intrusive and sedimentary rocks	53.271	171.595	53.278	171.597	3342	2903
DR	40	Kresta Ridge	1/4 full	1	lava fragments, intrusive rocks	53.380	171.218	53.387	171.221	3570	3054
DR	41	Kresta Ridge	1/2 full	1	lava fragm,, volcaniclastic and (meta)sedimentary rocks	53.405	171.172	53.412	171.173	3311	2815
DR	42	Aleutian Trench	2/3 full	1	lava fragm,, volcaniclastic and (meta)sedimentary rocks	52.661	170.400	52.669	170.402	6115	5628
DR	43	Aleutian Trench	1/6 full	1	lava fragment, sedimentary rocks, solidified sediments	52.778	170.336	52.785	170.335	5668	5377
DR	44	Aleutian Trench	1/5 full	1	sedimentary rocks	52.830	169.956	52.838	169.954	6670	6209
DR	45	Stalemate Fracture Zone (N-section)	1/2 full	1	lava fragm,, intrusive, voclaniclastic, and sed, rocks, Mn	52.661	169.692	52.656	169.680	5263	4705
DR	46	Stalemate Fracture Zone (N-section)	empty	0	*(dredge stucked at start point of the dredge track)*	52.705	169.716	52.701	169.716	6441	6432
DR	47	Stalemate Fracture Zone (N- section)	1/4 full	1	lava fragments, intrusive and sedimentary rocks	52.483	169.661	52.481	169.649	3429	3050
DR	48	Attu Canyons	1/4 full	1	lava fragments, sedimentary rocks, solidified sediments	52.605	171.400	52.605	171.386	3815	3493
DR	49	Attu Canyons	1/2 full	1	lava fragm,, volcaniclastic and sed, rocks, solidified sed,	52.282	172.276	52.289	172.269	3716	3307
DR	50	Attu Canyons	1/4 full	1	sedimentary rocks, semi-consolidated sediments (mud)	52.333	172.376	52.328	172.373	3713	3317
DR	51	Slope southwest of Agattu	1/4 full	1	lava fragments, volcaniclastic and sedimentary rocks	52.260	172.970	52.265	172.977	1512	1099
PR	52	Stalemate Fracture Zone			Profiling along Stalemate FZ (170°45,00´E - 173°31,45´E)						
DR	53	Stalemate Fracture Zone	few rocks	1	lava fragments, sedimentary rocks	50.079	173.422	50.077	173.431	4095	3708
DR	54	Stalemate Fracture Zone	1/2 full	1	lava fragments, subvolcanic and sedimentary rocks	50.056	173.507	50.050	173.498	3684	3202
DR	55	Stalemate Fracture Zone	1/6 full	1	lava fragments, sedimentary rocks	50.469	173.034	50.463	173.031	4166	3744
DR	56	Stalemate Fracture Zone	few rocks	1	lava fragments, sedimentary rocks	50.574	172.893	50.567	172.890	4147	3656
DR	57	Stalemate Fracture Zone	1/3 full	1	lava fragments, intrusive and sed. rocks, Mn-crusts	50.657	172.744	50.649	172.740	4054	3657
DR	58	Stalemate Fracture Zone	1/2 full	1	subvolcanic, intrusive, and sedimentary rocks	50.887	172.265	50.878	172.266	4453	3930
DR	59	Stalemate Fracture Zone	1/3 full	1	lava fragments, sedimentary rocks, Mn-crusts	51.024	172.022	51.018	172.017	4274	3814
DR	60	Stalemate Fracture Zone	few rocks	1	subvolcanic rocks	51.463	171.221	51.456	171.217	3836	3230
DR	61	Stalemate Fracture Zone	1/2 full	1	lava fragments, intrusive and volcaniclastic rocks, Mn	51.393	171.273	51.386	171.268	3071	2508
DR	62	Emperor Seamount Province	1/5 full	1	lava fragments, volcaniclastic rocks	51.303	170.344	51.299	170.335	4447	3880
DR	63	Emperor Seamount Province	1/8 full	1	lava fragments, subvolcanic and sedimentary rocks, Mn	51.158	169.857	51.150	169.852	4441	3947
DR	64	Emperor Seamount Province	few rocks	1	lava fragments, sedimentary rocks	51.065	168.799	51.058	168.796	2945	2446
DR	65	Emperor Seamount Chain. S of Detroit	1/8 full	1	lava fragment, dropstones, Mn-crusts	50.533	167.483	50.540	167.475	2897	2917
DR	66	Emperor Seamount Chain. Detroit	1/2 full	1	lava fragments, sedimentary rocks	50.652	167.366	50.643	167.361	2252	1917
DR	67	Emperor Seamount Chain. Detroit	few rocks	0	solidified sediments, dropstones	50.564	167.072	50.568	167.083	4308	3876
DR	68	Emperor Seamount Chain. Hanzei	few rocks	1	lava fragments, volcaniclastic rocks	49.990	167.361	49.998	167.356	4204	3641
DR	69	Emperor Seamount Chain. Hanzei	few rocks	1	lava fragments, sedimentary rocks, dropstones	50.028	167.212	50.019	167.217	3403	3004
DR	70	Emperor Seamount Chain. Hanzei	1/4 full	1	lava fragments, sedimentary rocks, Mn-crusts, dropstones	50.017	167.509	50.026	167.507	3685	3278
DR	71	Emperor Seamount Chain. Suizei	1/2 full	1	lava fragment, dropstones	49.810	167.797	49.801	167.797	2960	2469
DR	72	Emperor Seamount Chain. Suizei	empty	0		49.738	167.856	49.743	167.853	2639	2331

Type	Stat.	Location	total volume	Rec. DR	Rock summary	on bottom / start* lat °N	long °	off bottom / end* lat °N	long°	depth (m) begin	end
DR	73	Emperor Seamount Chain. Suizei	few rocks	0	dropstones	49.574	167.813	49.583	167.813	3230	2764
DR	74	Emperor Seamount Chain. Suizei	1/4 full	1	volcaniclastic rock, Mn-crusts, dropstones	49.625	168.557	49.624	168.543	3871	3881
DR	75	Emperor Seamount Chain. Suizei	few rocks	1	lava fragments, solidified sediments, dropstones	49.732	168.566	49.737	168.557	3378	2960
DR	76	Emperor Seamount Province	1/6 full	1	lava fragments, dropstones	50.282	169.938	50.274	169.939	3341	2922
DR	77	Emperor Seamount Province	few rocks	1	lava fragment, dropstones	50.096	169.929	50.103	169.929	4136	3680
DR	78	Emperor Seamount Province	1/6 full	1	lava fragment, Mn-crusts, dropstones	50.006	170.200	50.014	170.200	3130	2615
DR	79	Emperor Seamount Chain. Tenji	empty	0		49.382	169.853	49.389	169.851	4504	4059
DR	80	Emperor Seamount Chain. Tenji	few rocks	1	lava fragments, dropstones	49.297	169.717	49.303	169.713	4701	4174
DR	81	Emperor Seamount Chain. Tenji	few rocks	1	lava fragment, Mn-crusts, dropstones, corals	48.739	169.253	48.732	169.243	3139	2614
DR	82	Emperor Seamount Chain. Tenji	empty	0	squid	48.459	168.870	48.465	168.878	4417	3913
DR	83	Emperor Seamount Chain. Tenji	one rock	0	dropstone	48.414	167.903	48.413	167.909	4923	4432
DR	84	Emperor Seamount Chain. Tenji	few rocks	0	sediments, Mn-crusts and nodules	48.917	168.049	48.917	168.061	3903	3499
DR	85	Krusenstern Fracture Zone	two rocks	0	dropstones	48.535	167.161	48.541	167.169	6042	5560
DR	86	Krusenstern Fracture Zone	empty	0		49.295	166.336	49.302	166.342	5905	5365
CTD	87	Krusenstern Fracture Zone			*for sound profile*	49.302	166.342	49.302	166.342		
DR	88	Krusenstern Fracture Zone	1/4 full	1	lava fragments, volcaniclastic rocks	49.413	166.272	49.408	166.268	5189	4668
DR	89	Krusenstern Fracture Zone	few rocks	1	lava fragments, (meta)sedimentary rocks	50.303	165.640	50.298	165.633	5012	4565
DR	90	Krusenstern Fracture Zone	few rocks	1	lava fragments, volcaniclastic rocks	50.339	165.644	50.333	165.638	5256	4703
DR	91	Ocean crust SW of Krusenstern FZ	few rocks	1	lava fragments, subvolcanic and sedimentary rocks, Mn	49.909	163.588	49.901	163.585	5743	5362
DR	92	"Gummi Bear" Seamount	1/4 full	1	lava fragments, volcaniclastic rocks, Mn-crusts	50.067	163.035	50.062	163.030	5043	4674
DR	93	"Gummi Bear" Seamount	1/4 full	1	lava fragments, volcaniclastic rocks	49.947	163.079	49.941	163.071	5251	4830
DR	94	Basin between Krusenstern and NN FZ	3 rocks	1	lava fragments	49.361	163.349	49.355	163.342	5245	4707
DR	95	Basin between Krusenstern and NN FZ	few rocks	0	dropstones, Mn-nodules	49.385	163.226	49.379	163.224	5720	5138
DR	96	Basin between Krusenstern and NN FZ	few rocks	1	lava fragments, metamorphic rocks (dropstones)	49.509	163.137	49.504	163.136	5758	5420
DR	97	Basin between Krusenstern and NN FZ	2 rocks	1	lava fragment (dropstone?)	49.394	163.166	49.388	163.167	5008	4425
DR	98	Basin between Krusenstern and NN FZ	empty	0		49.322	163.245	49.329	163.245	5616	5190
DR	99	Basin between Krusenstern and NN FZ	empty	0		49.628	163.032	49.634	163.037	5909	5523
DR	100	NN FZ	empty	0		48.844	162.780	48.841	162.788	5639	5299
DR	101	NN FZ	empty	0		49.107	162.809	49.113	162.815	5737	5380
				77	yielded rocks						
Dredge Stations (DR): 98				21	returned empty or only soft sediment and / or Mn and / or dropstones				average depth:	4422	
CTD Stations (CTD): 2									max. depth:	6790	
									min. depth:	1512	