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Short Cruise Report R/V SONNE cruise SO265

Yokohama (Japan) - Kaohsiung (Taiwan)

27.09.2018 - 09.10.2018

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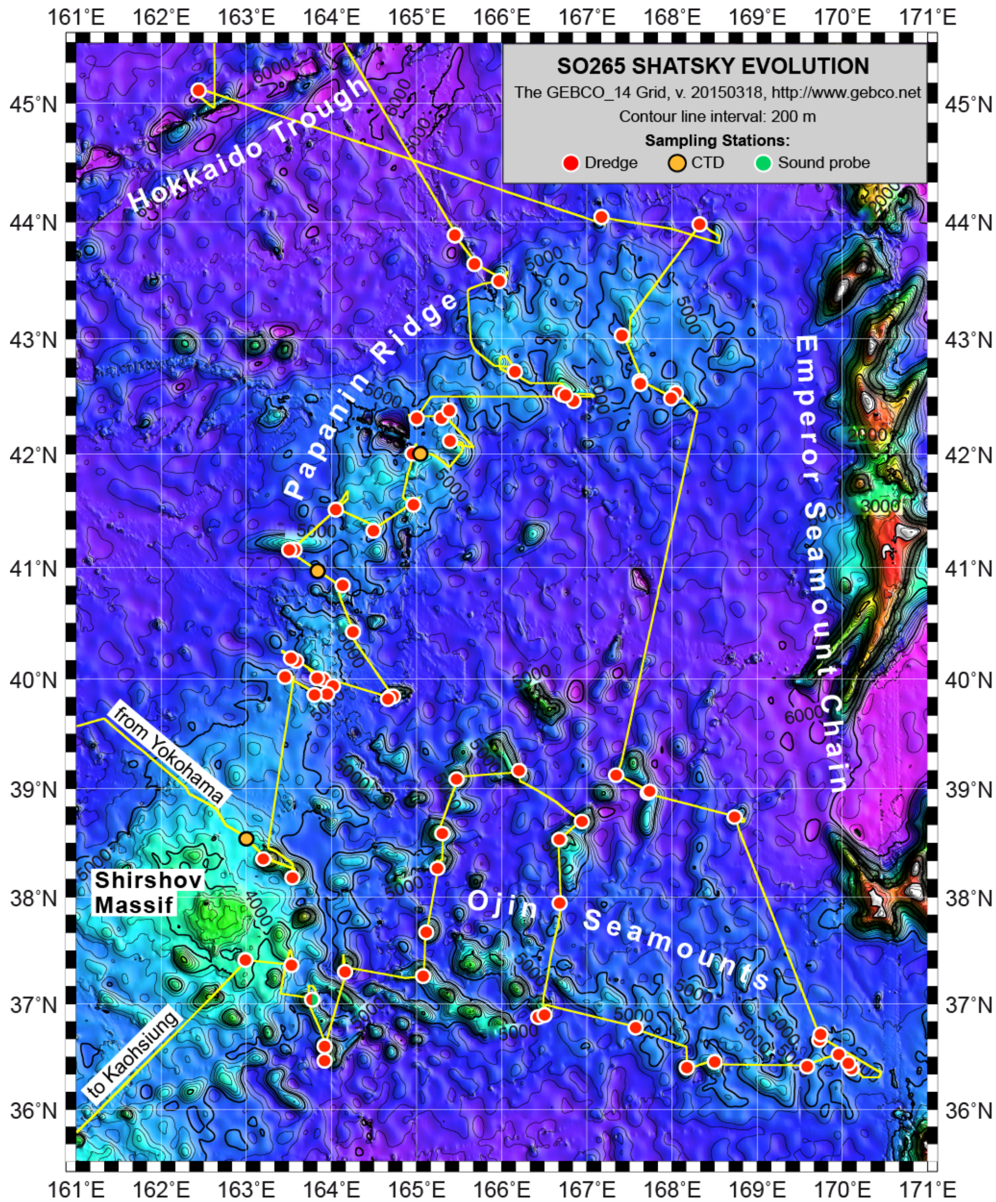
Captain: Lutz Mallon



Objectives

R/V SONNE expedition SO265 is the central activity of the research project "Shatsky Evolution" that is funded by the Federal Ministry of Education and Research and conducted by the GEOMAR Helmholtz Centre for Ocean Research Kiel in collaboration with international partners. The goal of the project is the investigation of the late stage evolution of Shatsky Rise, a vast, submarine volcanic plateau in the northwest Pacific. In particular, the project aims to investigate the transition from plateau volcanism (the main body of Shatsky Rise) to postulated hotspot track volcanism (Papanin Ridge and/or Ojin Rise seamounts).

Previous scientific drilling (Integrated Ocean Drilling Program Expedition 324) has considerably improved our knowledge about the timing and origin of the Shatsky Rise. Although new evidence has emerged from the drilled samples favoring the origin of the Shatsky Rise through the interaction of a mantle plume (head) with a triple junction of spreading centers, the evidence for the involvement of a mantle plume is not unequivocal. An association of the Shatsky Rise with an age-progressive hotspot track (i.e. decreasing ages along a volcanic track extending from the young end of the Shatsky Rise, i.e. Shirshov Massif) could be the “smoking gun” for the involvement of a mantle plume. Interestingly, two different bathymetric features emanate from the Shirshov Massif and could potentially serve as a possible Shatsky hotspot track. The Papanin Ridge extends to the northeast of the Shirshov Massif, whereas, the Ojin Rise Seamount Province extends as a broad belt to the east. Demonstrating that one (or both) of these features continues the age progression found at Shatsky Rise and has similar geochemistry, would provide strong evidence in favor of the plume hypothesis for the origin of the Shatsky Rise. Another aim of the postcruise research on the obtained lava samples is to look for evidence for a spatial geochemical zonation within Papanin Ridge or the Ojin Seamount belt. Since Shatsky Rise formed above the margin of a large-scale, low seismic velocity province (LLSVP) at the base of the lower mantle (from which zoned hotspot systems are believed to originate), finding such a zonation would provide additional evidence that Shatsky Rise (and its hotspot tracks) were generated by a mantle plume. In addition to the geological work, macro-benthic organisms were collected from the surfaces of the recovered rocks to study the diversity of deep-see invertebrates, and sediment sampling (by small sediment traps installed in the dredges) was conducted for meiofauna studies.

Narrative of the Cruise

In the morning of August 26, the SO265 scientific party embarked R/V SONNE in the port of Yokohama (Japan). After all equipment was loaded (including our two containers), the vessel set sail in the afternoon of August 27 with fine weather and begun its 4-day transit to our first planned sampling location on the northern Shatsky

Rise. The scientific party consists of 21 scientists (including students) and technicians from six different countries and eight international research institutions.

During transit the weather conditions deteriorated and the forecast for our planned first working area (Area I: Papanin Ridge) predicted wind speeds and swell highs that would drastically limit our operational options. Therefore, we decided to switch towards a more southerly located alternative area on the central Shatsky Rise (Working Area II: Ojin Rise Seamount Province) for which the weather forecast looked more promising. After arrival, we first conducted a water sound profile by running the CTD-Probe (conductivity, temperature, depth) down to 2000m water depths to calibrate the ship's-own multibeam echosound system. Thereafter, we successfully conducted two dredge hauls on two prominent seamounts located NE of the Shirshov Summit (DR 2 and DR 3). Two types of lava rocks were recovered; aphyric and plagioclase-phyric, similar to the rocks previously dredged by our Japanese colleagues on the southern Ojin seamounts. Afterwards, we continued our transit to northern Shatsky Rise where weather conditions had improved in the meantime. The beginning of Papanin Ridge is marked by the Thompson Trough, a tectonic graben structure separating Shatsky Rise with its Shirshov summit in the south and Papanin Ridge to the north. Because this structure provided the rare opportunity to obtain basement samples of both Shirshov Massif and Papanin Ridge, we conducted several dredge hauls at the northern and southern flanks of the trough. From the southern slope (Shirshov side) volcanic rocks could only be recovered from the lower slope of one seamount (DR 4), but it is currently unclear if this seamount belongs to the Shirshov basement or represents a later feature (e.g. an Ojin seamount?). Two attempts to sample the prominent "Earthwatch Semount" (named by the R/V Thompson scientific party who dredged this seamount in 1994) failed because the sea state prevented us from dredging its much steeper NE slope. In contrast, sampling the basement of Papanin Ridge (northern slope of Thompson Trough) was successful (DR 7). Another dredge haul up the slope of a seamount which southern flank forms the northern Thompson Trough hillside near its eastern end was also successful (DR 11), yielding well-preserved porphyritic lava rocks.

About 30 nm to the east, a strangely-shaped structure (a pointed, E-W elongated ridge) caught our attention and was given the working name "Sonne Ridge". Because of its form (that differs from the typical roundish Ojin seamounts) a possible tectonic origin of this ridge (related to movements at the nearby Thompson Trough) is speculated. Dredge hauls DR 12 and DR 14 at the deeper and upper slope of Sonne Ridge respectively, recovered well-preserved olivine and plagioclase-phyric pillow lava fragments. Afterwards, the vessel returned to the main body of Papanin Ridge.

By the end of the second week, we had sampled the Papanin Ridge up to a latitude of 42°30' N which roughly corresponds to one half of its North-South extension. Successfully sampled structures include Shuleykin Seamount (DR 18, 19), which forms a prominent E-W elongated edifice off the eastern edge of Papanin Ridge at

41°10'N and the deep slope of Papanin Ridge at 41°36' (DR 20), which we believed to represent the "basement" of Papanin Ridge.

At the beginning of the third week we reached the northeastern extension of Papanin Ridge (east of ~165°30'). Sampling this area was of great importance to us because based on paleomagnetic data the ridge is here proposed to have no longer formed at a spreading axis, but originated by true intraplate volcanism (i.e. volcanism away from plate boundaries). Accordingly, we expect that the lavas obtained from this area possess a different geochemical composition (compared to the southern part of Papanin Ridge). Initially, our dredging program continued as planned but in the middle of the week, we had to avoid an approaching storm. After the ship's command and the expedition leadership consultations with the ship-board meteorologist from the German National Meteorological Service (DWD), the decision was made to northwardly sidestep the storm (by steaming 290 nm to the NE and weather at a position near 48°N,162°E) and then safely return on its backside into the working area. This plan worked out well. By Saturday morning, Sept. 15 we found ourselves dredging again on the northern edge of Papanin Ridge in nice weather conditions. The little unintended excursion to the north, furthermore, enabled us to map and sample the hitherto totally uninvestigated Hokkaido Trough, a 1000 km long canyon that likely represents an abandoned spreading ridge. Although the sea state did not allow us to dredge the steeper southern side of the trough flank, we managed to obtain pillow fragments from its northern slope (DR 38), which are altered but still suitable for most geochemical analyses and possibly even age dating (abundant plagioclase microphenocrysts). The recovered samples will hopefully allow us to determine the age of this structure and thus better constrain the plate tectonic history of this little investigated part of the Pacific Ocean.

Getting samples from the "intraplate" part of Papanin Ridge turned out to be challenging. Many dredges were empty or just returned large numbers of manganese nodules. Moreover, after completing a 40 km long transit to an apparently large volcano (15 km in diameter) at 188°30'E, the far edge of the working area, that was predicted to exist based on satellite gravimetry data, the structure could not be found. We finished our work at the northeastern extension of Papanin Ridge on Sept. 17., in the fourth week of this expedition, and began our long transit to the Ojin Seamount Province, our second main working area. Overall, however, we managed to get suitable samples for addressing the research objectives for the northeastern tip of Papanin Ridge, from five spatially well-distributed locations (DR 30, 35, 39, 42, 44).

The transit was conducted in two legs: The first leg led us 200 nm (about 370 km) southward to the northernmost representatives (at ~39°N) of the broad belt of Ojin seamounts. We managed to get volcanic rocks from two out of three sampled structures. DR 47 returned moderately to strongly altered slightly phyric to aphyric, angular lava fragments within manganese nodules. In contrast, DR 49 returned a large number (the chain bag was half full!) of pillow lavas including some very well-preserved vesicular rocks which contained vesicles still unfilled by secondary material. The second leg of the transit led us another 240 km southeastwards to the eastern termination of the Ojin Seamount Province (at ~ 36°N and 170°E). If this widespread belt of seamounts represents an age-progressive hotspot track, this must be its youngest end. Therefore, it was of great importance to us to recover well-preserved rocks suitable for radiometric age dating. The alleged end of the hotspot track turned out to consists of a cluster of medium-sized (c. 10 km Ø), pancake-shaped seamounts. We managed to get suitable lava rock material from three out of four sampled pancake volcanoes (DR 52, 53, 54). One of the seamounts features an almost perfectly round, several hundred meters deep "crater" of more than 3 km diameter at its summit. This depression probably represents a caldera instead a classical (explosive) crater. Interestingly, we have frequently detected such caldera structures on medium-sized (pancake-shaped) seamounts in both working areas (Papanin Ridge and Ojin Seamounts). Because of the remarkable steepness of the inner caldera wall of this seamount, we decided to conduct a dredge haul up the caldera wall and we were awarded with exceptionally fresh pillow lava fragments (DR 53). The obtained lava rocks contain phenocrysts of feldspar and we found relicts of fresh glass in the chilled margins! Fresh glass can be used for a variety of geochemical application and is therefore particular desired.

During the following days, we worked our way west in an attempt to retrieve spatially well-distributed samples covering the entire 760 km long E-W as well as the up to 350 km wide S-N extension of the Ojin Seamount Province. This approach was successful: In total, 35 dredge hauls were conducted on Ojin seamounts of which 27 returned igneous rocks and 24 of those cases yielded quantitatively and qualitatively sufficient material for addressing the project's objectives. Occasionally, the recovered rocks contained well-preserved, large feldspar crystals (e.g. DR 63) and in two instances (DR 69 and DR 73) even fresh volcanic glass was discovered. Therefore, all three research goals for this working area (Do the Ojin volcanoes get younger towards the east? Does the geochemical composition vary with time? Can we see a geographic zonation in the geochemistry?) can be addressed by the planned analyses on shore. To avoid duplication of efforts, we did not re-sample those five seamounts that were successfully dredged by T. Sano's R/V KAIREI expedition in 2014.

The last 1.5 days of operational time were dedicated to Working Area III (Northern Shatsky Rise, i.e. the Shirshov Massif). When we lost 3 days of operation time during the third week due to the passing storm (see above), we decided to cut this time out of the 5 days that were originally planned for Northern Shatsky Rise. This Working Area III was at the lowest priority and primarily served as a potential contingency site in case weather conditions would not have allowed us to substantially operate further north (Papanin Ridge) or east (Ojin Seamount Province). Finding suitable dredge sites on Shirshov Massif, however, proved to be difficult. In addition, another approaching storm system (with predicted wave heights up to 12 m) forced us to leave Shatsky Rise a day earlier than originally planned, thus further reducing the time available to search for a better dredge location (e.g. with steeper slopes). We placed high hopes in dredging a newly discovered 100m high and >30° steep cliff east of the Shirshov summit, but dredge DR 74 (despite recording a 80 KN bite on the rope tension meter) returned completely empty. Our last attempt targeted a little structure on the eastern Shirshov summit, which could be either a small Ojin seamount or, more likely, a second Shirshov summit that peaks through the thick sediments. DR 75 returned at least one small piece of well-preserved volcanic rock (containing plagioclase microphenocrysts) that could be excavated from a larger Mn crust.

Autumn is quickly approaching in the North Pacific, as evidenced by the increase of heavy storms at these latitudes. Such an approaching storm forced us to leave our operational area one day earlier as originally planned. Therefore, DR75 was the last dredge haul of this expedition and on Friday, September 28 we set sail for the long transit southward to the port of destination, Kaohsiung in Taiwan. In total we have conducted 3 CTD stations and 72 dredge hauls of which 49 (=68%) returned *in situ* volcanic rocks. The SONNE arrived in Kaohsiung on October 9, 2018 and this fantastic journey came to an end.

Acknowledgements

Our sincerest thanks go to Captain Mallon, his officers and the entire crew, whose help and full support we have always been able to count on. Their hard work, high level of skill and experience, great flexibility and willingness to help, as well as the pleasant working atmosphere on board of the SONNE, contributed directly to the success of the SO265 expedition. We are also grateful to the German Federal Ministry of Education and Research for its continuing support of marine geological research. Additional funding was provided by GEOMAR, the Museum für Naturkunde Berlin, the Oregon State University (USA), the National Museum of Nature and Science Tokyo (Japan), Chiba University (Japan) and the Japan Agency for Marine-Earth Science and Technology (JAMSTEC). Masao Nakanishi (Chiba University) is particular thanked for providing new, unpublished bathymetric data that helped with the cruise track planning. We also would like to thank the German National Meteorological Service (Deutscher Wetterdienst) for sending such a skillful meteorologist for this expedition. The specially tailored weather and sea state forecasts and daily briefings of the ships command and the chief scientist were of great help for the cruise track planning.

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2. Dürkefälden, Antje	Shift Leader Geology	GEOMAR
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7. Heitmann-Bacza, Carola	Weather Forecast	DWD
8. Husch, Sabine	Rock Sampling	GEOMAR
9. Kipf, Andrea	Rock Sampling	GEOMAR
10. Nora Krebs	Rock Sampling	GEOMAR
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Appendix I (SO265 Station Summary)

Type	Stat.	Location	total volume	Rec. DR	Station summary	start / on bottom		end / off bottom		depth (m)		Rock sampling			
						lat °N	long °	lat °N	long°	begin	end	Mag	VC	Sed	Mn
CTD	1	Northern Shirshov Massif			*sound velocity profile for EM122 (2000 m)*	38,533	163,000	38,533	162,000						
DR	2	Seamount on northern Shirshov Massif	1/3 full	1	lava fragments, volcaniclastic rocks, Mn-crusts	38,359	163,187	38,357	163,197	3416	2949	yes	yes		yes
DR	3	Seamount on northern Shirshov Massif	1/4 full	1	lava fragments, volcaniclastic rocks, Mn-crusts	38,197	163,529	38,201	163,536	3355	2960	yes	yes		yes
DR	4	Shirshov Massif / Thompson Trough	1/3 full	1	lava fragments, volcaniclastic rocks (pumice), Mn-crusts	40,018	163,467	40,011	163,472	5141	4664	yes	yes		yes
DR	5	Earthwatch Seamount	minor	0	Mn-nodules	39,862	163,813	39,859	163,820	4439	4032				yes
DR	6	Earthwatch Seamount	minor	0	Mn-nodules	39,870	163,962	39,863	163,957	5234	4865				yes
DR	7	Papanin Ridge / Thompson Trough	1/5 full	1	lava fragments, Mn-nodules	39,940	164,030	39,947	164,031	5324	4880	yes			yes
DR	8	Papanin Ridge / Thompson Trough	few rocks	1	Mn-nodules enclosing pumice, lava fragments, and sediment	40,180	163,537	40,185	163,537	5345	5184	yes	yes	yes	yes
DR	9	Papanin Ridge / Thompson Trough	few rocks	0	Mn-nodules enclosing pumice, phosphate, and sediment	40,157	163,598	40,164	163,598	5252	5081		yes	yes	yes
DR	10	Papanin Ridge / Thompson Trough	few rocks	1	Mn-nodules, partly enclosing lava fragments	40,007	163,843	40,014	163,843	5300	5040	yes	yes		yes
DR	11	Papanin Ridge / Thompson Trough	1/6 full	1	lava fragments, volcaniclastic rocks (e.g. pumice)	39,997	163,917	40,004	163,916	4904	4478	yes	yes		
DR	12	"Sonne Ridge" west of Thompson Trough	1/5 full	1	lava fragments, volcaniclastic rocks (pumice), Mn-crusts	39,810	164,653	39,817	164,648	5190	4753	yes	yes	yes	yes
DR	13	"Sonne Ridge" west of Thompson Trough	empty	0		39,849	164,713	39,855	164,708	4080	3650				
DR	14	"Sonne Ridge" west of Thompson Trough	1/4 full	1	lava fragments, volcanicl. rocks (conglomerate), Mn-crusts	39,847	164,705	39,854	164,703	4120	3690	yes	yes		yes
DR	15	Papanin Ridge / southern part	few rocks	1	Mn-nodules, partly enclosing lava fragments	40,407	164,265	40,413	164,261	5103	4671	yes			yes
DR	16	Papanin Ridge / southern part	1/4 full	1	Mn-nodules, partly enclosing lava fragments	40,810	164,144	40,806	164,135	4835	4420	yes			yes
CTD	17	Papanin Ridge / western margin			*sound velocity profile for EM122 (2000 m)*	40,959	163,850	40,959	163,851						
DR	18	Shuleykin Seamount	minor	1	lava fragment, Mn-nodules, partly enclosing lava fragments	41,174	163,563	41,180	163,561	4602	4200	yes			yes
DR	19	Shuleykin Seamount	few rocks	1	lava fragments, Mn-crusts, dropstone?	41,176	163,579	41,183	163,576	4473	3995	yes			yes
DR	20	Papanin Ridge / southwestern margin	1/3 full	1	lava fragments, volcanicl. rocks, Mn-nodules, dropstones	41,518	164,039	41,525	164,037	5155	4727	yes	yes		yes
DR	21	Papanin Ridge / southern part	few rocks	1	lava fragments, Mn-crusts and -nodules, dropstones	41,320	164,482	41,327	164,484	4822	4480	yes			yes
DR	22	Papanin Ridge / southern part	few rocks	1	lava fragments, Mn-crusts and -nodules	41,542	164,976	41,545	164,967	4672	4241	yes			yes
DR	23	Papanin Ridge / southern part	1/5 full	1	lava fragments, Mn-nodules	41,999	164,973	41,995	164,965	4756	4453	yes			yes
CTD	24	Papanin Ridge / southern part			*sound velocity profile for EM122 (2000 m)*	41,995	164,965	41,995	164,965						
DR	25	Papanin Ridge / central part	1/5 full	1	*Mn-crust with lava fragments*	42,103	165,405	42,096	165,403	4488	4017	yes			yes
DR	26	Papanin Ridge / central part	1/4 full	1	lava frag., volcanicl. rocks, Mn-crusts and -nodules, dropst.	42,382	165,396	42,379	165,388	4708	4289	yes	yes		yes
DR	27	Papanin Ridge / central part	one rock	0	dropstone	42,319	165,303	42,326	165,303	4405	4013				
DR	28	Papanin Ridge / central part	few rocks	0	Mn-nodules, dropstones	42,317	165,014	42,320	165,005	4900	4490				yes
DR	29	Papanin Ridge / northeastern part	few rocks	0	Mn-nodules, dropstones	42,527	166,761	42,534	166,760	4309	3843				yes
DR	30	Papanin Ridge / northeastern part	few rocks	1	lava fragments, Mn-nodules	42,479	166,856	42,486	166,854	5044	4669	yes			yes
DR	31	Papanin Ridge / northeastern part	few rocks	0	*Mn-crusts and nodules, dropstones*	42,548	166,700	42,556	166,702	4330	3890				yes
DR	32	Papanin Ridge / northeastern part	few rocks	0	Mn-crusts and nodules, dropstones	42,534	166,726	42,541	166,727	4235	3857				yes
DR	33	Papanin Ridge / northern part	empty	0		42,742	166,168	42,749	166,168	4915	4450				
DR	34	Papanin Ridge / northern part	minor	0	Mn-crusts and nodules, dropstones	43,503	165,982	43,511	165,979	4756	4484				yes
DR	35	Papanin Ridge / northern part	few rocks	1	lava fragments, Mn-crusts, dropstones	43,646	165,692	43,653	165,690	4467	4987	yes			yes
DR	36	Papanin Ridge / northern part	one rock	0	dropstone	43,888	165,461	43,893	165,462	5543	5180				
DR	37	Papanin Ridge / northern part	empty	0		43,886	165,467	43,892	165,468	5559	5195				
DR	38	Hokkaido Trough	few rocks	1	lava fragments	45,105	162,453	45,110	162,447	5930	5580	yes			
DR	39	Papanin Ridge / northern part	1/8 full	1	lava fragments, sedimentary rocks, Mn-crusts, dropstones	44,041	167,184	44,034	167,178	5300	4900	yes		yes	yes
DR	40	Papanin Ridge / easternmost part	empty	0		43,979	168,336	43,983	168,336	5512	5250				
DR	41	Papanin Ridge / easternmost part	empty	0		43,046	167,424	43,042	167,427	4756	4560				

Appendix I (SO265 Station Summary)

Type	Stat.	Location	total	Rec.	Station summary	start / on bottom		end / off bottom		depth (m)		Rock sampling			
			volume	DR		lat °N	long °	lat °N	long°	begin	end	Mag	VC	Sed	Mn
DR	42	Papanin Ridge / easternmost part	minor	1	one lava fragment (mn-coated), Mn-crusts, dropstones	42,624	167,616	42,628	167,620	5044	4729	yes			yes
DR	43	Papanin Ridge / easternmost part	minor	0	very small Mn-nodules and dropstones, sediment	42,645	167,608	42,645	167,617	5010	4587				
DR	44	Papanin Ridge / easternmost part	minor	0	one dropstone	42,501	168,002	42,509	167,998	5146	4736				
DR	45	Papanin Ridge / easternmost part	1/4 full	1	lava fragments, Mn-crusts, sediment	42,545	168,057	42,549	168,049	5066	4569	yes			yes
DR	46	Ojin Seamounts / northern part	empty	0		39,128	167,356	39,127	167,364	4779	4379				
DR	47	Ojin Seamounts / northern part	1/6 full	1	Mn-nodules, partly enclosing lava fragments	38,967	167,749	38,961	167,753	5089	4642	yes			yes
DR	48	Ojin Seamounts / northern part	empty	0		38,953	167,728	38,947	167,732	5283	4875				
DR	49	Ojin Seamounts / northern part	1/2 full	1	lava fragments, Mn-crusts and -nodules	38,738	168,747	38,733	168,751	4580	4190	yes			yes
DR	50	Ojin Seamounts / eastern part	1/6 full	1	Mn-crusts and -nodules, enclosing one small lava fragment	36,723	169,758	36,716	169,760	4590	4190	yes			yes
DR	51	Ojin Seamounts / eastern part	1/8 full	1	Mn-nodules, partly enclosing lava fragments	36,690	169,719	36,686	169,727	4280	3862	yes			yes
DR	52	Ojin Seamounts / eastern part	minor	1	Mn-nodules, enclosing one small lava fragment	36,440	170,083	36,436	170,088	4654	4290	yes			yes
DR	53	Ojin Seamounts / eastern part	few rocks	1	lava fragments, volcaniclastic rocks, Mn-crusts	36,391	170,121	36,387	170,121	4057	3835	yes	yes		yes
DR	54	Ojin Seamounts / eastern part	1/2 full	1	lava fragments, Mn-crusts and -nodules	36,520	169,971	36,513	169,970	4865	4383	yes			yes
DR	55	Ojin Seamounts / eastern part	few rocks	1	lava fragments, sedimentary rocks, Mn-nodules	36,410	169,599	36,407	169,608	5029	4579	yes		yes	yes
DR	56	Ojin Seamounts / south-eastern part	1/3 full	1	lava fragments, volcaniclastic rocks, Mn-nodules and -crusts	36,471	168,514	36,464	168,514	4630	4162	yes	yes		yes
DR	57	Ojin Seamounts / south-eastern part	1/5 full	1	lava fragments, Mn-crusts and -nodules	36,419	168,187	36,412	168,183	4451	3954	yes			yes
DR	58	Ojin Seamounts / central part	minor	1	Mn-crusts and -nodules, partly enclosing lava fragments	36,767	167,586	36,774	167,586	4805	4426	yes			yes
DR	59	Ojin Seamounts / central part	1/3 full	1	Mn-nodules, a few enclosing lava fragments, pumice	36,901	166,515	36,907	166,513	4655	4210	yes	yes		yes
DR	60	Ojin Seamounts / central part	*missing!*	1	lava fragments	36,900	166,488	36,906	166,485	4670	4170	yes			
DR	61	Ojin Seamounts / north-western part	2/3 full	1	Mn-nodules enclosing pumice, lava fragments, and sediment	37,927	166,693	37,935	166,697	4664	4153	yes	yes	yes	yes
DR	62	Ojin Seamounts / north-western part	few rocks	1	lava fragments, volcaniclastic rocks (pumice), Mn-crusts	38,538	166,689	38,534	166,694	3756	3330	yes	yes		
DR	63	Ojin Seamounts / north-western part	1/4 full	1	lava fragments	38,698	166,931	38,702	166,939	3440	2950	yes			
DR	64	Ojin Seamounts / north-western part	1/2 full	1	lava fragments, Mn-crusts and -nodules	39,151	166,192	39,144	166,191	4020	3590	yes			yes
DR	65	Ojin Seamounts / north-western part	1/6 full	1	lava fragments, volcaniclastic rocks (pumice), Mn-crusts	39,075	165,482	39,078	165,480	3906	3650	yes	yes		yes
DR	66	Ojin Seamounts / western part	empty	0		38,590	165,314	38,593	165,310	3391	3088				
DR	67	Ojin Seamounts / western part	1/3 full	1	lava fragments, very large Mn-crust, Mn-nodules	38,280	165,258	38,287	165,257	3822	3373	yes			yes
DR	68	Ojin Seamounts / western part	1/4 full	1	lava fragments	37,660	165,126	37,666	165,129	3520	2885	yes			
DR	69	Ojin Seamounts / western part	1/4 full	1	lava fragments, volcaniclastic rocks (e.g. pumice), Mn-crusts	37,257	165,089	37,263	165,090	3570	3081	yes	yes		yes
DR	70	Ojin Seamounts / western part	minor	0	(three pumice clasts of unclear origin, not sampled)	37,296	164,172	37,303	164,176	5011	4552				
DR	71	Ojin Seamounts / western part	empty	0		36,482	163,932	36,483	163,940	5332	4970				
DR	72	Ojin Seamounts / western part	few rocks	1	lava fragments	36,614	163,932	36,607	163,933	4180	3720	yes			
DR	73	Ojin Seamounts / western part	few rocks	1	Mn-crusts, with pillow margins attached	37,042	163,786	37,042	163,777	3767	3342	yes			yes
DR	74	Shirshov Massif / eastern flank	empty	0		37,358	163,543	37,357	163,536	4666	4460				
DR	75	Shirshov Massif / seamount on plateau	1/3 full	1	two lava fragments, Mn-crusts and -nodules	37,405	163,002	37,397	163,011	3680	3330	yes			yes
OFOS	76	Makarov Seamount			ocean floor observation and technical test (failed)	29,466	153,592	29,466	153,000	1535	1534				
				49	**dredges yielded magmatic and / or sed. rocks 68.1%)**							**49**	**18**	**6**	**50**
Dredge Stations (DR): 72				**23**	**dredges returned empty or yielded only soft sediment and / or Mn and / or dropstones (31.9%)**										

CTD Stations (CTD): 3
OFOS Stations (OFOS): 1

Mag: magmatic rocks
VC: volcaniclastic rocks
Sed: sedimentary rocks
Mn: Mn-crusts, - nodules