

CRUISE REPORT
Japan Agency for Marine-Earth Science and Technology
(JAMSTEC)

R/V Yokosuka
Cruise YK10-14

Tectonic reconstruction of initial stage of
Philippine Sea Plate formation
(and recovery of Triton Buoy No.13)

October 22 to November 9, 2010

(JAMSTEC to Palau)



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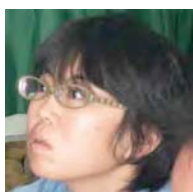
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CRUISE NARRATIVE AND SCHEDULE OF OPERATIONS

Actual schedule (YK10-14 10/10/22 - 10/11/09)				Position/Weather/Wind/Sea condition (Noon)
Date	Time	Description	Remark	
22,Oct,10	9:00	embarked science group		10/22 12:00(JST)
	11:00	scientific meeting,	for safety YOKOSUKA life	JAMSTEC
	-11:30	on board education		
23,Oct,10	15:30	departure from JAMSTEC		10/23 12:00(JST)
	16:00	anchored at YOKOSUKA Sec.4		JAMSTEC
24,Oct,10	6:00	recovered anchor		10/24 12:00(JST)
	18:00	scientific meeting		33-56.8N, 139-49.1E
				fine but cloudy
				E-5(Fresh breeze)
25,Oct,10	18:00	scientific meeting		10/27 12:00(JST)
				27-54.0N, 140-00.0E
				fine but cloudy
				WNW-4(Moderate breeze)
26,Oct,10	10:00	on board seminar		10/26 12:00(JST)
	-11:00			
	16:40	pray to KONPIRASAN for safety cruise		21-42.5N, 139-31.8E
				fine but cloudy
				calm
27,Oct,10	17:44	set on proton magnetometer		10/27 12:00(JST)
	18:00	scientific meeting		16-10.8N, 136-11.0E
				fine but cloudy
				SE-4(Moderate breeze)
28,Oct,10	6:00	released XBT	13-06.0N, 133-08.2E	10/28 12:00(JST)
	6:30	arrived at research area		11-54.2N, 132-20.0E
	6:49	commenced MBES mapping survey		fine but cloudy
	15:09	recovered proton magnetometer		ENE-2(Light breeze)
	15:18	figure eight turn		
	-15:34			
	18:00	scientific meeting		
29,Oct,10	6:05	finished MBES mapping survey		10/29 12:00(JST)
	7:24	started Dredge sampler (D1)		8-03.6N, 129-57.2E
	9:46	reached at bottom	D=5759m	fine but cloudy
	10:59	leave the bottom	D=5330m	NE-4(Fresh breeze)
	14:16	recovered Dredge sampler		
	14:55	started Dredge sampler (D2)		
	17:28	reached at bottom	D=6132m	
	19:20	leave the bottom	D=5555m	
	21:57	recovered Dredge sampler		
	22:20	set on proton magnetometer		
30,Oct,10	1:20	commenced MBES mapping survey		10/30 12:00(JST)
	8:06	finished MBES mapping survey		8-02.4N, 131-28.2E
	9:15	recovered proton magnetometer		fine but cloudy
	9:30	started Dredge sampler (D3)		SE-5(Fresh breeze)
	11:50	reached at bottom	D=5795m	
	14:17	leave the bottom	D=5119m	
	16:28	recovered Dredge sampler		
	16:45	set on proton magnetometer		
	16:56	commenced MBES mapping survey		
	19:30	scientific meeting		
31,Oct,10	7:27	finished MBES mapping survey		10/31 12:00(JST)
	7:39	recovered proton magnetometer		8-26.1N, 129-55.5E
	8:01	started Dredge sampler (D4)		over cast
	10:28	reached at bottom	D=6063m	SE-3(Gentle breeze)
	12:51	leave the bottom	D=5353m	
	15:23	recovered Dredge sampler		
	15:48	commenced MBES mapping survey		
	15:52	set on proton magnetometer		
	16:15	figure eight turn		
	-16:32			
	18:30	scientific meeting		
01,Nov,10	7:14	finished MBES mapping survey		11/1 12:00(JST)
	7:30	recovered proton magnetometer		6-54.1N, 132-49.8E
	7:37	started Dredge sampler (D5)		fine but cloudy
	8:51	reached at bottom	D=3044m	ESE-2(Light breeze)
	10:53	leave the bottom	D=2394m	
	11:58	recovered Dredge sampler		

Actual schedule (YK10-14 10/10/22 - 10/11/09)				Position/Weather/Wind/Sea condition (Noon)
Date	Time	Description	Remark	
	12:59	started Dredge sampler (D6)		
	14:29	reached at bottom	D=3719m	
	16:35	leave the bottom	D=3100m	
	17:55	recovered Dredge sampler		
	18:04	set on proton magnetometer		
	18:10	commenced MBES mapping survey		
	18:50	scientific meeting		
02,Nov,10	18:00	scientific meeting		11/2 12:00(JST)
				6-06.2N,129-45.0E
				fine but cloudy
				NE-2(Light breeze)
03,Nov,10	7:46	finished MBES mapping survey		11/3 12:00(JST)
	7:59	recovered proton magnetometer		5-12.7N,129-56.9E
	8:16	started Dredge sampler (D7)		fine but cloudy
	10:22	reached at bottom	D=5265m	N-3(Gentle breeze)
	12:49	leave the bottom	D=4610m	
	14:50	recovered Dredge sampler		
	15:05	set on proton magnetometer		
	15:12	figure eight turn		
	15:28			
	15:45	commenced MBES mapping survey		
	18:00	scientific meeting		
04,Nov,10	6:34	finished MBES mapping survey		11/4 12:00(JST)
	6:53	recovered proton magnetometer		3-58.4N,129-57.5E
	7:21	started Dredge sampler (D8)		fine but cloudy
	9:04	reached at bottom	D=4483m	S-3(Gentle breeze)
	10:39	leave the bottom	D=3964m	
	12:27	recovered Dredge sampler		
	13:49	started Dredge sampler (D9)		
	15:33	reached at bottom	D=4202m	
	16:55	leave the bottom	D=4036m	
	18:36	recovered Dredge sampler		
	19:10	set on proton magnetometer		
	19:15	commenced MBES mapping survey		
	20:00	scientific meeting		
05,Nov,10	7:44	recovered proton magnetometer		11/5 12:00(JST)
	7:55	started Dredge sampler (D10)		2-39.8N,129-57.4E
	9:10	reached at bottom	D=3339m	fine but cloudy
	10:45	leave the bottom	D=2965m	S-3(Gentle breeze)
	12:08	recovered Dredge sampler		
	13:00	left research area for recover the TRITON BUOY No.13		
	18:00	scientific meeting		
06,Nov,10	9:30	arrived at TRITON BUOY No.13		11/6 12:00(JST)
	15:25	finished recovering TRITON BUOY No.13		1N,134E
				fine but cloudy
				E-2(Light Breeze)
07,Nov,10	12:28	set on proton magnetometer		11/7 12:00(JST)
	18:00	scientific meeting		5-56.3N,134-42.2E
				fine but cloudy
				E-2(Light Breeze)
08,Nov,10	6:05	finished MBES mapping survey		11/8 12:00(JST)
	6:42	recovered proton magnetometer		8-55.7N,134-44.4E
	7:04	started Dredge sampler (D11)		fine but cloudy
	8:33	reached at bottom	D=3828m	NE-2(Light Breeze)
	10:54	leave the bottom	D=3381m	
	12:21	recovered Dredge sampler		
	13:30	started Dredge sampler (D12)		
	14:28	reached at bottom	D=2493m	
	15:39	leave the bottom	D=2004m	
	16:35	recovered Dredge sampler		
	17:03	commenced MBES mapping survey		
	19:20	scientific meeting		
09,Nov,10	0:18	finished MBES mapping survey		11/9 12:00(JST)
	10:00	arrived at Marakal Port		Palau Marakal Port
	12:00	concluded YK10-14		

ACKNOWLEDGEMENTS

We are grateful to Captain Satoshi Susami and the excellent crew of the Yokosuka, for their outstanding efforts to make this scientific program successful. We also thank JAMSTEC for their support of this project.

1. Cruise objectives

Recent advances in understanding crustal structure and composition of oceanic arcs demonstrate that such arcs could represent the building blocks of continental crust formation (Suyehiro et al., 1996; Takahashi et al., 1998). In order to understand the formation of arc and continental crust, it is necessary to estimate growth rates of arc crust coupled with petrological and chemical evolution. Oceanic arcs, where thickened arc crust has formed on oceanic lithosphere provide a unique opportunity to investigate this problem. The Izu-Bonin-Mariana (IBM) arc is an outstanding example of such an arc system.

Forearcs with thin sediment cover are particularly valuable for understanding how subduction zones begin. Our recent research in the Izu-Bonin fore-arc revealed volcanic section representing earliest record of IBM arc magmatism (e.g., Ishizuka et al., 2006; Reagan et al., 2010). The obtained stratigraphy combined with petrological, geochemical and geochronological study led us to propose a model for subduction initiation along this arc (Fig.1-1). This model assumes spontaneous subduction of old and cold, thus, with higher density plate begins to sink beneath younger and hotter plate with lower density (Stern, 2005). This is followed by rapid retreat of subducting plate which caused seafloor spreading at the overlying plate and MORB-like basaltic magmatism. As slab goes into deeper in the

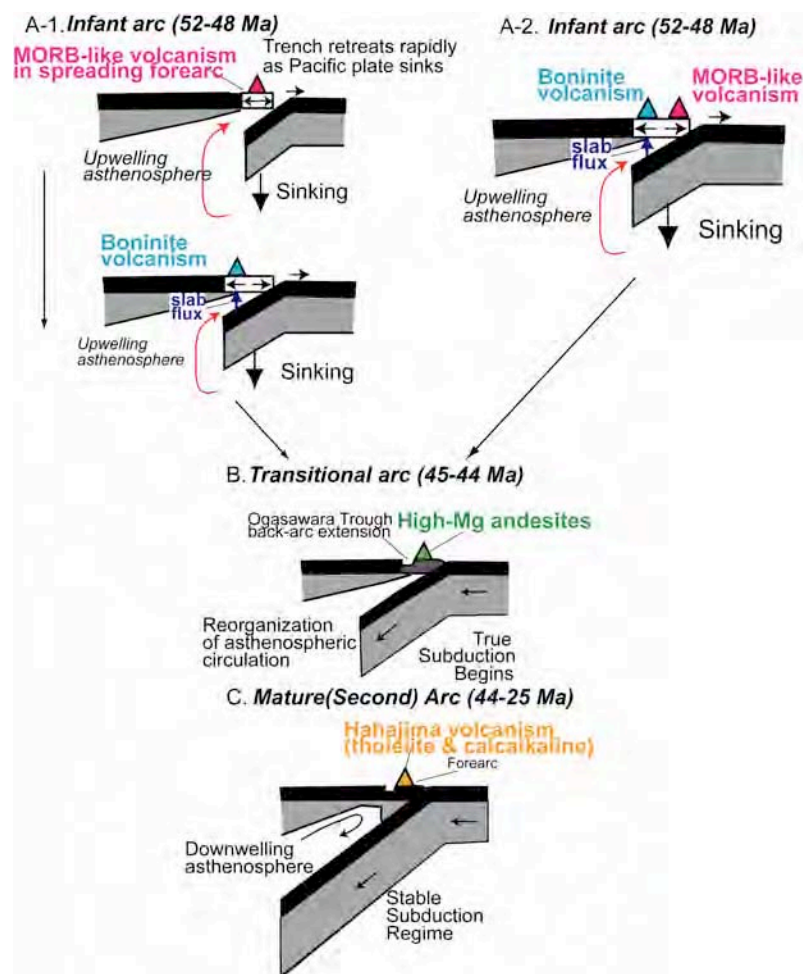


Fig. 1-1 Model of subduction initiation and evolution of infant arc (modified from Ishizuka et al. 2006)

mantle wedge, release of hydrous fluid/siliceous melt from subducting slab and upwelling of hot asthenosphere cause boninitic magmatism as a first expression of arc magmatism. Dating results on this boninitic magmatism revealed that the boninitic magmatism occurred synchronously along the entire length of the IBM arc at c. 48-46 Ma. This result put strong constraint on the possible model for subduction initiation, i.e., subduction initiation must have taken place contemporaneously along the c. 3000km length of the arc. This constraint can be not satisfied by previously-proposed models (e.g., Pearce et al., 1992; Macpherson and Hall, 2001; Deschamps and Lallemand, 2003) assuming ridge subduction, hotspot-subduction interaction etc., but can be explained by spontaneous nucleation of subduction along plate boundary.

This model for subduction initiation, however, has not been tested from a tectonic point of view. To do this, it is absolutely necessary to reconstruct tectonic environment at c. 50 Ma and before. Among the geologic and tectonic features in the Philippine Sea region, tectonic history of relatively younger (younger than c. 25 Ma) features such as Shikoku and Parece Vela Basins and Mariana Trough, are fairly-well constrained. However, Daito Ridge group and basins among the ridges, West Philippine Basin, and Palau Basin have been poorly understood. This hampers understanding of tectonic environment at subduction initiation of IBM arc and what triggered subduction initiation.

This cruise is planned to survey one of the most poorly-understood area in the Philippine Sea, i.e., southern part of West Philippine Basin and Palau Basin (Fig. 1-2), and provide new constraints on tectonic reconstruction of Philippine Sea before 50 Ma. The main goals of this cruise are;

- 1) To recover igneous rock samples from Palau Basin for the first time. This will enable us to reveal the age of basin floor and chemical characteristics of magmatism in this basin, which could provide crucial constraint on the origin of this basin.

- 2) To reveal seafloor fabric and magnetic anomaly of southern part of

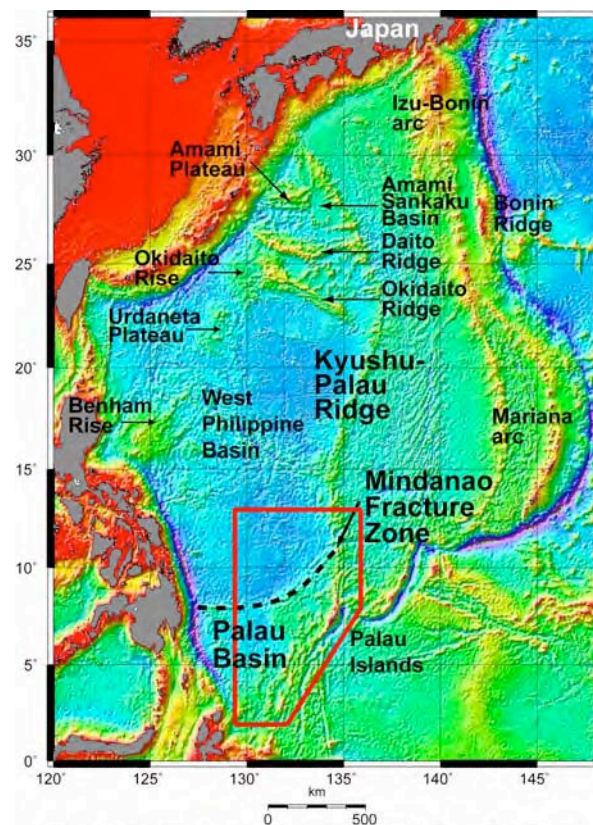


Fig. 1-2 Index map of survey area of YK10-14 cruise. Survey area is shown in red polygon.

West Philippine Basin and Palau Basin to understand how these basins were formed. Recovery of igneous rock samples from these basins will help interpretation of magnetic anomaly by providing age constraint.

3) To recover samples from volcanic edifices in the Palau Basin. There are numerous cone-shaped volcanic edifices in the Palau Basin. These could have formed during the basin formation or later. In terms of their origin, they could be a) rear-arc magmatism of IBM arc in Eo-Oligocene, b) OIB-like magmatism widely distributed in western part of the Philippine Sea region. c) volcanism associated with basin formation. This could have occurred at the spreading axis or off-axis.

4) Basement of southern KPR. Russian ship recovered plutonic rocks dated to be Cretaceous. This could mean that this part of KPR did not grow on the normal oceanic crust as is always assumed for IBM arc, but on an old arc or continental crust. Age and geochemistry of the recovered samples will provide crucial information on origin of the arc basement.

2. Previous studies

There are few bathymetric and magnetic anomaly data available in Palau Basin and southern part of West Philippine Basin area. Hilde and Lee (1984) published magnetic lineation data for this area. Based on these data, they insisted that West Philippine Basin was formed by spreading from the Central Basin Fault (Central Basin Spreading Center). Spreading direction of West Philippine Basin was NE-SW between 60-45 Ma at a half rate of 4.4cm/year. After 45 Ma, spreading direction changed to more N-S direction associated with reconfiguration of Central Basin Spreading Center, and spreading rate was decreased to 18mm/year. Major phase of spreading is inferred to have finished at c. 35 Ma. In their model, Palau Basin is regarded as the oldest part of the West Philippine Basin.

Origin of the West Philippine Basin (and Palau Basin) has been a long debate. Lewis et al. (1982) proposed that the West Philippine Basin was formed as a back-arc basin opened behind East Mindanao-Samar arc. Seno and Maruyama (1984) proposed that this basin was formed behind KPR.

The idea that West Philippine Basin (and Palau Basin) is a back-arc basin has been further developed by recent works (e.g., Fujioka, et al., 1999; Deschamps and Lallemand, 2002, 2003; Okino and Fujioka, 2003) based on new detailed bathymetric and geomagnetic data from mainly around Central Basin Fault and northern part of the West Philippine Basin. Combined with the notion that initiation of IBM subduction was contemporaneous or preceded the opening of West Philippine Basin, Hall et al. (1995),

Hall (2002), Deschamps and Lallemand (2002) proposed models assuming West Philippine Basin opened between the two subduction zones of east Philippines and IBM arc. Deschamps and Lallemand (2002) insisted that rifting started at 55 Ma and spreading ended at 33-30 Ma. Spreading axis was parallel to the east Philippine arc, but became inactive when a new spreading ridge propagated from the eastern part of the basin. Spreading of the basin occurred mainly from this axis, and the axis continuously rotated counter-clockwise.

Another hypothesis for the origin of these basins is so called "trapped basin" model (e.g., Uyeda and Ben-Avraham, 1972). Le Pichon et al. (1985) proposed that the extinct spreading center of the West Philippine Basin was a remnant of the North New Guinea-Kula spreading ridge which captured at 43 Ma. Jolivet et al. (1989) presented similar, but modified model insisting that the West Philippine Basin is a remnant of Pacific-North New Guinea spreading ridge captured at 43 Ma by inception of a new subduction zone (i.e., Izu-Bonin-Mariana arc) along a transform fault.

Concerning Palau Basin, Taylor and Goodliffe (2004) presented a single line of multibeam bathymetry across the Mindanao Fracture Zone. They recognized that Mindanao Fracture Zone is composed of four curve linear fractures based on satellite altimetry data, and named the basin south of this fracture zone as Palau Basin. Palau Basin floor is generally shallower than West Philippine Basin and appears to have thicker pelagic sediment cover (Mrozowski et al., 1982). Taylor and Goodliffe (2004) also pointed out that magnetic anomalies 25 and 26 identified by Hilde and Lee (1984) are incorrect because ridge jump and several fracture zones were not recognized.

Deschamps and Lallemand (2003) proposed that Palau Basin (southernmost part of West Philippine Basin in their figure) was formed by back-arc spreading center parallel to east Philippine arc. They regarded Palau Basin as the oldest part of West Philippine Basin. This spreading appears to have ceased by 45 Ma when secondary spreading axis that formed NE-SW to NNE-SSW trending abyssal hills in West Philippine Basin became active.

Geological information of southern part of West Philippine Basin and Palau Basin is very sparse. No rock samples have been recovered from these areas so far. Some dredge sampling was conducted by Russian ship in 1970's along the Kyushu-Palau Ridge that corresponds to northeastern margin of Palau Basin (Malyarenko and Lelikov, 1995). This dredge sampling recovered shist, gneissoid granite, diorite and hornblende gabbro from 3 sites between 8°56.2' -8°58.1'N. K-Ar ages for these granitic rocks range from 86-125 Ma (Malyarenko and Lelikov, 1995), implying presence of Cretaceous basement for Kyushu-Palau Ridge. Palau Islands, only subaerially-exposed section of

Kyushu-Palau Ridge, exposed Eocene to Oligocene volcanic section mainly composed of tholeiitic to calcalkaline rocks in Eocene to Oligocene.

3.1. Dredge sampling system

GSJ/AIST Dredge sampler system (YK10-14, deeper than 4,000m)	1.6t Pin dia. 19	2.0t Pin dia. 21
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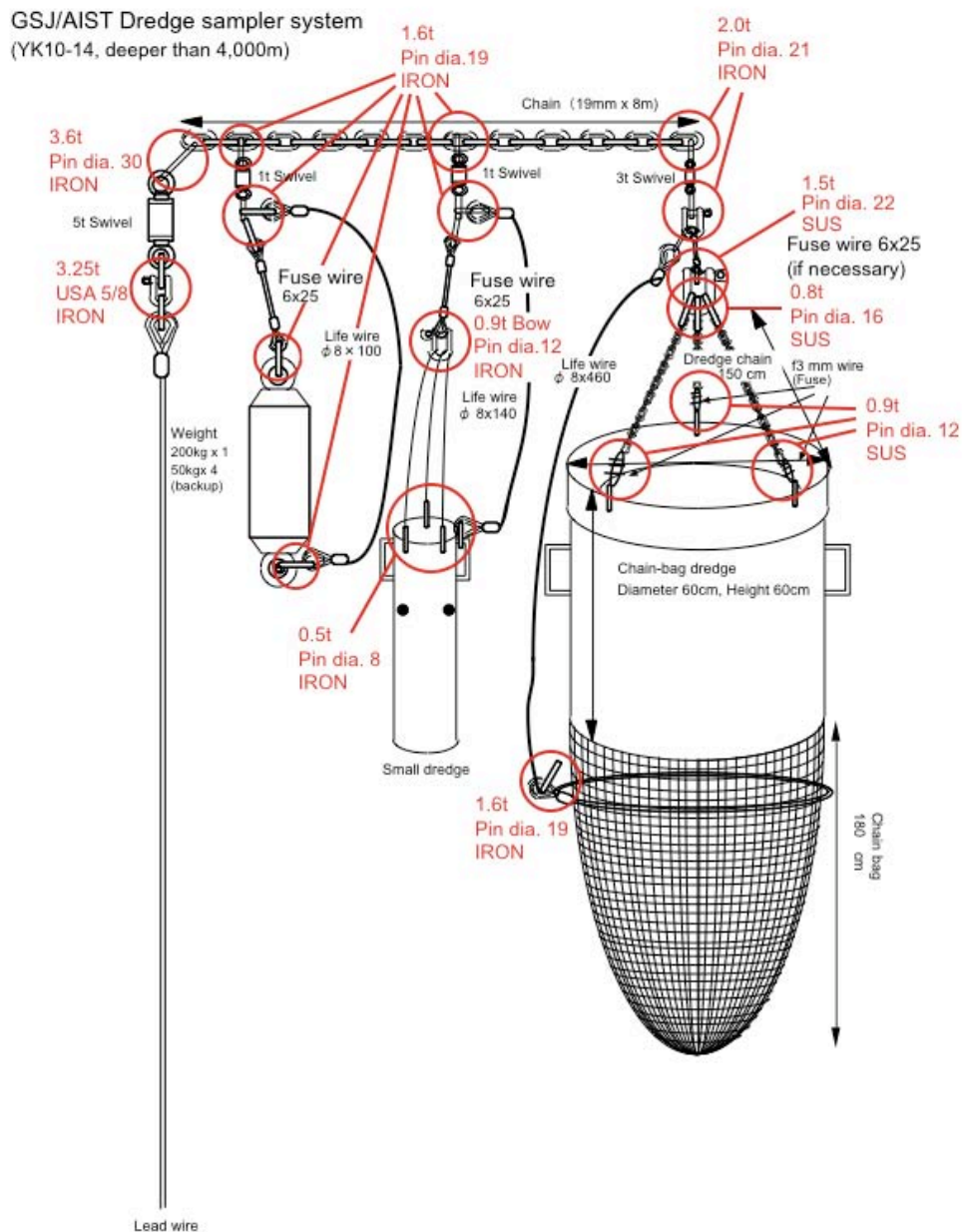


Fig.3-1 dredge sampler system (in case of water depth is more than 4,000m)

GSJ/AIST Dredge sampler system
(YK10-14, shallower than 4,000m)

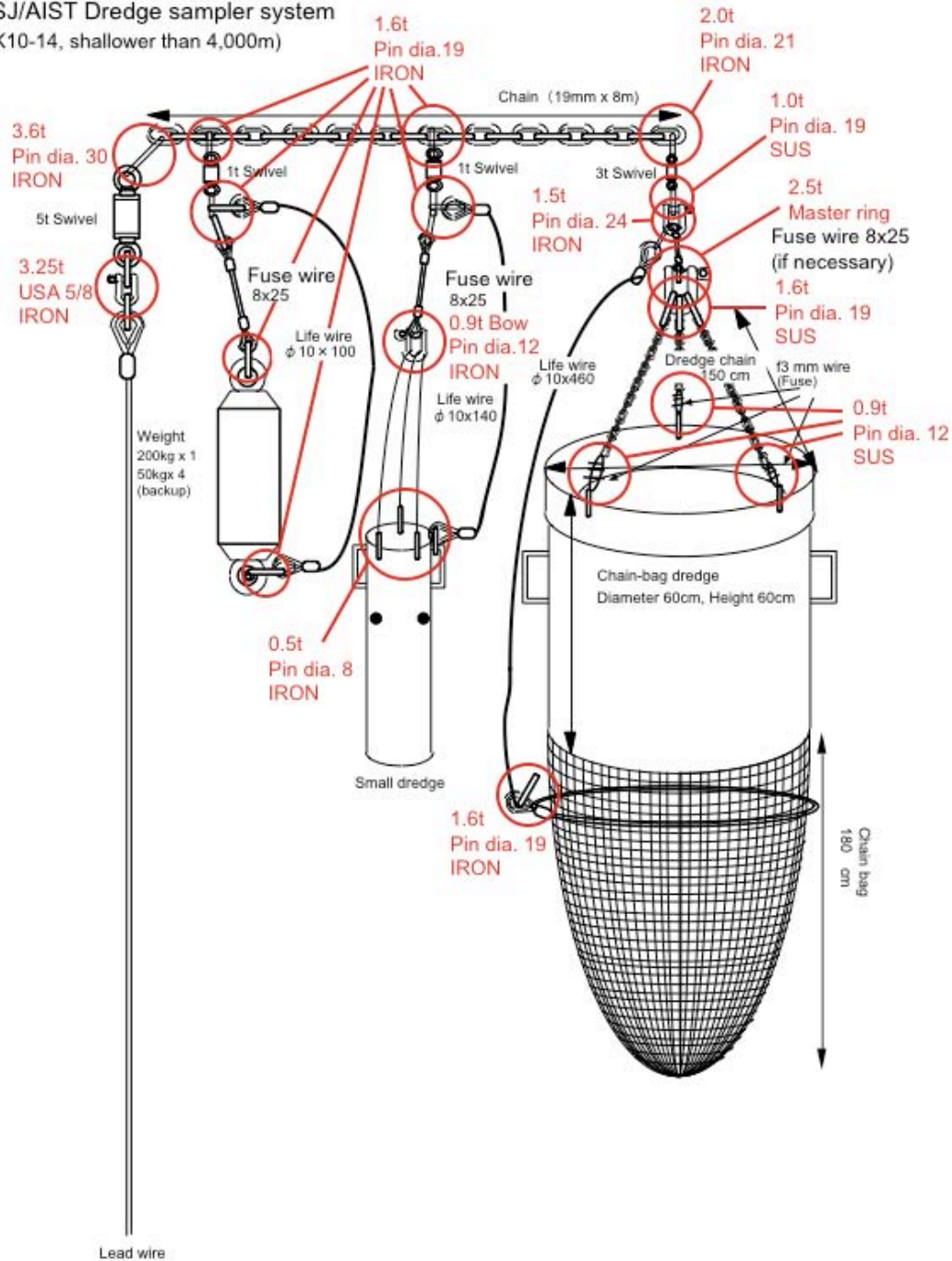


Fig. 3-2 The dredge sampler system (in case of water depth is less than 4,000m)

Winch wire: The diameter of the winch wire is 12mm and the weight in the water is 0.511kg per m. The breaking-load shows 12.1t. In this cruise, the No.5 winch of JAMSTEC was used.

Lead wire: This wire was put between the winch wire and the chain, and it was connected by shackles (3.15t) and swivel (5t). To tow a dredge on the seafloor, it was used for the protection of the winch wire. The diameter is 12mm (10mm diameter is used in case of the water depth which exceeds 4,000m) and the length is 200m.

Chain: In this cruise, it was used with 19mm diameter, 3m length. It was connected the upper part to lead wire by the shackle of SC24 and swivel (5t) and it connected the lower part to the fuse wire by the shackle of SC16 and swivel (3t).

Weight (200kg): In this cruise, one sinker (200kg) was used. It was connected the upper part to the fuse wire by the bow shackle of 0.9 t and swivel (1t) and it was put the upper part in the chain. The life wire (1m) was connected at the bottom end of the sinker, and the upper end was connected to become parallel to the fuse wire.

Pipe dredge: The pipe dredge is used as the back-up of the dredge main unit. The life wire was connected the shackles, the swivel, like way of the sinker. The length of the life wire is 1.4m.

Life wire (main dredge): The life wire to put in the dredge main unit is 4.6m long. The upper part was connected to become parallel to the fuse wire and the lower part was connected with the interstitial-segment of the chain bag. When the fuse wire breaks by the big tension or the anchoring on the seafloor, it will work to recover a dredge main unit and rock samples.

Fuse wire: The fuse wire has a role of the fuse when it is broken by big tension of towing or anchoring on the seafloor. It is used in the purpose to prevent damaging the winch wire. The length is 0.25 m.

Chain-bag dredge: The circular cylinder type dredge consists of three chains for up lifting (1.5m), the pipe part (0.6m inner diameter, the 0.6m length), the chain bag part (1.8m length). The upper part is connected to the fuse wire.

Each wire of the fuse, the life, the lead is decided by the regulation of JAMSTEC to change a diameter to protect a winch wire, making 4,000 m water depth a border. Each wire of diameters 6, 8, 10mm is used in over 4,000m and each wire of diameters 8, 10, 12 mm is used in 4,000m shallower. For the details of each wire, it is shown below.

Diameter	Breaking Force
6mm	1.81t
8mm	3.22t
10mm	5.03t
12mm	7.24t

3.2. Summary of each dredge haul

12 dredge hauls were made during YK10-14 cruise. Sampling targets are: 1) oceanic crust of Palau Basin exposed along Mindanao Fracture Zone. 2) oceanic crust of oldest part of West Philippine Basin. 3) volcanic structure within the Palau Basin. 4) Basement of Southern Kyushu-Palau Ridge. Locations of all dredge hauls are shown in Fig. 3-3. Summary of each dredge haul is described below. List of dredge hauls, comprehensive sample list and sample photographs are attached at the end of this chapter.

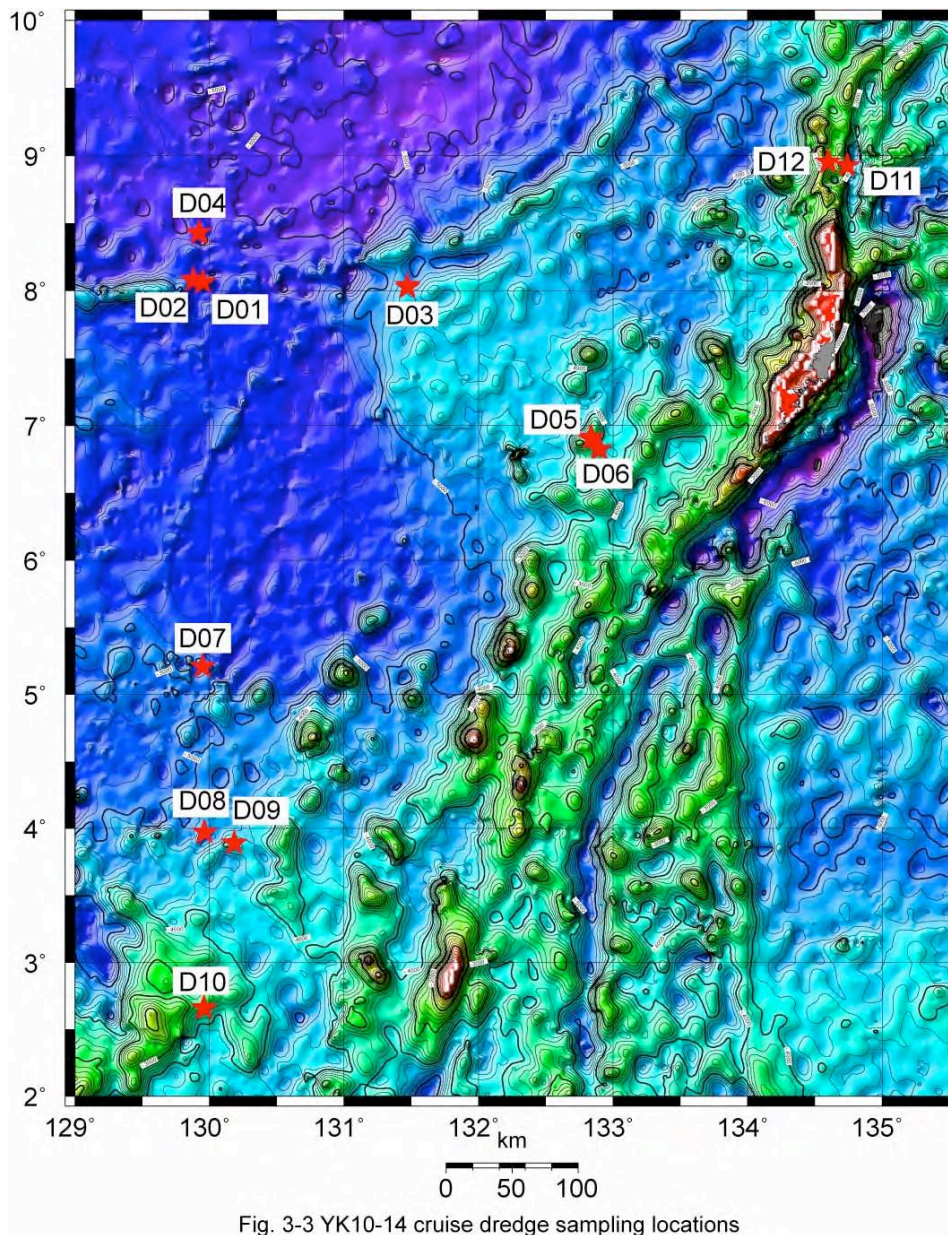
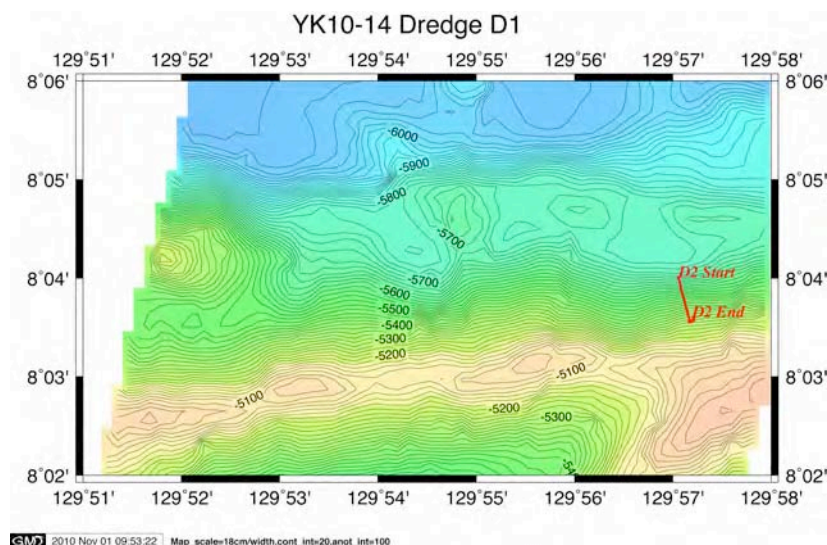


Fig. 3-3 YK10-14 cruise dredge sampling locations

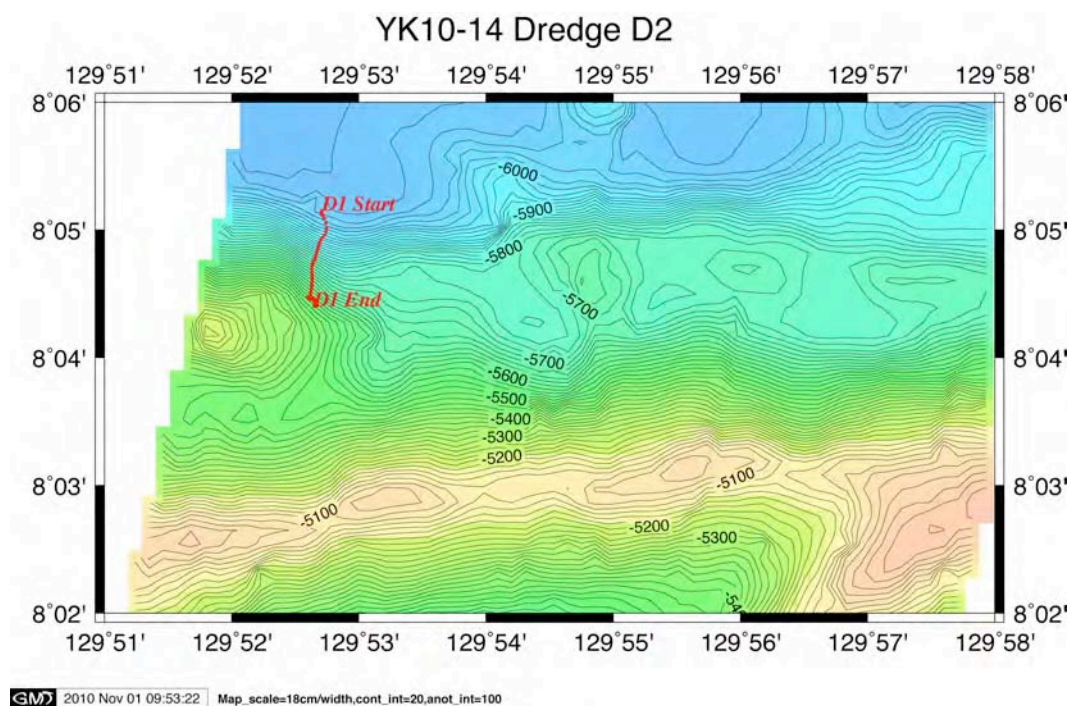
D01 (October 29, 2010): Southern margin of Mindanao Fracture Zone (Palau Basin)

Summary: Southern cliff of the Mindanao Fracture Zone, where the basement of Palau Basin is expected to be exposed, was the target of D01. The dredge landed and started from water depth of 5685 m and finished at 5120 m. We could collect only small amount of rock fragments and sediment (S01, brownish gray mud) in a small dredge by this operation. The total amount of samples is ~150 g. Small fragments, each of them is less than 30 g, are numbered from R01 to R06. Three of them (R01, R03 and R06) are dolerite, two (R02 and R04) are basalt and one (R05) is breccia. Dolerite consists of ~70 % of altered olivine, ~30 % of plagioclase and rare clinopyroxene. Basalt contains pyroxene, olivine and plagioclase in an ascending order of volume.



D02 (October 29, 2010): Southern margin of Mindanao Fracture Zone (Palau Basin)

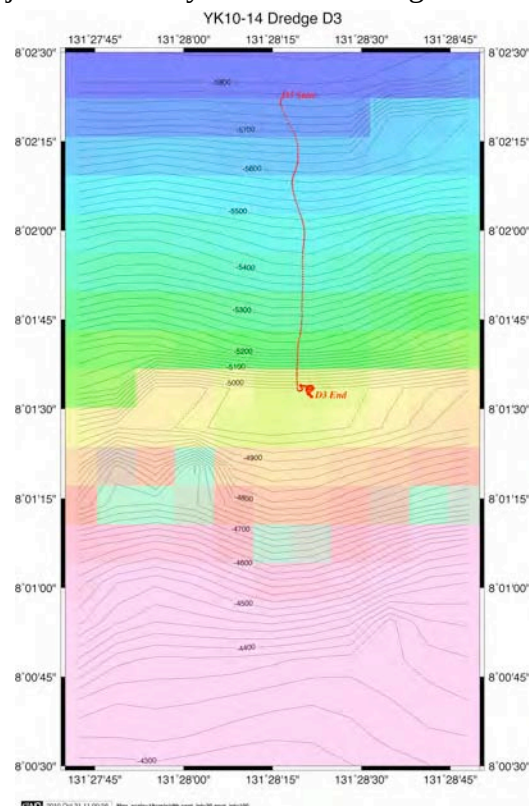
Summary: Southern cliff of the Mindanao Fracture Zone, which is deeper and 10 km west of D01, was the target of D02. The dredge landed and started from water depth of 6132 m and finished at 5541 m. We collected a fragment of pillow basalt (D01) having glassy rind. Others are fragments of manganese oxide. The total amount of samples is ~1 kg and R-01 weighs 600 g. Basalt of R-01 is fine-grained and contains olivine, pyroxene and plagioclase in an ascending order of volume.



D03 (October 30, 2010): Southern margin of Mindanao Fracture Zone (Palau Basin)

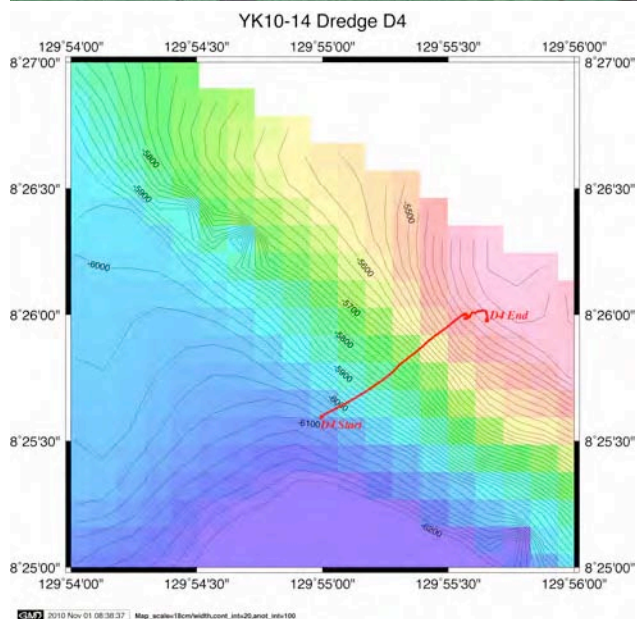
Summary: The target of D03 is also the southern cliff of the Mindanao Fracture Zone, which is similar to those of D01 and D02 in terms of the depth of the valley, but the top of the cliff is much shallower than the previous dredges, thus the cliff is ~1400 m high. The dredge landed and started from water depth of 5795 m and finished at 5119 m because of the break of the fuse wire of the main dredger, which is caused by the excess tension of more than 2 tons. In spite of this break, we recovered about 60 kg of rocks from the chain bag of the dredger, which was saved by the life wire.

Most rocks are fragments of pillow basalts and some have beautiful glassy rinds. One dolerite (R11) was recovered. Basalts lavas are classified into olivine basalt, olivine-plagioclase basalt, plagioclase-basalt and aphyric basalt. There might be some olivine-pyroxene basalt, but phenocrysts of clinopyroxene are much fewer than those of plagioclase and olivine. Thus, these basalts might not be derived from arc volcanoes, which are more hydrous and thus contain quite a few amount of clinopyroxene. Manganese oxides are rare and all rocks were just covered by film of the manganese.



D04 (October 31, 2010): Southernmost part of West Philippine Basin

Summary: The dredge D04 was designed to recover rocks from the southern and oldest part of the West Philippine Basin (WPB), which records the beginning magmatism of the WPB. One of abyssal hills dissected by NW-SE trending fault was dredged from the water depth of 6063 m to 5353 m. There were nine significant bites at the bottom of the hill and we recovered about 20 kg of aphyric basalt. Most rocks are fragments of aphyric pillow basalts. They also occur as clast of breccia with matrix composed of calcareous (?) sediment and Mn-oxides. One fragment is dolerite. Manganese oxides crusts were also abundant in volume. All basalts lavas are classified as aphyric basalt, containing <1% of olivine and plagioclase phenocrysts.

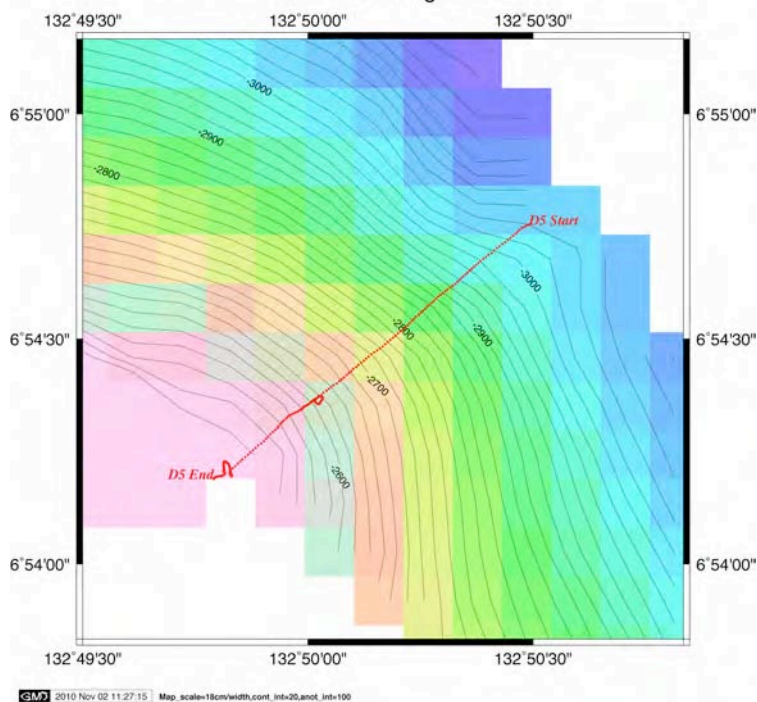


D05 (November 1, 2010): Eastern Palau Basin seamounts

Summary: There are many seamounts in the eastern part of the Palau Basin, which might be ancient rear arc volcanoes. One of conical seamounts at 6°54' N, 132°49'E was a target of D05. The dredge started at water depth of 3044 m along a ridge on the NE flank of the seamount and finished at the depth of 2394 m. There were several bites during this dredge, but unfortunately only sand was recovered and no materials from the volcano were obtained.

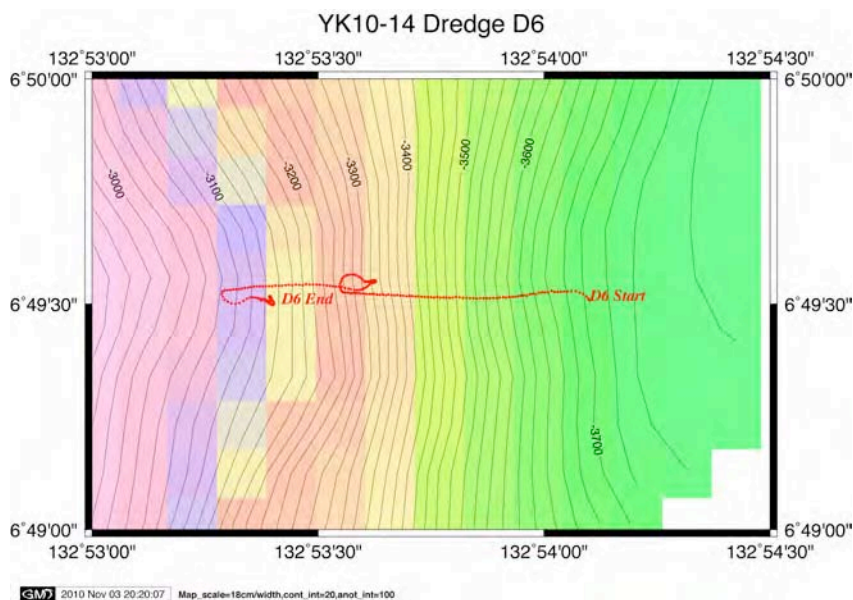


YK10-14 Dredge D5



D06 (November 1, 2010): Eastern Palau Basin seamounts

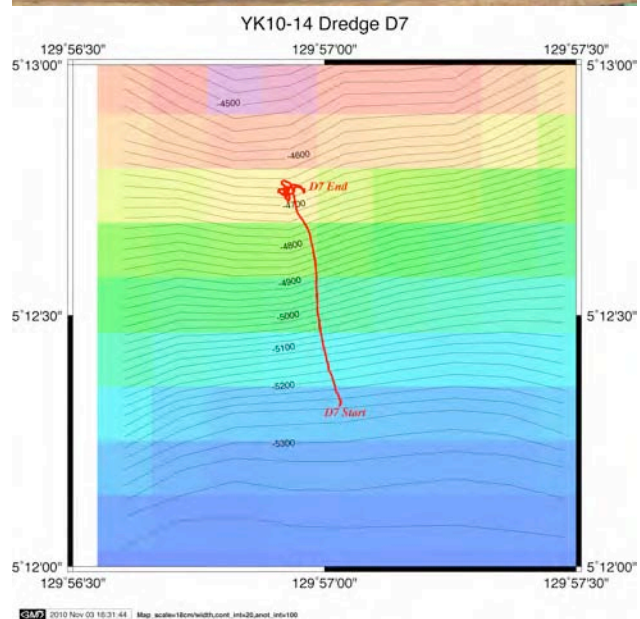
Summary: The target of D06 was another small volcano southeast of the seamount dredged by D05. This volcano has a fault cliff at the SE flank and D06 was designed to recover rocks from this fault cliff. The dredge has landed at the water depth of 3719 m and left the bottom at 3100 m. Unfortunately, two pumice fragments and some manganese oxides were recovered but no rocks from the volcano were obtained.



D07 (November 3, 2010): WNW-ESE trending fracture zone in the central Palau Basin

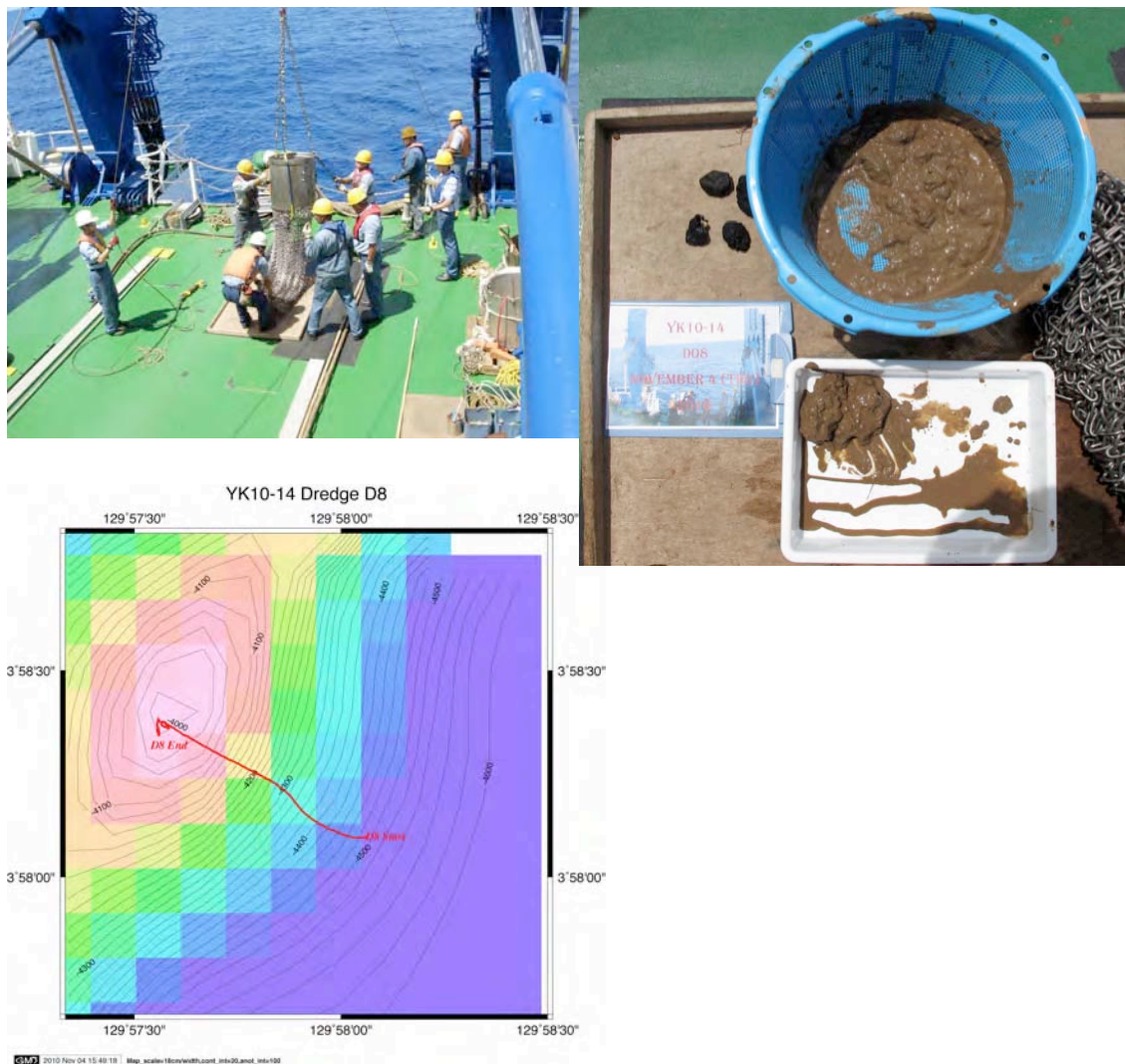
Summary: There is a strange WNW-ESE fault trough or rift in the Palau basin, which extends more than 160 km. The northern cliff of the fault trough ($5^{\circ}12.5' \text{ N}$, $129^{\circ}57' \text{ E}$) from $\sim 5200 \text{ m}$ to $\sim 4800 \text{ m}$ below the surface of the sea was targeted by the dredge D07.

We have recovered about 40 kg of basalt breccia. Most lava breccias have thick crust of Mn oxides, but glassy rinds have been observed in several samples. Most rocks are fairly vesiculated (10-20 % vesicles) and three types of rocks are recognized by loupe. The most abundant type is olivine basalt, which contain about $\sim 5\text{-}10 \text{ vol. } \%$ of olivine and 10-20 % vesicles). There are several aphyric basalts, which are more vesiculated ($\sim 30 \%$) than the olivine basalt. One out of 22 total samples is plagioclase-pyroxene basalt, which seems to be the most differentiated sample in this dredge.



D08 (November 4 2010): NE-SW trending ridge in the southern Palau Basin

Summary: In the southern Palau Basin, there are many NE-SW trending ridges, which origin is not understood very well. The trends of abyssal hills in the northern part of the Palau basin are almost N-S, thus these southern ridges stand obliquely to the abyssal hills. One of these southern ridges ($3^{\circ} 58.5' \text{ N}$, $129^{\circ} 57.5' \text{ E}$) is the target of D08. The dredge scratched the SE cliff of the ridge from 4479 to ~ 4100 m depth of the water. There was only one weak bite, but we collected about 200 g of rocks, which will show us the origin of the ridge. These are clinopyroxene-olivine-plagioclase basalts with $\sim 10\%$ of vesicles. Unlike the previous dredges, we can observe clinopyroxene phenocrysts in the rocks of this ridge. Palau Basin abyssal hill basalts were free of clinopyroxene so far.



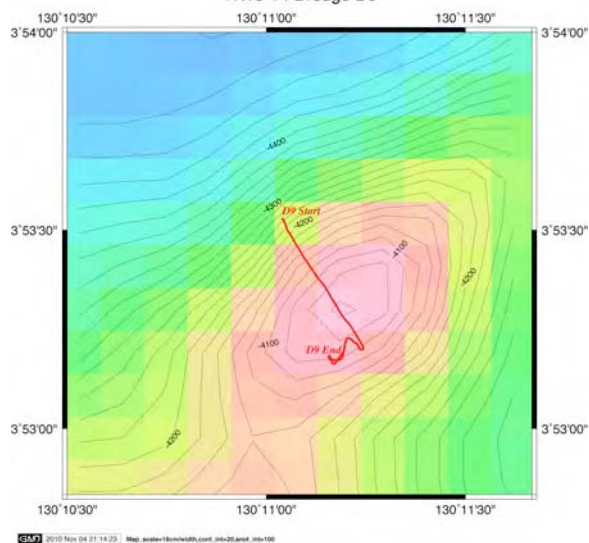
D09 (November 4 2010): broad high including NE-SW trending ridge in the southern Palau Basin

Summary: This site is a topographic high, which is about 12 miles east of D08 and have three NE-SW trending ridges. Thus the topographic characteristics of this area are similar to the previous dredge area and the objectives are also the same with those of D08 to recover rocks of these ridges.

The dredge scratched the NW cliff of the ridge from 4300 to ~4000 m depth of the water, and the dredge left the bottom almost at the top of the ridge. There was only one weak bite, but we collected about 3 kg of rocks, most of them are mudstone and Mn oxides. There was one cpx-olivine-plagioclase basalt fragment with ~10 % of vesicles in the small dredge. This basalt is similar to the basalts collected in D08.



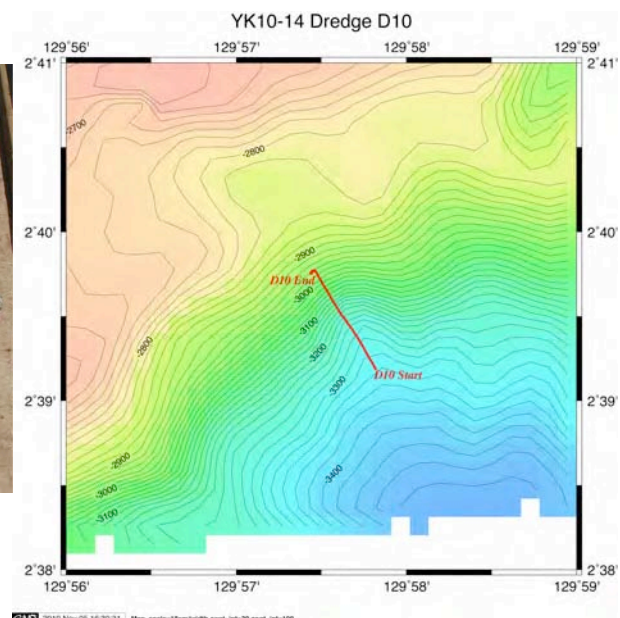
YK10-14 Dredge D9



D10 (November 5 2010): broad high in the southernmost part of Palau Basin

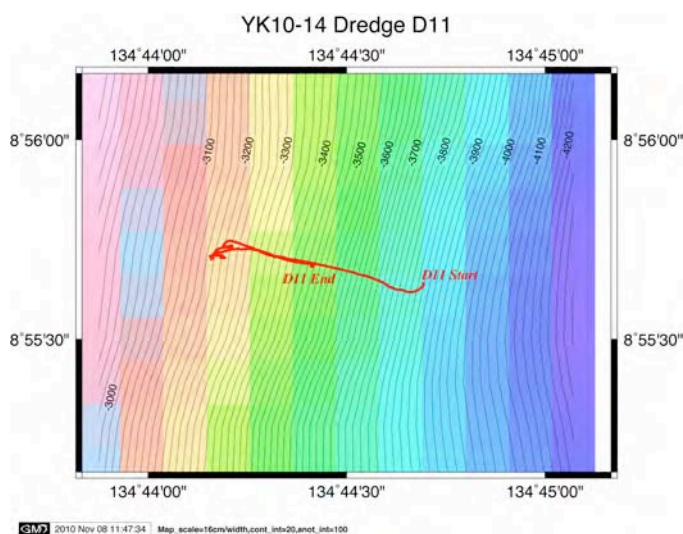
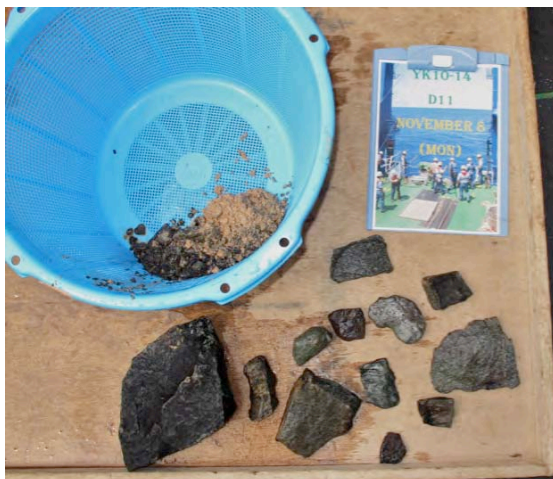
Summary: The southern end of the Palau Basin shows a complex topography and much shallower water depths than the northern part. D11 (2°39.5 N, 129°57.5 E) was aimed at a cliff of one of dissected gorges of a broad topographic high of the southern end of the Palau Basin.

The dredge scratched the SE cliff of the gorge from 3340 to ~3000 m depth of the water. There were many small bites, and we collected about 20 kg of rocks, about half of them are tuff breccia and another half is mud cakes. The tuff breccia consists of pumice, lithic fragments and crystals, and it looks very similar to tuff breccia of the Shirahama Group, Izu Peninsula, Japan, which have been emplaced at the bottom of the sea by the submarine eruption. One of characteristics of subaqueous pyroclastic deposits is that fines (fine-sized ash) are depleted in their matrixes. We also recovered the similar rocks from the Izu-Bonin arc by dredging the eastern cliff of the Sumisu rift. Pumices in the tuff breccia could be andesitic to dacitic in composition, which shows a sharp contrast with basin basalts recovered from previous dredges. The tuff breccia can be the product of a submarine eruption of arc volcano, which could have existed nearby and have been lost by erosion.



D11 (November 8 2010): Eastern slope of eastern Kyushu-Palau Ridge

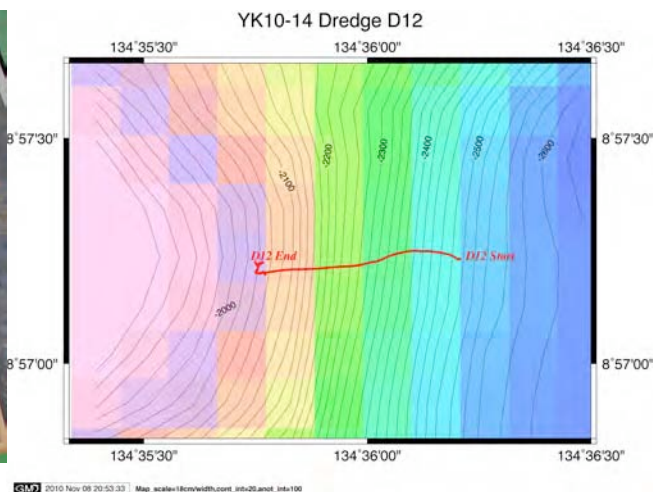
Summary: The site of dredge D11 ($8^{\circ}55.7'N$, $134^{\circ}44.5'E$) is the eastern cliff of the southern part of the Kyushu-Palau ridge, where previous dredges by Russian cruise have recovered hornblende gabbros, diorite, granite and metamorphic rocks nearby (Evlanov et al., 1978). The dredge started from the water depth of 3800 m. We had several good bites but the dredge was got hung up. By controlling the ship direction and the dredge wire length, finally we have recovered $\sim 10\text{kg}$ of rocks, consisting of hornblende schist, hornblende-plagioclase schist, amphibolites and siliceous schist. These rocks seem to have derived from the lower crust of the Kyushu-Palau ridge. There were no volcanic rocks in this site, which means that this ridge itself is not the volcanic ridge or that the upper part of the ridge might be composed of volcanic rocks. The next dredge D12 targets the ridge, just seven miles west of this ridge, which might give us some answer to this question.



D12 (November 8 2010): Eastern slope of Kyushu-Palau Ridge

Summary: The dredge D12 was aimed at the eastern cliff of the Kyushu-Palau ridge, which is seven miles west of the D12 site. The dredge started from 8°57.2'N, 134°36.2'E at the water depth of 2500 m and was hauled toward west until 134°35.8'E at the water depth of 2100 m. We have recovered about 55 kg of rocks and 1.5 kg of foraminifera sand.

Most rocks are crystal-rich volcanic sandstone and fine volcanic siltstone. Lapilli tuff, which contains pieces of lapilli-sized volcanic glasses in the matrix of volcanic sandstone, was also recovered. Thin turbidite layers are observed in some volcanic siltstones. Both sandstone and siltstone are well-sorted and when they coexist in one specimen, the boundary is very clear, suggesting sorting by water column. These rocks seem to have deposited on the flank of submarine volcano, which is one of arc volcanoes of the Oligocene Kyushu-Palau arc (ridge). The previous dredge recovered the basement of Kyushu-Palau ridge and this dredge recovered the volcanic deposit of Kyushu-Palau ridge. Thus this ridge is the extension of the Oligocene Kyushu-Palau ridge and the east ridge seems to be the forearc basement high when Kyushu-Palau ridge was active arc volcanoes.



YK10-14 dredge station list

Date	St. No.	SP/EP	Time(JST)	Depth(m)	lat.	lon.	wireout (m)	Max. tension (kN)	dir.(deg)	speed(kN)	dredger	remarks
2010.10.29	D01	on bottom	9:46	5759	08-04.0107N	129-57.0572E	5644	41	169	1.0	chain-bag	crack on lead wire lock
		off bottom	10:59	5330	08-03.6047N	129-57.1981E	5120					
	D02	on bottom	17:28	6132	08-05.1492N	129-52.7107E	6057	42	194	1.0	chain-bag	
		off bottom	19:20	5541	08-04.3995N	129-52.6430E	5600					
2010.10.30	D03	on bottom	11:50	5795	08-02.3716N	131-28.2768E	5737	53	176	1.0	chain-bag	fuse wire broken
		off bottom	14:17	5119	08-01.5397N	131-28.3512E	4975					
2010.10.31	D04	on bottom	10:28	6063	08-25.5972N	129-54.9933E	6030	42	55	1.0	chain-bag	
		off bottom	12:50	5353	08-25.9814N	129-55.6564E	5241					
2010.11.1	D05	on bottom	8:51	3044	06-54.7534N	132-50.4903E	2910	42	231	1.0	chain-bag	
		off bottom	10:52	2394	06-54.1887N	132-49.7921E	2318					
	D06	on bottom	14:29	3719	06-49.5063N	132-54.1019E	3580	36	270	1.0	chain-bag	
		off bottom	16:35	3100	06-49.5127N	132-53.3773E	3036					
2010.11.3	D07	on bottom	10:22	5265	05-12.3209N	129-57.0299E	5200	46	330	1.0	chain-bag	
		off bottom	12:49	4610	05-12.7366N	129-56.9231E	4600					
2010.11.4	D08	on bottom	9:04	4483	03-58.0980N	129-58.0642E	4370	30	304	1.0	chain-bag	
		off bottom	10:39	3964	03-58.3583N	129-57.5560E	3881					
	D09	on bottom	15:33	4202	03-53.5288N	130-11.0404E	4200	30	144	1.0	chain-bag	
		off bottom	16:55	4036	03-53.1986N	130-11.1983E	3836					
2010.11.5	D10	on bottom	9:10	3339	02-39.1876N	129-57.8179E	3210	27	290	1.0	chain-bag	
		off bottom	10:45	2965	02-39.7704N	129-57.4530E	2825					
2010.11.8	D11	on bottom	8:32	3828	08-55.6404N	134-44.6824E	3705	53	285	1.0	chain-bag	
		off bottom	10:54	3381	08-55.6814N	134-44.4159E	3305					
	D12	on bottom	14:28	2493	08-57.2317N	134-36.2068E	2337	26	260	1.0	chain-bag	
		off bottom	15:39	2004	08-57.2266N	134-35.7483E	1910					

YK10-14 Dredge sample list

YK10-14 D01 2010.10.29 Lat.: 8°N4.0107' Lon.: 129°E57.0572' depth: 5685m

sample No.	rock type	shape	size X (cm)	size Y (cm)	size Z (cm)	weight	colour	alteration	surface	Mn coating	igneous texture	glass (mm)	pheno %	% of each pheno	vesiculation	weathering	Memo
R01	dolerite	angular	5	2.5	2.5	<0.1	brownish gray	altered		0			ol, px, pl	ol: 70, px: +, pl: 30	weakly		
R02	basalt	rounded	3	2.5	1.7	<0.1	grayish brown	altered		3			ol, px, pl	ol: 3, px: 2, pl: 15	0		chilled margin, xenocryst: pl, px
R03	dolerite	rounded	3	1.9	1.5	<0.1	brownish gray	altered		3-5			ol, px, pl	ol: 70, px: +, pl: 30	weakly		
R04	basalt	rounded	2.5	2.5	1.5	<0.1	grayish brown	altered		film			ol, px, pl	ol: 3, px: 5, pl: 30	0		
R05	breccia	sub-rounded	3.5	2	1	<0.1	brown	altered		film							
R06	dolerite	sub-rounded	2	1	0.8	<0.1	brownish gray	altered		film			ol, px, pl	ol: 70, px: +, pl: 30	0		
S01	mud					<0.1	brownish gray										

YK10-14 D02 2010.10.29 Lat.: 8°N5.1492' Lon.: 129°E52.7107' depth: 6132m

sample No.	rock type	shape	size X (cm)	size Y (cm)	size Z (cm)	weight	colour	alteration	surface	Mn coating	igneous texture	glass (mm)	pheno %	% of each pheno	vesiculation	weathering	Memo
R01	basalt	sub-angular	15	7.5	6	0.6	dark gray	moderate		0-3			ol, cpx, pl	pl: 20, ol: 3, cpx: 10			glass
R02	Mn-oxide phosphate	sub-angular	10	8	7	0.4											conglomerate include Mn-crust
R03	Mn-oxide	sub-angular	5.8	4	1.5	0.1	black										
R04	Mn-oxide	sub-rounded	5.5	3.8	1.5	<0.1	black										
R05	Mn-oxide	sub-angular	5.2	2	0.5	<0.1	black										
R06	Mn-oxide	sub-angular	3	2	0.5	<0.1	black										
R07	Mn-oxide	sub-angular	3	3	1.5	<0.1	black										
R08	Mn-oxide	rounded	2.6	1.8	0.6	<0.1	black										
R09	Mn-oxide	sub-rounded	2.5	2.5	0.6	<0.1	black										
R10	Mn-oxide	sub-rounded	2.1	2	0.8	<0.1	black										
R11	Mn-oxide	rounded	1.6	1.5	0.9	<0.1	black										
R12	Mn-oxide	sub-rounded	2.3	1.4	0.5	<0.1	black										
S01	mud					<0.1											

YK10-14 D03 2010.10.30 Lat.: 8°N2.3716' Lon.: 131°E28.2768' depth: 5795m

sample No.	rock type	shape	size X (cm)	size Y (cm)	size Z (cm)	weight	colour	alteration	surface	Mn coating	igneous texture	glass (mm)	pheno %	% of each pheno	vesiculation	weathering	Memo
R01	ol basalt	angular	29	22	20	6.7	gray	weakly		film	phyric	15	ol	ol: 10	1	weak	chilled margin with glass
R02	ol-px basalt	sub-angular	24	14	10	4.5	dark gray	moderate		film	phyric		ol, cpx, opx	ol: 10, cpx: 10, opx: 10	0	weak	
R03	ol-pl basalt	sub-rounded	19	19	14	3.7	yellowish gray	moderate		film	porphyritic	10	pl, ol	pl: 30, ol: 5		moderate	chilled margin
R04	ol basalt	angular	20	15	9	2.9	gray	moderate		film	aphyric	5	ol	ol: 1	1	weak	chilled margin contact to hyaloclastite
R05	aphyric basalt	sub-rounded	12	11	11	2	gray	moderate		film	aphyric		pl	pl: 1	1	weak	
R06	ol basalt	angular	20	15	8	2.1	brownish gray	moderate		film	aphyric	13	ol	ol: 1	1	weak	a pair of chilled margins
R07	basalt	angular	18	13	7	1.6	gray	moderate		film	aphyric		ol	ol: 1	0	weak	shiny glass
R08	ol-px basalt	sub-angular	15	13	8	2	dark gray	moderate		film	phyric	3	ol, cpx, opx	ol: 10, cpx: 10, opx: 10	1	weak	thin chilled margin
R09	aphyric basalt	sub-angular	12	11	6	1	gray	moderate		film	aphyric						
R10	ol-pl basalt	sub-angular	12	12	8	1.5	gray	moderate		film	phyric		pl, ol	pl: 20, ol: 10	0	weak	
R11	dolerite	sub-angular	10	10	8	1.1	brownish gray	moderate		film			pl, ol	pl: 50, ol: 50		weak	
R12	aphyric basalt	sub-angular	12	8	7	1.1	gray	moderate		film	aphyric				10	weak	
R13	ol-pl basalt	angular	16	12	5	1.1	gray	moderate		film	phyric		pl, ol	pl: 20, ol: 10		weak	
R14	porphyritic basalt	sub-angular	9	9	8	0.8	gray	moderate		film	porphyritic		pl, ol	pl: 5, ol: 2		weak	
R15	ol-pl basalt	sub-angular	12	11	8	1	gray	moderate		film	phyric		pl, ol	pl: 20, ol: 10		weak	
R16	pl basalt	sub-angular	12	10	6	0.8	brownish gray	higher		film	phyric		pl	pl: 15	1	weak	coarse-grained pl
R17	porphyritic basalt	angular	11	9	5	0.8	gray	moderate		film	porphyritic		pl, ol, cpx, opx	pl: 5, ol: 2, cpx: +, opx: +		weak	
R18	aphyric basalt	sub-rounded	12	7	5	0.8	gray	moderate	smooth	film	aphyric		pl	pl: 1		weak	
R19	ol-pl basalt	sub-rounded	9	8	6	0.7	brownish gray	moderate	smooth	film	phyric		pl, ol	pl: 20, ol: 10		weak	
R20	aphyric basalt	sub-angular	11	7	7	0.6	brownish gray	higher		film	aphyric						
R21	porphyritic basalt	sub-angular	9	7	5	0.6	gray	moderate		film	porphyritic		pl, ol	pl: 5, ol: 2		weak	black layer
R22	aphyric basalt	sub-rounded	10	9	8	0.6	gray	moderate	smooth	film	aphyric		pl	pl: 1		weak	
R23	aphyric basalt	angular	10	9	6	0.6	gray	moderate		film	aphyric	13			10	weak	chilled margin contact to hyaloclastite
R24	aphyric basalt	sub-angular	10	9	5	0.5	gray	moderate		film	aphyric	10			10	weak	chilled margin contact to hyaloclastite
R25	hyaloclastite	angular	12	8	3	0.4		moderate		film						weak	matrix: phosphate(white) altered clast: green(aphyric basalt)
R26	aphyric basalt	angular	10	7	4	0.3	gray	moderate		film	aphyric	15			5	weak	chilled margin contact to hyaloclastite
R27	aphyric basalt	sub-rounded	4	3	3	0.05	gray	moderate		film	aphyric	8			5	weak	chilled margin contact to hyaloclastite
R28	aphyric basalt	sub-rounded	4	2	2	0.03	gray	moderate			aphyric	6				weak	chilled margin contact to hyaloclastite
others						0.5											

YK10-14 D04		2010.10.31 Lat.: 8°N25.5972'			Lon.: 129°E54.9933'		depth: 6063m										
sample No.	rock type	shape	size X (cm)	size Y (cm)	size Z (cm)	weight	colour	alteration	surface	Mn coating	igneous texture	glass (mm)	pheno %	% of each pheno	vesiculation	weathering	Memo
R01	basalt breccia	sub-rounded	51	27	13	5.5	gray	moderate		15-60	aphyric		pl, ol	pl: 1, ol: 1		weak	sub-rounded mud matrix & aphyric basalt clast
R02	Mn-oxide	sub-angular	27	18	17	5.1	black										
R03	Mn-oxide	sub-angular	16	10	8	0.9	black										
R04	aphyric basalt	angular	12	8	6	0.55	brownish gray	higher		1	aphyric					weak	
R05	aphyric basalt breccia	sub-angular	12	8	6	0.6	gray	moderate		5-35	aphyric		pl, ol	pl: 1, ol: 1		weak	
R06	aphyric basalt	sub-angular	10	7	5	0.3	brownish green	higher		10	aphyric					weak	
R07	aphyric basalt	angular	9	6	3	0.3	gray	moderate	smooth	film	aphyric		ol	ol: +		weak	
R08	aphyric basalt	sub-angular	10.5	5	5.5	0.3	brownish gray	higher		5	aphyric					weak	
R09	aphyric basalt	angular	8	4.5	4.5	0.3	gray	moderate	smooth	film	aphyric		pl, ol	pl: 0.5 ol: 1		weak	
R10	aphyric basalt	angular	8	5	4	0.3	gray	moderate	smooth	film	aphyric		pl, ol	pl: 0.5 ol: 1		weak	
R11	aphyric basalt	sub-angular	8	6.5	3	0.2	brownish gray	higher		10	aphyric					weak	
R12	aphyric basalt	angular	6.5	4.5	3.5	0.15	brownish gray	higher	smooth	film	aphyric		pl, ol	pl: 1, ol: 1		weak	
R13	aphyric basalt	angular	8	5	4	0.2	gray	moderate	smooth	1	aphyric		pl, ol	pl: 1, ol: 1		weak	
R14	aphyric basalt	sub-angular	13	9	8	0.6	gray	moderate		10	aphyric		pl, ol	pl: +, ol: 2		weak	basalt enclosed Mn-oxide
R15	aphyric basalt breccia	sub-rounded	13	8	7	0.5	gray	moderate		20	aphyric		pl, ol	pl: 1, ol: 1		weak	
R16	aphyric basalt	angular	6	5	4	0.2	brownish gray	moderate	smooth	film	aphyric		pl, ol	pl: 1, ol: 1		weak	
R17	aphyric basalt	angular	8	5.5	3.5	0.2	brownish gray	higher		1	aphyric					weak	
R18	aphyric basalt	angular	7	5	4	0.15	brownish gray	higher		film	aphyric					weak	
R19	aphyric basalt	sub-angular	6.5	6	4	0.2	brownish gray	moderate		15	aphyric	8	pl, ol	pl: 0.5, ol: 0.5		weak	
R20	dolerite	angular	5.5	5	3	0.1	yellowish gray	moderate		2			pl, cpx	pl: 50, cpx: 50		weak	
R21	aphyric basalt	sub-angular	6	4.5	4.5	0.1	brownish gray	higher		40	aphyric	4				weak	two basalt clasts enclosed Mn-oxide
R22	Mn-oxide	sub-rounded	16	8	7	0.5	black										small mud pieces enclosed Mn-oxide
R23	Mn-oxide	sub-angular	13.5	10	4	0.5	black										
S01	mud					0.3											
others						0.5											
YK10-14 D05		2010.11.1 Lat.: 6°N54.7534'			Lon.: 132°E50.4903'		depth: 3044m										
sample No.	rock type	shape	size X (cm)	size Y (cm)	size Z (cm)	weight	colour	alteration	surface	Mn coating	igneous texture	glass (mm)	pheno %	% of each pheno	vesiculation	weathering	Memo
S01	sand (foraminifera)					0.3											
YK10-14 D06		2010.11.1 Lat.: 6°N49.5063'			Lon.: 132°E54.1019'		depth: 3719m										
sample No.	rock type	shape	size X (cm)	size Y (cm)	size Z (cm)	weight	colour	alteration	surface	Mn coating	igneous texture	glass (mm)	pheno %	% of each pheno	vesiculation	weathering	Memo
R01	pumice	rounded	9	8	5	0.2	light gray				aphyric		pl, cpx	pl: 2, cpx: +			qtz=1%
R02	carbonate - like rock	sub-rounded	7	5.5	4	0.1	cream			5							
R03	pumice	sub-rounded	6	4.5	3	0.05	light gray				aphyric		pl, cpx	pl: 2, cpx: +			qtz=1%
R04	Mn-oxide	sub-rounded	16	9.5	2.5	0.4	black										
R05	agate	sub-angular	13.5	2.5	2	<0.01				film	aphyric						core is gray, rim is yellow
R06	agate	sub-angular	3	1.5	1	-				film	aphyric						
R07	Mn	angular	6.5	3.5	0.5	-	black										
S01	sand					0.3											
Others						0.5											

[illegible]

YK10-14 D12		2010.11.8 Lat.: 8°N57.2317'			Lon.: 134°E36.2068'		depth: 2493m										
sample No.	rock type	shape	size X (cm)	size Y (cm)	size Z (cm)	weight	colour	alteration	surface	Mn coating	igneous texture	glass (mm)	pheno %	% of each pheno	vesiculation	weathering	Memo
R01	volcanic sand stone	angular	35	25	14	10.5	greenish gray			film							
R02	silt stone (tuff)	angular	26	20	16	9.6				film							
R03	lapilli tuff	angular	19	18	14	3.6				film							altered glass pieces
R04	tuff	angular	18	13	10	2.5				2							volcanic, sand & tuff
R05	volcanic sand stone	angular	14	14	11	2.8				film							
R06	volcanic sand stone	angular	17	13	12	2.1				6							
R07	volcanic sand stone	angular	13	12	10	1.6				11							volcanic sand stone with silt stone
R08	volcanic sand stone	angular	23	13	10	2				4							
R09	silt stone	angular	25	15	8	1.3				film							
R10	silt stone	angular	19	9	8	1.5				5							
R11	silt stone	angular	20	10	9	1.9				film							silt stone with volcanic sand stone
R12	silt stone	angular	22	19	5	2.7				film							
R13	volcanic sand stone	angular	12	7	7	1.1				film							a many volcanic rock pieces in volcanic sand stone
R14	volcanic sand stone	angular	16	10	8	1				5							
R15	volcanic sand stone	sub-angular	10	8	8	0.9				film							
R16	volcanic sand stone	angular	15	14	8	1.1				39							turbidite-like layerring
R17	volcanic sand stone	angular	19	12	9	1.3				2							
R18	volcanic sand stone	angular	16	11	5	0.8				film							
R19	volcanic sand stone	angular	21	14.5	10	2				6							
R20	volcanic sand stone	angular	10.5	8	6.5	0.5				4							
R21	lapilli tuff	sub-angular	10	9	5.5	0.5				film							altered glass pieces
R22	silt stone	angular	12	10	6.5	0.8				film							
R23	lapilli tuff	angular	11	9	7	0.6				film							litic pieces
R24	volcanic sand stone	angular	7.5	7	3	0.25				film							
R25	volcanic sand stone	angular	9.5	6.5	4.5	0.15				12							
R26	volcanic sand stone	angular	9	8	7	0.5				2							
R27	volcanic sand stone	angular	13	9	6	0.6				film							
R28	lapilli tuff	sub-angular	10.5	8	6	0.4				film							
others	sand (foraminifera)					1.5											

4. Geophysical Survey

Geophysical survey including bathymetry, magnetic and gravity anomalies has been conducted during the YK10-14 cruise in the southern part of the West Philippine Basin and Palau Basin. This area remained almost unsurveyed up-to-date, but this is a key area for understanding configuration of the Philippine Sea Plate at the initiation of the Izu-Ogasawara (Bonin) Arc at ~50 Ma.

4.1. Instruments and measurements

A SeaBeam 2112 multi-narrow-beam echo-sounder (MBES) was used for bathymetry. Sound velocity correction was applied using XBT data. A shipboard gravity meter (Lacoste-Romberg Air-Sea S-63) was used for gravity measurement. Shipboard gravity meter reading on 21 Oct. 2010 at the JAMSTEC pier was 10861.1, which was tied to the absolute gravity value 979757.8 mgal.

For magnetic anomaly measurements, a towed proton magnetometer (PM-217, Kawasaki Geological Engineering & Tierra Technica) and two sets of onboard three-component magnetometers, a Tierra Technica SFG-1212 system equipped with R/V Yokosuka (called the Yokosuka system hereafter) and a STCM (Shipboard Three-Component Magnetometer) system of Kobe University type with a ring-laser gyro (the Kobe system hereafter), were used. The Kobe system (modified Tierra Technica SFG-1211) consists of a three-axes flux-gate magnetic sensor, a ring-laser gyro of Nihon Koku-densi Kogyo, a GPS unit, a controller, and a logging PC (Fig. 4-1). The sensor of the Kobe system was installed on the roof above the bridge, below the sensor of the Yokosuka system (Fig. 4-1). The Yokosuka system was recently (in January 2010) modified to import ship's altitude data from an OCTANS fiber-optical gyro equipped for the SeaBeam MBES system. When using the data, please note the magnetic sensor orientation; the +Y axis of the Yokosuka system orients starboard whereas the +Y axis of the Kobe system orients port. The orientations of the +X and +Z axes of the two systems are common: +X points the ship's stem and +Z is downward.

The geophysical mapping was conducted at ship's speeds of 12 to 15 knots according to sea conditions. The proton magnetometer was operated at sampling intervals of 20 seconds. Because of the malfunction of the proton magnetometer, its data were not obtained before the morning of 29 October. Due to severe noise, the raw data collected since the evening of 29 October requires editing and low-pass filtering before analyses, which will be conducted on land after the cruise. The data of the Kobe STCM system from the evening of 31 October to the morning of 1 November were lost by an accident. To remove the effect of ship's magnetization for the onboard three-component measurements, the "figure-8" turn was performed four times, and the results are summarized in Table 4-1. For calculating magnetic anomalies, the 11th generation IGRF was used.

4.2. Preliminary results

(1) Bathymetry

Swath bathymetry data obtained during this cruise are shown in Figure 4-2. Topographic fabric associated with seafloor spreading can be recognized in the southern part of the West Philippine Basin (WPB). The Mindanao Fracture Zone (MFZ) branches out into two or three scarps to the east of 130°E, and it is not clear where is the boundary between the WPB crust and Palau Basin crust. The Palau Basin south of MFZ is shallower than the WPB in general. The basin floor of the Palau Basin is almost flat, suggesting thick sediment cover. A trough of unknown origin runs WNW-ESE near 5°N, 130°E. The southern and eastern part of the Palau Basin is occupied by numerous seamounts.

(2) Magnetic anomaly

An example of the result of magnetic vector measurements in the Palau Basin is shown in Fig. 4-3.

In the east (+Y) component anomaly, there are discrepancies between the Kobe and Yokosuka systems at the beginning of the survey lines for several tens of minutes. It is estimated that there are some problems in the ship's heading data of the Yokosuka system. Probably the accuracy of ship's heading measurement of the Yokosuka system deteriorates at turnings of the ship and it takes some time for recovery.

Long-wavelength variations that are probably not related to seafloor magnetization are visible in particular in the north (+N) component. The cause of the variations includes viscous remanent magnetization of the ship, variations in ship's magnetic susceptibility and permanent magnetization with temperature (note that in low latitudes a large temperature difference between daytime and nighttime can be generated on the upper deck), and diurnal variations of the geomagnetic field caused by ionospheric currents, which can be significant in daytime in low latitudes. Ship's magnetization is usually assumed to be constant because it is difficult to evaluate precisely the time variations. We will apply a band-pass filter to extract magnetic anomalies of crustal origin as much as possible.

An example of magnetic total force anomaly measured with a proton magnetometer in the Palau Basin is shown in Fig. 4-4. Despite severe noise, an anomaly pattern is visible. The amplitude of total force anomaly (~100 nT) is smaller than that of three component anomalies (~300 nT), which indicates the advantage of the magnetic vector measurement.

Table 4-1 Summary of "figure-8" turns

No.	Date(UTC)	Start Time(UTC)	End Time(UTC)	Latitude	Longitude
1	2010.10.28	6:18	6:35	11°18.1'N	131°53.6'E
2	2010.10.31	7:15	7:32	8°28.0'N	129°49.7'E
3	2010.11.3	6:12	6:29	5°13.9'N	129°57.4'E
4	2010.11.4	22:14	22:30	2°37.5'N	129°59.4'E

Coordinates of B and H matrix calculated

Yokosuka system

B(1,*)	B(2,*)	B(3,*)	H(*)
1.08685	0.00205	-0.00041	-892.1
0.00361	1.21782	0.05978	5387.7
-0.00037	0.12878	0.88927	-5061.2

Kobe System

B(1,*)	B(2,*)	B(3,*)	H(*)
1.08571	0.01251	0.01639	-147.2
0.00506	1.28849	0.05510	5675.5
-0.01504	0.15379	0.90181	-5177.8



Fig. 4-1 Kobe University type shipboard three-component magnetometer system.

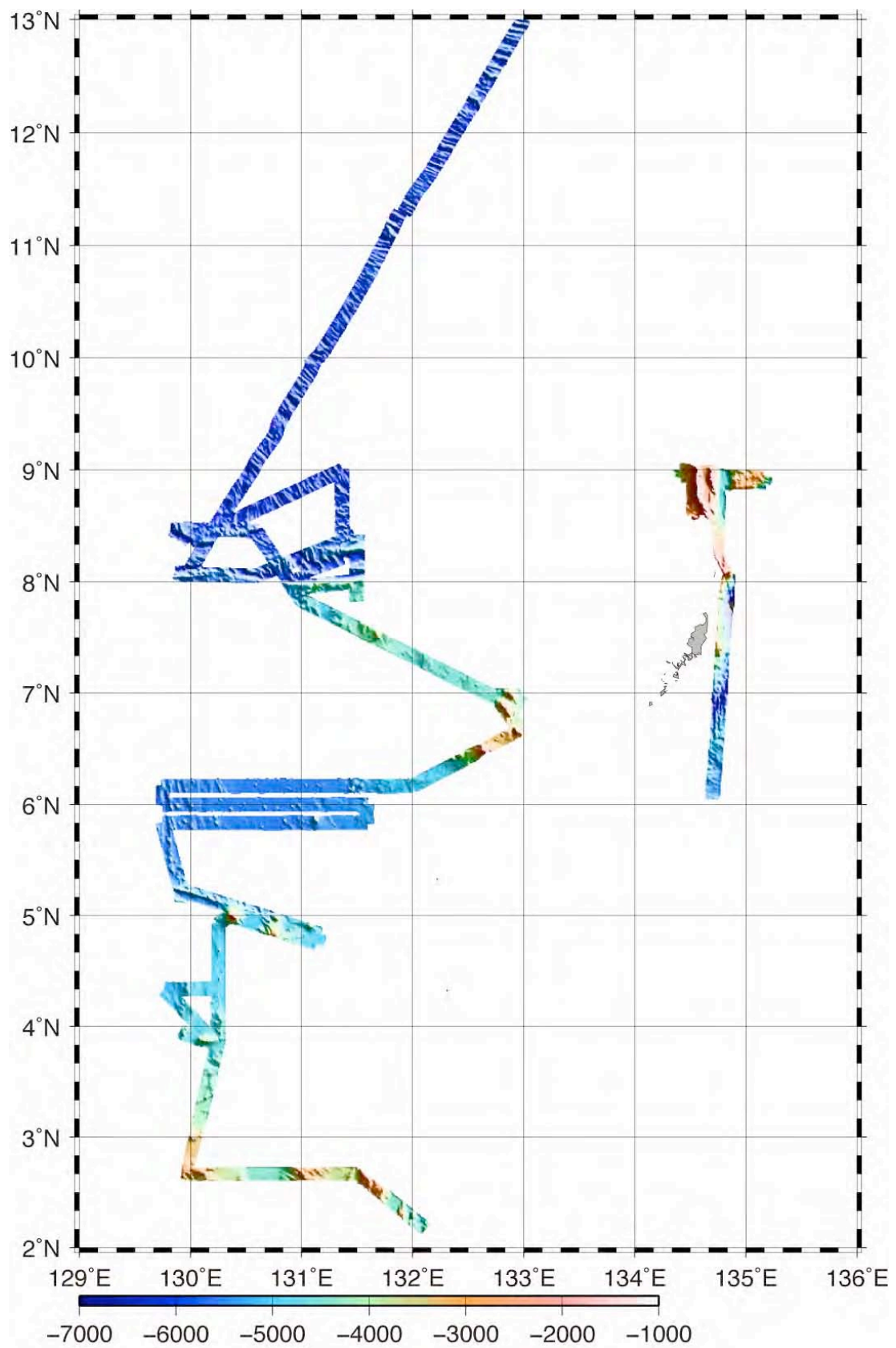


Fig. 4-2 Swath bathymetry data obtained during the YK10-14 cruise, presented as a shaded relief map.

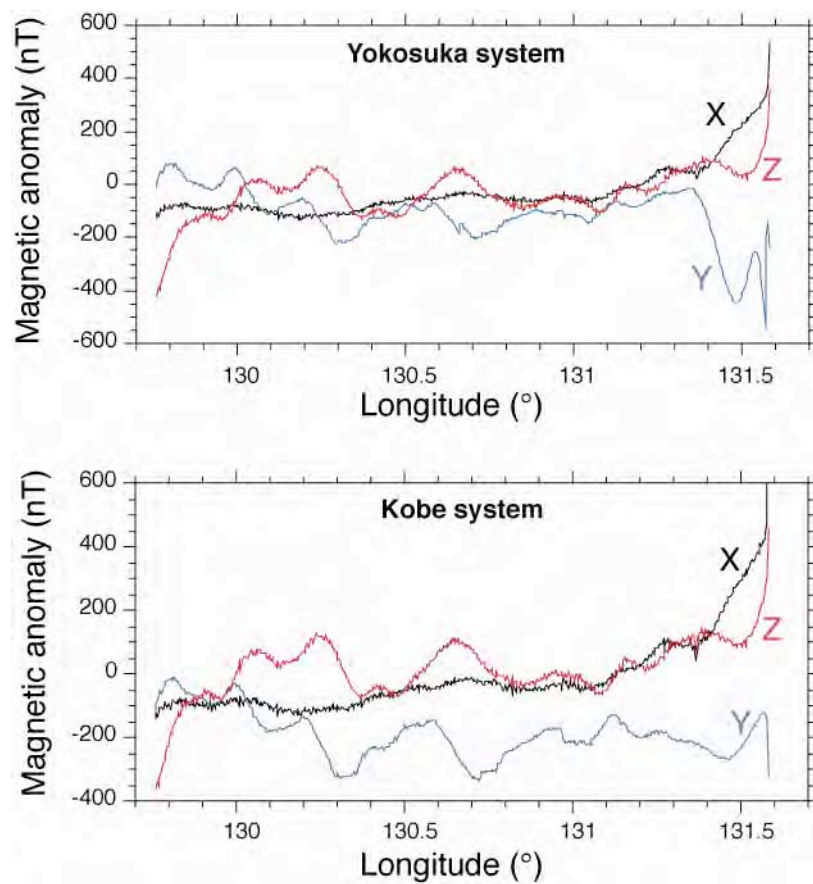


Fig.4-3 Magnetic vector anomalies along 5°50'N. +X: north component, +Y: east component, +Z: down component.

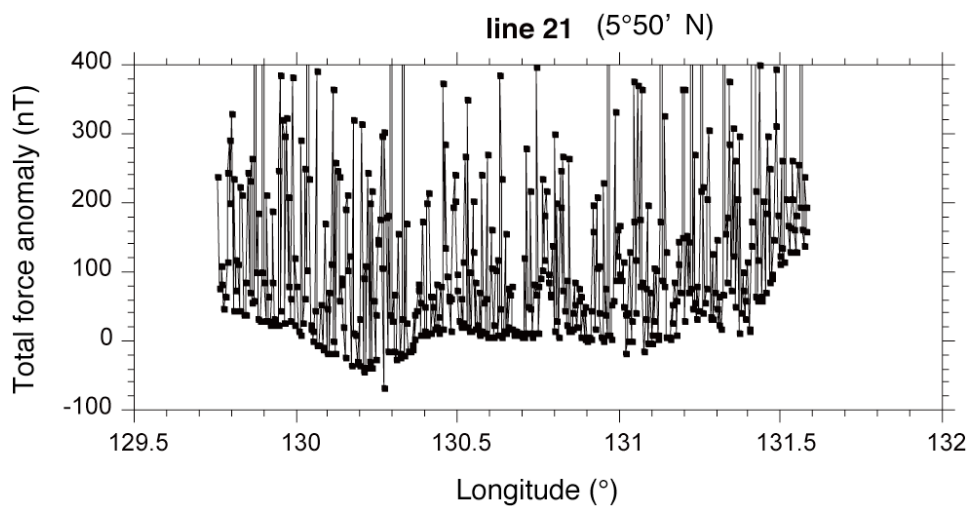


Fig. 4-4 Magnetic total force anomaly along 5°50'N.

5. Shore-based studies

A comprehensive work plan for the rock samples was developed by the shipboard scientific party. This work will include major element analyses, trace element analyses, geochronology studies, mineral analyses, petrographic characterization, and stable and radiogenic isotope characterization. The work will be completed at the Geological Survey of Japan/AIST, JAMSTEC, Kanazawa University, Tokai University and other possible collaborators. Analytical responsibilities include:

Volcanic rocks:

Petrological, geochemical and geochronological study on volcanic rocks will be conducted to reveal age, magmatic processes and magma sources of oceanic crust of Palau and West Philippine Basins and volcanic construct in the Palau Basin.

- Whole rock chemical composition (XRF, ICP-MS): GSJ
- Mineral chemistry (major elements: EPMA): GSJ, IFREE
- Ar/Ar dating (GSJ)
- Radiogenic isotopes (Sr, Nd, Pb, Hf?): GSJ etc.
- melt inclusion studies, if applicable (IFREE)
- Description of volcanic textures for marginal part of subaqueous volcanic rocks

(Tokai University).

- Clay-minerals and rock alteration process (Tokai University).
- Index analysis of pumiceous volcanic glass (Tokai University).

Metamorphic and deformed rocks

1) In order to understand the tectonics of rifting or faulting in the Kyushu-Palau Ridge, I would like to reveal the petrogenesis of analyzed rocks and the deformation condition (including pressure, temperature, strain rate and stress) using by microstructural analysis (deformation microstructure, fabrics and mineral chemistry). I am going to use the SEM-EBSD system, EPMA and Raman micro-spectrophotometer at Shizuoka, Kanazawa Universities for these analyses. (Kanazawa University)

2) Geochemical and geochronological study will be conducted at IFREE:

- SHRIMP zircon/titanite U-Pb dating
- LA-MC-ICP-MS zircon Hf isotope analyses
- LA-ICP-MS zircon trace element analyses
- Whole-rock major and trace element analyses
- Whole-rock isotope analyses (Sr, Nd, Pb, Hf)

3)Ar/Ar dating on mica will be conducted at GSJ, if applicable.

Volcaniclastic rocks

- 1) Geochemical and geochronological study will be conducted at IFREE:
 - SHRIMP zircon U-Pb dating
 - LA-MC-ICP-MS zircon Hf isotope analyses
 - LA-ICP-MS zircon trace element analyses
 - LA-ICP-MS analyses on other minerals and glass
- 2) XRF and EPMA analysis on relative fresh clast and glass will be conducted at GSJ.

Sedimentary rocks

- Description of sediments and sedimentary rocks (Tokai University).
- Paleo-Microfossils (foraminifera, diatom, and nanno-fossils)
- SHRIMP zircon U-Pb dating (IFREE)
- LA-MC-ICP-MS zircon Hf isotope analyses (IFREE)
- LA-ICP-MS zircon trace element analyses (IFREE)

Mn-nodules and Mn-oxides crust

Features and mineralogy of Mn-oxides. (Tokai Univ. and Kochi Univ.)

Geophysical data

- Bathymetric and magnetic data will be merged with existing data and synthesized at GSJ.

Other shore-based studies include:

- Volcanic and geologic synthesis will be done at GSJ, JAMSTEC, Kanazawa University and Tokai University.
- Links between ocean basin structure and characteristics of magma will be extensively investigated with shore-based collaborators.

6. Summary

1) YK10-14 cruise investigated Palau Basin and southern part of West Philippine Basin to obtain crucial geological and geophysical data for reconstruction of this one of the oldest part of the Philippine Sea Plate. Rock sampling using chain-bag dredge and geophysical survey including bathymetric, geomagnetic and gravity survey were conducted.

12 dredge hauls were made during YK10-14 cruise. Sampling targets are: 1) oceanic crust of Palau Basin exposed along Mindanao Fracture Zone. 2) oceanic crust of oldest part of West Philippine Basin. 3) volcanic structure within the Palau Basin. 4) basement of Southern Kyushu-Palau Ridge. Sampling of Palau Basin crust was conducted in 2 regions. One is at c. 130°E, where Palau basin floor is relatively deep (generally deeper than 6000m) and shows series of abyssal hills trending N-S to NE-SW. The 2 dredge hauls made in this region (D01 and D02) recovered small amount of basaltic lava and ol-rich dolerite. D02 recovered radially-jointed pillow lava block (olivine-clinopyroxene basalt) with remaining fresh glass rind. Another dredge haul (D03) was made in the eastern part of the basin at c. 131°30'E along the Mindanao Fracture Zone, where depth of the basin floor is shallower, c. 4500 - 4000 m. This dredge haul recovered abundant pillow basalt lava blocks with some fresh glass rind. The lavas are dominantly olivine basalt with plagioclase phenocrysts. Samples from these 3 dredge hauls will enable us to elucidate origin and age of this basin as well as regional variation within the basin crust.

Ocean crust of West Philippine Basin was sampled at the NW-SE trending scarp at c. 8°26'N. Moderately-weathered pillow lava blocks of aphyric basalt were recovered. These samples should correspond to basaltic crust in the poorly-understood southern half of West Philippine Basin. For the first time we will be able to directly date the ocean crust of this part of the basin, and link this age with magnetic anomaly we have obtained during this cruise.

Another attempt (D07) to recover Palau Basin crust was made in the central part of the basin, where NW-SE-trending fracture zone can be traced more than 160km. Abundant fresh and vesiculated basaltic pillow lavas were recovered from northern cliff of the fracture zone. These basalts are mainly olivine basalt or aphyric basalt with one exception of clinopyroxene basalt. These samples combined with those from Mindanao Fracture Zone will give us firm age constraints on spreading history of Palau Basin.

5 dredges were used to investigate prominent bathymetric highs possibly of volcanic origin in the Palau Basin. Sampling at two conical seamounts in the eastern part of the

basin only recovered Mn-oxides crust and semi-consolidated sediments (D05, D06). Olivine-clinopyroxene and clinopyroxene-olivine basalt were recovered from NE-SW-trending ridges crosscutting N-S-trending abyssal hills in the southern part of Palau Basin (D08, D09). This is a sharp contrast to basalt from Palau Basin floor that are generally free from pyroxene phenocryst. This observation strongly implies that NE-SW-trending ridges were formed by different magmatic event from Palau Basin formation (i.e., magmatism at spreading axis). Broad plateau-like bathymetric high occupying southernmost part of Palau Basin was dredged by D10. South-facing steep galley was dredged, and pumiceous tuff breccia and semi-consolidated mud/siltstone were recovered. Occurrence of pumiceous tuff breccia indicates that explosive subaqueous eruption occurred and pyroclastic flow deposit covered this area. Origin of this bathymetric high remains unclear.

Even though the difficulty of collecting rocks from Mn-oxides--encrusted outcrop, we successfully recovered samples from most of the key geological features in the surveyed area.

2) Geophysical survey: Bathymetry, magnetic and gravity anomalies has been conducted during this cruise. Preliminary results of the swath bathymetry are summarized as follows. Topographic fabric associated with seafloor spreading can be recognized in the southern part of the West Philippine Basin (WPB). The Mindanao Fracture Zone (MFZ) branches out into two or three scarps to the east of 130°E. The Palau Basin south of MFZ is shallower than the WPB in general. The basin floor of the Palau Basin is almost flat, suggesting thick sediment cover. A trough of unknown origin runs WNW-ESE near 5°N, 130°E. The southern and eastern part of the Palau Basin is occupied by numerous seamounts.

For magnetic vector measurements, the Kobe University type shipboard three-component magnetometer system with a ring-laser gyro (the Kobe system) was used as well as the system equipped with R/V Yokosuka (the Yokosuka system). The results of the two systems basically coincide, but the Kobe system showed better performance than the Yokosuka system for several tens of minutes after turnings of the ship. It is expected that the data collected can be a clue for understanding the formation process of the southern part of the West Philippine Basin and the Palau Basin. Magnetic total force measurement with a proton magnetometer was annoyed with severe noise, but magnetic anomaly patterns were still visible.

3) Triton buoy No. 13 was recovered at 1°N, 134°E on November 6. This

buoy has drifted since late October from original location of 0°N, 138°E. There is a strong westward current in this area, and the buoy was drifted westward, then westnorthwestward.

All the installed sensors as well as buoys were recovered, but a releaser was lost. A rope between sensors and a releaser had been broken, and this caused drift of the buoy. The tower on top of the buoy was partly damaged.

7. References

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8. Recovery of Triton buoy

Triton buoy No. 13 was recovered at 1°N, 134°E on November 6. This buoy has drifted since late October from original location of 0°N, 138°E. There is a strong westward current in this area, and the buoy was drifted westward, then westnorthwestward.

All the installed sensors as well as buoys were recovered, but a releaser was lost. A rope between sensors and a releaser had been broken, and this caused drift of the buoy. The tower on top of the buoy was partly damaged.



9. Notice on using

This cruise report is a preliminary documentation as of the end of the cruise. This report may not be corrected even if changes on contents (i.e. taxonomic classifications) may be found after its publication. This report may also be changed without notice. Data on this cruise report may be raw or unprocessed. If you are going to use or refer to the data written on this report, please ask the Chief Scientist for latest information. Users of data or results on this cruise report are requested to submit their results to the Data Management Group of JAMSTEC.

Appendix A: Dredge log

Cruise Name: YK10-14

Date: 2010/10/29

Area: Mindanao Fracture Zone

DR Number: D01

Weather: rain

Wind Direction: 352.0 deg

Wind Speed: 6.7 m/s

Current Direction: 307.1 deg

Current Speed: 1.1 knt

Time (JST)	Depth (m)	Lat.	Long.	Wire Length (m)	Wire in/out (↑/↓)	Wire Speed (m/min)	Tension (kN)	Ship Direction (deg)	Ship Speed (knt)	Remarks
7:16	5589							288.1	2.1	Winch operation start
7:24	5690							33.3	0.8	Dredge on surface
7:42	5601	08-03.9717N	129-57.2606E	0			4	96.4	0.2	Wire length reset
7:43	5647			10	↓	10	4	12.9	0.9	Wire speed up ~55m/min
7:52	5649			500	↓	55	6	200.8	0.6	
8:02	5553			1000	↓	55	8	326.6	1.3	
8:11	5570			1500	↓	55	10	292.9	0.5	
8:21	5693			2000	↓	50	14	180.5	1.2	
8:31	5054			2500	↓	50	15	99.4	0.6	
8:42	5715			3000	↓	50	19	142.2	0.9	
8:53	5726			3500	↓	49	19	345.7	1.1	
9:04	5622			4000	↓	48	23	152.7	1.6	
9:15	5708			4500	↓	47	25	334	1.6	
9:27	5724			5000	↓	45	27	158.1	2.4	
9:39	5739			5480	↓	30	30	170.3	0.3	Wire speed down
9:46	5759	08-04.0107N	129-57.0572E	5644	↓	30	27	324.9	0.5	Dredge on bottom
9:47	5682			5685	-	-	27	170.3	1.1	Winch Stop
10:18	5333			5691	↑	10	34	168.1	1.4	Wire in
10:36	5343			5500	↑	10	30	125.4	0.8	
10:45	5261			5400	↑	20	30	353	0.1	Wire speed up
10:55	5311			5222	↑	25	30	159.6	1.8	Wire speed up
10:57	5324			5272	↑	30	30	335.2	2.2	Wire speed up
10:59	5330	08-03.6047N	129-57.1981E	5120	↑	30	30	317.7	0.7	Dredge off bottom
										Wire speed up ~40m/min
11:02	5358			5000	↑	40	30	342	1.8	
11:15	5377			4500	↑	41	27	178.8	0.7	
11:33	5414			4000	↑	40	26	287.2	2.4	
11:50	5567			3500	↑	45	25	324.3	1	
12:26	5770			3000	↑	25	19	19.7	1.1	
12:43	5710			2500	↑	20	17	311	1.7	
13:01	6000			2000	↑	48	14	322.9	0.8	
13:21	5922			1500	↑	48	12	101.4	0.6	
13:33	6014			1000	↑	35	9	28.6	1.3	
13:45	6100			500	↑	52	7	329.1	0.5	
13:55	6118	08-05.4904N	129-55.5347E	0	↑	10	4	169.4	0.4	Wire length zero
14:14	6109							266.2	1.1	Dredge off surface
14:17	6117							226.9	1.4	Dredge on deck

Cruise Name: YK10-14

Date: 2010/10/29

Area: Mindanao Fracture Zone

DR Number: D02

Weather: rain

Wind Direction: 25.0 deg

Wind Speed: 6.6 m/s

Current Direction: 267.4 deg

Current Speed: 0.5 knt

Time (JST)	Depth (m)	Lat.	Long.	Wire Length (m)	Wire in/out (↑/↓)	Wire Speed (m/min)	Tension (kN)	Ship Direction (deg)	Ship Speed (knt)	Remarks
14:56	6118							129.2	0.8	Winch operation start
14:59	6130							323.0	1.5	Dredge on surface
15:16	6111	08-05.1205N	129-52.7325E	0			4	316.8	1.2	Wire length reset Wire speed up ~59m/min
15:25	6128			500	↓	59	5	348.8	0.9	
15:35	6127			1000	↓	58	9	135.9	0.7	
15:45	6125			1500	↓	55	11	247.4	0.6	
15:54	6119			2000	↓	55	14	117.3	0.9	
16:04	6119			2500	↓	53	16	213.4	0.5	
16:15	6124			3000	↓	52	18	309.4	1.1	
16:26	6120			3500	↓	50	20	47.1	0.6	
16:37	6126			4000	↓	47	23	148.6	0.5	
16:48	6120			4500	↓	47	26	84.7	0.5	
17:04	6123			5000	↓	45	30	307.7	1.2	
17:13	6125			5500	↓	43	31	139.9	2.6	
17:24	6126			5900	↓	30	32	120.4	0.2	Wire speed down
17:27	6125			6000	↓	30	32	139.9	2.6	
17:28	6132	08-05.1492N	129-52.7107E	6057	↓	30	28	311.8	0.6	Dredge on bottom
17:30	6133			6095	-	0	30	140.5	1.2	Winch Stop
18:21	5484			6096	↑	10	30	349.8	0.8	Wire in
18:32	5484			6000	↑	10	33	349.6	0.1	
18:46	5551			5870	↑	10	40	294.0	0.3	Bite!
19:02	5523			5730	↑	0	31	147.6	1.0	Winch Stop
19:06	5652			5730	↑	10	32	117.0	1.4	Wire in
19:19	5490			5610	↑	13	33	154.0	0.2	Wire speed up
19:20	5541	08-04.3995N	129-52.6430E	5600	↑	13	32	156.4	1.1	Dredge off bottom
19:24	5497			5542	↑	20	33	310.0	1.0	Wire speed up
19:25	5574			5500	↑	20	33	166.1	0.9	
19:27	5481			5477	↑	25	33	313.5	0.6	Wire speed up ~40m/min
19:48	5408			5000	↑	40	30	353.9	0.6	
20:01	5560			4500	↑	41	27	148.8	1.8	
20:13	5533			4000	↑	42	24	277.2	0.6	
20:25	5648			3500	↑	42	22	357.3	2.4	
20:37	5672			3000	↑	45	20	324.3	0.6	
20:48	5672			2500	↑	48	17	152.5	1.9	
20:59	5741			2000	↑	50	14	131.7	0.7	
21:10	5710			1500	↑	50	12	356.0	1.0	
21:20	5724			1000	↑	51	10	165.9	1.8	
21:31	5745			500	↑	51	7	353.6	1.2	
21:40	5705	08-04.4849N	129-52.8789E	0	↑	10	4	325.4	2.0	Wire length zero
21:53	5645							310.1	0.9	Dredge off surface
21:58	5665							180.6	1.0	Dredge on deck

Cruise Name: YK10-14
Date: 2010/10/30
Area: Mindanao Fracture Zone
DR Number: D03
Weather: rain
Wind Direction: 130.0 deg
Wind Speed: 1.9 m/s
Current Direction: 325.6 deg
Current Speed: 0.2 knt

Time (JST)	Depth (m)	Lat.	Long.	Wire Length (m)	Wire in/out (↑/↓)	Wire Speed (m/min)	Tension (kN)	Ship Direction (deg)	Ship Speed (knt)	Remarks
9:26	5833							178.1	2.8	Winch operation start
9:31	5833							208.2	1.0	Dredge on surface
9:45	5813	08-02.3972N	131-28.1579E	0		0	4	33.8	0.9	Wire length reset
9:46	5833			10	↓	10	4	189.6	0.8	Wire speed up ~56m/min
9:55	5827			500	↓	56	7	55.6	0.6	
10:05	5791			1000	↓	56	8	156.9	0.3	
10:14	5793			1500	↓	56	11	98.9	0.2	
10:24	5774			2000	↓	53	14	21.3	1.8	
10:34	5774			2500	↓	53	16	21.2	1.2	
10:45	5822			3000	↓	51	17	329.4	0.4	
10:56	5800			3500	↓	50	21	307.4	0.9	
11:07	5799			4000	↓	48	22	175.5	0.6	
11:18	5815			4500	↓	46	25	140.4	0.2	
11:30	5819			5000	↓	45	28	151.4	0.8	
11:43	5823			5500	↓	44	30	309.7	0.5	
11:45	5812			5600	↓	30	30	357.4	0.7	Wire speed down
11:50	5795	08-02.3716N	131-28.2768E	5737	↓	30	27	139.8	0.2	Dredge on bottom
11:53	5826			5805	-	0	27	193.9	1.4	Winch Stop
12:49	5095			5805	↑	10	32	138.1	0.4	Wire in
12:54	5094			5750	↑	10	41	157	0.1	Bite!
13:02	5102			5695	↑	10	40	182.8	1.2	Bite!
13:03	5152			5692	-	0	50	331.7	0.8	Winch Stop
13:04	5079			5692	↑	5	43	181.4	1.2	Wire in
13:05	5166			5694	-	0	51	171.6	0.6	Winch Stop
13:07	5182			5696	↑	5	45	19.4	1.0	Wire in
13:08	5154			5692	-	0	52	75.8	0.4	Winch Stop
13:09	5143			5693	↑	5	45	7.2	0.8	Wire in
13:10	5118			5690	-	0	52	87.9	0.3	Winch Stop
13:11	5120			5692	↑	5	46	331.2	0.2	Wire in
13:12	5150			5690	↑	10	32	205.2	0.5	Wire speed up Max53kN
13:36	5115			5500	↑	10	31	181.5	0.1	
14:08	5086			5181	↑	15	30	222.9	0.4	Wire speed up
14:10	5136			5145	↑	20	29	196.9	0.5	Wire speed up
14:13	5089			5080	↑	25	30	336.6	0.1	Wire speed up
14:16	5063			5015	↑	30	30	80.1	0.4	Wire speed up
14:16	5132			5000	↑	30	30	32.0	0.6	
14:17	5119	08-01.5397N	131-28.3512E	4975	↑	30	30	195.8	1.2	Dredge off bottom
14:20	5089			4900	↑	40	30	358.3	0.2	Wire speed up ~40m/min
14:30	5136			4500	↑	40	25	92.8	0.7	
14:45	5100			4000	↑	40	27	1.1	2.1	
14:57	5090			3500	↑	40	22	74.3	0.3	
15:09	5061			3000	↑	45	20	339.3	0.4	
15:20	5072			2500	↑	45	18	321.1	0.9	
15:31	4992			2000	↑	45	15	204.3	0.8	
15:42	4927			1500	↑	50	13	156.0	0.5	
15:52	4773			1000	↑	50	10	174.6	0.6	
16:02	4696			500	↑	51	8	182.8	1.2	
16:12	4559	08-01.0358N	131-28.3395E	0	↑	40	5	224.0	0.8	Wire length zero
16:24	4472							210.8	0.9	Dredge off surface
16:28	4381							181.6	0.6	Dredge on deck

Cruise Name: YK10-14
Date: 2010/10/31
Area: West Philippine Basin
DR Number: D04
Weather: cloudy
Wind Direction: 80.0 deg
Wind Speed: 4.7 m/s
Current Direction: 304.9 deg
Current Speed: 0.8 knt

Time (JST)	Depth (m)	Lat.	Long.	Wire Length (m)	Wire in/out (↑/↓)	Wire Speed (m/min)	Tension (kN)	Ship Direction (deg)	Ship Speed (knt)	Remarks
7:58	5903							226.3	0.2	Winch operation start
8:00	5891							2.6	0.1	Dredge on surface
8:16	5987	08-25.6750N	129-55.0029E	0			4	238.7	0.8	Wire length reset
8:16	5981			10	↓	10	4	254.2	0.9	Wire speed up ~59m/min
8:26	6038			500	↓	58	6	209.5	1.3	
8:35	6076			1000	↓	57	9	191.9	0.8	
8:45	6077			1500	↓	56	11	207.3	0.2	
8:55	6090			2000	↓	54	13	193.8	0.3	
9:05	6048			2500	↓	53	15	191.8	0.9	
9:15	6097			3000	↓	52	17	34.3	1.4	
9:26	6055			3500	↓	50	21	24.5	0.4	
9:38	6020			4000	↓	47	21	158.3	0.1	
9:49	6014			4500	↓	47	27	117.2	0.4	
10:01	6045			5000	↓	45	29	210.8	0.4	
10:14	6048			5500	↓	43	30	34.2	1.6	
10:23	6029			5860	↓	34	30	210.0	1.2	Wire speed down
10:28	6063	08-25.5972N	129-54.9933E	6030	↓	33	28	40.7	0.4	Dredge on bottom
10:30	6097			6065	-	-	28	214.8	1.8	Winch Stop
11:19	5380			6065	-	-	31	183.8	0.2	Ship stop
11:20	5375			6065	↑	10	31	315.2	0.2	Wire in
11:25	5389			6021	↑	10	42	344.0	0.6	Bite!
11:27	5381			6000	↑	10	34	8.2	0.4	
11:30	5396			5978	↑	10	42	22.8	0.6	Bite!
11:39	5380			5878	↑	10	41	19.7	1.6	Bite!
11:42	5416			5855	↑	10	41	150.6	1.1	Bite!
11:48	5390			5794	↑	10	41	203.0	1.0	Bite!
12:11	5358			5615	↑	10	42	213.6	1.5	Bite!
12:12	5371			5609	↑	10	37	148.7	0.3	Bite!
12:12	5342			5602	↑	10	37	115.6	0.4	Bite!
12:13	5367			5595	↑	10	41	31.2	1.1	Bite!
12:25	5367			5500	↑	10	31	145.5	0.1	
12:34	5378			5418	↑	12	32	54.4	0.7	Wire speed up
12:46	5363			5318	↑	15	32	29.3	0.3	Wire speed up
12:48	5366			5285	↑	20	29	18.5	1.0	Wire speed up
12:50	5353	08-25.9814N	129-55.6564E	5241	↑	20	31	19.6	0.4	Dredge off bottom
12:52	5371			5211	↑	25	32	20.9	1.2	Wire speed up
13:03	5331			5100	↑	38	30	22.4	0.3	Wire speed up ~full
13:05	5356			5000	↑	38	31	44.1	1.2	
13:18	5334			4500	↑	40	27	86.2	0.4	
13:38	5321			4000	↑	42	23	42.0	0.6	
13:50	5312			3500	↑	43	23	271.2	0.4	
14:02	5307			3000	↑	45	20	54.0	0.9	
14:13	5333			2500	↑	47	17	151.5	0.4	
14:26	5330			2000	↑	48	16	216.9	1.0	
14:36	5323			1500	↑	50	14	85.0	0.3	
14:47	5348			1000	↑	50	10	190.2	0.8	
14:57	5362			500	↑	51	7	143.3	0.7	
15:07	5359	08-25.9558N	129-55.9816E	0	↑	10	4	200.4	0.9	Wire length zero
15:21	5331							262.1	0.9	Dredge off surface
15:23	5349							142.1	0.7	Dredge on deck

Cruise Name: YK10-14
Date: 2010/11/1
Area: Eastern Palau Basin Sea mounts
DR Number: D05
Weather: fine
Wind Direction: 131.0 deg
Wind Speed: 1.8 m/s
Current Direction: 350.2 deg
Current Speed: 0.5 knt

Time (JST)	Depth (m)	Lat.	Long.	Wire Length (m)	Wire in/out (↑/↓)	Wire Speed (m/min)	Tension (kN)	Ship Direction (deg)	Ship Speed (knt)	Remarks
7:36	3081							200.3	1.1	Winch operation start
7:38	3031							65.5	1.3	Dredge on surface
7:52	3056	06-54.7564N	132-50.4592E	0			5	198.2	0.6	Wire length reset
7:54	3044			10	↓	59	5	191.3	0.6	Wire speed up ~59m/min
8:02	3002			500	↓	58	7	222.3	1.1	
8:11	3025			1000	↓	56	9	242.7	0.3	
8:21	3028			1500	↓	56	11	217.6	0.9	
8:31	3009			2000	↓	53	14	44.7	0.9	
8:41	3033			2500	↓	53	16	56.6	0.2	
8:47	3027			2800	↓	34	18	44.4	1.5	Wire speed down
8:51	3044	06-54.7534N	132-50.4903E	2910	↓	34	16	256.5	0.8	Dredge on bottom
8:53	3043			2945	-	0	15	250.2	1.6	Winch Stop
9:33	2613			2945	↑	10	15	36.3	0.5	Wire in
9:37	2589			2895	↑	10	28	269.4	0.6	Bite!
9:46	2602			2795	↑	10	28	241.4	0.7	Bite!
9:47	2559			2780	↑	10	27	145.9	0.1	Bite!
9:52	2564			2728	↑	10	42	195.8	0.3	Bite!
9:57	2555			2667	-	0	17	273.4	0.7	Winch Stop
10:12	2338			2667	-	0	26	162.8	0.6	Bite!
10:13	2388			2667	↑	10	17	244.7	0.4	Wire in
10:17	2403			2637	↑	10	26	43.5	0.5	Bite!
10:27	2410			2551	↑	10	31	102.9	0.6	Bite!
10:33	2389			2500	↑	10	17	230.9	1.1	
10:48	2387			2371	↑	12	16	198.0	0.6	Wire speed up
10:50	2377			2344	↑	15	17	290.3	0.1	Wire speed up
10:51	2371			2320	↑	20	17	233.2	0	Wire speed up
10:52	2394	06-54.1887N	132-49.7921E	2318	↑	25	17	231.1	1.8	Dredge off bottom, Wire speed up
10:58	2354			2150	↑	48	17	184.5	0.3	Wire speed up ~full
11:01	2367			2000	↑	48	15	251.0	0.6	
11:12	2376			1500	↑	50	13	188.5	0.3	
11:22	2359			1000	↑	50	11	99.4	0.4	
11:32	2357			500	↑	50	8	57.1	0.3	
11:42	2316	06-54.0803N	132-49.7925E	0	↑	10	5	86.8	0.4	Wire length zero
11:55	2309							254.1	0.6	Dredge off surface
11:57	2296							272.8	0.7	Dredge on deck

Cruise Name : YK10-14
Date : 2010/11/1
Area : Eastern Palau Basin Sea mounts
DR Number : D06
Weather : fine
Wind Direction : 131.0 deg
Wind Speed : 2.3 m/s
Current Direction : 268.0 deg
Current Speed : 0.4 knt

Time (JST)	Depth (m)	Lat.	Long.	Wire Length (m)	Wire in/out (↑/↓)	Wire Speed (m/min)	Tension (kN)	Ship Direction (deg)	Ship Speed (knt)	Remarks
12:59	3711							338.2	1.0	Winch operation start
13:01	3714							4.4	0.9	Dredge on surface
13:16	3698	06-49.5197N	132-54.0740E	0			5	5.3	1.2	Wire length reset, Wire speed up
13:26	3713			500	↓	58	7	15.7	0.2	
13:35	3731			1000	↓	57	9	329.1	0.5	
13:45	3697			1500	↓	56	11	213.8	0.3	
13:55	3700			2000	↓	54	14	143.7	0.3	
14:05	3711			2500	↓	53	16	173.1	2.2	
14:15	3719			3000	↓	52	18	232.2	0.1	
14:26	3715			3500	↓	33	22	154.9	0.6	Wire speed down
14:29	3719	06-49.5063N	132-54.1019E	3580	↓	33	17	208.3	0.2	Dredge on bottom
14:30	3717			3615	-	0	18	333.4	0.3	Winch Stop, Ship start
15:10	3234			3615	-	0	21	30.0	0.5	Ship stop
15:11	3287			3615	↑	10	21	31.0	0.4	Wire in
15:19	3343			3552	↑	10	31	172.7	0.7	Bite!
15:25	3340			3500	↑	10	21	15.2	1.4	
15:29	3338			3466	↑	0	20	208.3	0.2	Winch stop, Ship start
15:56	3036			3466	↑	0	20	152.0	0.9	Ship stop
15:58	3088			3453	↑	10	28	29.4	0.2	Bite!
16:05	3120			3378	↑	10	28	129.8	0.2	Bite!
16:20	3120			3212	↑	12	21	200.8	0.9	Wire speed up
16:22	3124			3186	↑	10	36	69.8	0.8	Bite! Wire speed down
16:27	3113			3132	↑	10	28	274.4	0.4	Bite!
16:32	3117			3085	↑	12	20	129.6	1.1	Wire speed up
16:34	3113			3063	↑	15	20	18.2	1.0	Wire speed up
16:35	3093			3044	↑	20	20	235.0	0.2	Wire speed up
16:35	3100	06-49.5127N	132-53.3773E	3036	↑	20	20	26.4	1.2	Dredge off bottom
16:36	3095			3014	↑	25	20	20.0	0.5	Wire speed up
16:37	3109			3000	↑	30	20	264.8	0.1	Wire speed up
16:41	3102			2900	↑	48	19	30.8	1.2	Wire speed up ~full
16:50	3083			2500	↑	48	15	291.6	0.4	
17:01	3019			2000	↑	48	15	242.3	0.7	
17:11	3003			1500	↑	48	13	65.7	0.7	
17:22	3014			1000	↑	50	10	33.0	0.4	
17:32	3001			500	↑	50	8	12.3	0.6	
17:42	3000	06-49.7424N	132-53.0515E	0	↑	30	5	135.2	0.0	Wire length zero
17:55	2936							268.1	0.6	Dredge off surface
17:57	2910							268.5	1.4	Dredge on deck

Cruise Name : YK10-14

Date : 2010/11/3

Area : Southern Palau Basin

DR Number : D07

Weather : cloudy

Wind Direction : 24.0 deg

Wind Speed : 4.5 m/s

Current Direction : 87.1 deg

Current Speed : 1 knt

Time (JST)	Depth (m)	Lat.	Long.	Wire Length (m)	Wire in/out (↑/↓)	Wire Speed (m/min)	Tension (kN)	Ship Direction (deg)	Ship Speed (knt)	Remarks
8:14	5296							260.9	0.5	Winch operation start
8:16	5273							279.9	0.8	Dredge on surface
8:31	5254	05-12.2990N	129-57.0694E	0			4	88	0.4	Wire length reset
8:41	5145			500	↓	58	6	203.6	0.9	
8:50	5246			1000	↓	57	9	174.2	0.2	
9:00	5220			1500	↓	56	11	249.8	1	
9:10	5246			2000	↓	54	13	36.2	0.3	
9:20	5282			2500	↓	53	15	53.1	1.3	
9:30	5269			3000	↓	52	18	230	1.2	
9:41	5245			3500	↓	50	20	52.1	0.2	
9:52	5256			4000	↓	48	23	66.2	0.8	
10:04	5228			4500						
10:16	5273			5000						
10:17	5272			5050	↓	30	24	268.6	0.8	Wire speed down
10:22	5265	05-12.3209N	129-57.0299E	5200	↓	30	22	241.5	0.8	Dredge on bottom
10:24	5266			5242	-	0	22	354.5	0.2	Winch Stop, Ship start
10:59	4611			5242	↑	10	22	106.8	0.6	Ship stop
11:00	4598			5242	-	0	24	84.2	0.9	Wire in
11:01	4566			5237	↓	20	20	208.5	0.4	Winch Stop
11:03	4717			5235	-	0	20	169.5	0.3	Wire in
11:04	4637			5236	↑	10	20	267.5	0.4	Winch Stop
11:05	4601			5235	↑	10	30	76.6	1	Wire in, Bite!
11:34	4636			5131	↑	12	23	253.6	0.5	Bite!
11:39	4570			5090						Bite!
11:42	4623			5065						Bite!
11:47	4644			5031	↑	15	24	256.1	0.1	Winch Stop
11:49										Wire in
11:49	4641			5031						Winch Stop
11:51	4479			5031						Wire in
11:52	4545			5031						Wire out
11:53	4585			5045						Wire in
11:55	4558			5035						Bite!
11:57	4549			5020						Winch Stop
11:59	4575			5020						Wire in
12:00	4539			5018						Winch Stop
12:01	4614			5018						Wire in
12:02	4574			5018						Wire out
12:03	4622			5036						Wire in
12:13	4554			4953						Bite!
12:25	4579			4845						Bite!
12:35	4589			4746						Bite!
12:47	4567			4633						Wire speed up
12:48	4590			4614	↑	20	24	238.7	0.3	Wire speed up
12:49	4610	05-12.7366N	129-56.9231E	4600	↑	20	24	272.9	0.7	Dredge off bottom
12:52	4665			4570	↑	25	24	15.1	0.5	Wire speed up
12:54	4610			4525	↑	30	24	261.4	0.6	Wire speed up
12:58	4620			4420	↑	48	23	272.9	0.7	Wire speed up ~full
13:08	4602			4000						
13:20	4600			3500	↑	48	22	73.6	1	
13:31	4565			3000	↑	45	20	239.6	0.2	
13:43	4572			2500	↑	48	17	105.5	0.1	
13:54	4597			2000	↑	49	15	252.2	0.5	
14:04	4594			1500	↑	50	12	265.5	1.4	
14:15	4650			1000	↑	50	9	65.7	0.5	
14:25	4632			500	↑	51	7	346.2	0.2	
14:35	4572	05-12.7112N	129-56.9475E	0	↑	10	4	330	0.6	Wire length zero
14:47	4932							1.6	1	Dredge off surface
14:50	5013							353.8	1	Dredge on deck

Cruise Name: YK10-14
Date: 2010/11/4
Area: Southern Palau Basin
DR Number: D08
Weather: fine
Wind Direction: 171.0 deg
Wind Speed: 3.3 m/s
Current Direction: 5.9 deg
Current Speed: 0.6 knt

Time (JST)	Depth (m)	Lat.	Long.	Wire Length (m)	Wire in/out (↑/↓)	Wire Speed (m/min)	Tension (kN)	Ship Direction (deg)	Ship Speed (knt)	Remarks
7:18	4449							260.9	0.5	Winch operation start
7:20	4462							279.9	0.8	Dredge on surface
7:33	4416	03-58.0905N	129-58.0016E	0			4	88	0.4	Wire length reset
7:34	4431			30	↓	59	4	71.5	0.5	Wire speed up ~59m/min
7:43	4422			500	↓	58	6	203.6	0.9	
7:52	4455			1000	↓	57	9	174.2	0.2	
8:03	4531			1500	↓	56	11	249.8	1	
8:12	4437			2000	↓	54	13	36.2	0.3	
8:22	4473			2500	↓	53	15	53.1	1.3	
8:32	4492			3000	↓	52	18	230	1.2	
8:43	4518			3500	↓	50	20	52.1	0.2	
8:54	4496			4000	↓	48	23	66.2	0.8	
9:00	4458			4250	↓	30	24	268.6	0.8	Wire speed down
9:04	4483	03-58.0980N	129-58.0642E	4370	↓	30	22	241.5	0.8	Dredge on bottom
9:05	4500			4410	-	0	22	354.5	0.2	Winch Stop
9:43	3927			4410	↑	10	22	106.8	0.6	Wire in
10:15	3938			4079	-	0	24	84.2	0.9	Winch Stop
10:16	3932			4079	↓	20	20	208.5	0.4	Wire out
10:17	3922			4100	-	0	20	169.5	0.3	Winch Stop
10:17	3928			4100	↑	10	20	267.5	0.4	Wire in
10:25	3959			4035	↑	10	30	76.6	1	Bite!
10:34	3946			3956	↑	12	23	253.6	0.5	Wire speed up
10:36	3922			3931	↑	15	24	256.1	0.1	Wire speed up
10:38	3937			3898	↑	20	24	238.7	0.3	Wire speed up
10:39	3964	03-58.3583N	129-57.5560E	3881	↑	20	24	272.9	0.7	Dredge off bottom
10:41	3937			3834	↑	25	24	15.1	0.5	Wire speed up
10:43	3931			3796	↑	30	24	261.4	0.6	Wire speed up
10:45	3935			3731	↑	48	23	272.9	0.7	Wire speed up ~full
10:50	3956			3500	↑	48	22	73.6	1	
11:02	3690			3000	↑	45	20	239.6	0.2	
11:13	3934			2500	↑	48	17	105.5	0.1	
11:24	3934			2000	↑	49	15	252.2	0.5	
11:35	3942			1500	↑	50	12	265.5	1.4	
11:45	3941			1000	↑	50	9	65.7	0.5	
11:57	3971			500	↑	51	7	346.2	0.2	
12:07	4072	03-58.4490N	129-57.4312E	0	↑	10	4	330	0.6	Wire length zero
12:24	4175							1.6	1	Dredge off surface
12:26	4180							353.8	1	Dredge on deck

Cruise Name : YK10-14
 Date : 2010/11/4
 Area : Southern Palau Basin
 DR Number : D09
 Weather : fine
 Wind Direction : 170.0 deg
 Wind Speed : 3.8 m/s
 Current Direction : 348.1 deg
 Current Speed : 0.4 knt

Time (JST)	Depth (m)	Lat.	Long.	Wire Length (m)	Wire in/out (↑/↓)	Wire Speed (m/min)	Tension (kN)	Ship Direction (deg)	Ship Speed (knt)	Remarks
13:47	4297							128.0	0.1	Winch operation start
13:49	4293							170.5	0.2	Dredge on surface
14:06	4307	03-53.5543N	130-10.9617E	0		59	4	199.3	0.2	Wire length reset, Wire speed up
14:16	4265			500	↓	58	6	231.8	0.2	
14:25	4237			1000	↓	57	8	226.2	0.5	
14:34	4280			1500	↓	56	11	250.6	0.8	
14:44	4267			2000	↓	54	13	79.6	0.4	
14:54	4237			2500	↓	53	16	280.4	0.4	
15:05	4238			3000	↓	51	18	243.1	0.6	
15:15	4269			3500	↓	50	21	72.6	0.8	
15:27	4221			4000	↓	30	23	85.6	0.7	Wire speed down
15:33	4202	03-53.5288N	130-11.0404E	4200	↓	30	20	242.9	0.3	Dredge on bottom
15:35	4206			4235	-	0	20	121.9	0.6	Winch Stop, Ship start
16:03	4110			4235	-	0	23	247.9	0.8	Ship stop
16:05	4075			4235	↑	10	24	318.7	0.6	Wire in
16:45	4095			3993	↑	12	24	74.5	0.4	Wire speed up
16:46	4081			3967	↑	15	24	59.1	0.3	Wire speed up
16:48	4059			3951	↑	12	30	56.1	0.4	Bite!, Wire speed down
16:52	4041			3885	↑	15	24	282.9	0.6	Wire speed up
16:54	4044			3860	↑	20	24	70.1	0.2	Wire speed up
16:55	4036	03-53.1986N	130-11.1983E	3836	↑	25	24	49.3	0.2	Dredge off bottom
16:59	4062			3750	↑	41	24	159.8	0.7	Wire speed up
17:05	4067			3500	↑	42	21	101.3	0.8	
17:16	4065			3000	↑	45	19	64.7	0.6	
17:27	4054			2500	↑	47	17	273.0	0.5	
17:38	4110			2000	↑	48	15	88.2	0.3	
17:49	4141			1500	↑	49	12	30.4	0.2	
17:59	4248			1000	↑	50	10	259.4	0.7	
18:09	4170			500	↑	50	7	94.2	1.0	
18:19	4226	06-53.2432N	130-11.4817E	0	↑	10	4	79.7	0.2	Wire length zero
18:35	4232							74.5	0.1	Dredge off surface
18:38	4222							72.5	0.4	Dredge on deck

Cruise Name : YK10-14
 Date : 2010/11/5
 Area : Southern Palau Basin
 DR Number : D10
 Weather : fine
 Wind Direction : 176.0 deg
 Wind Speed : 6.6 m/s
 Current Direction : 321.5 deg
 Current Speed : 1.7 knt

Time (JST)	Depth (m)	Lat.	Long.	Wire Length (m)	Wire in/out (↑/↓)	Wire Speed (m/min)	Tension (kN)	Ship Direction (deg)	Ship Speed (knt)	Remarks
7:52	3323							124.8	1.8	Winch operation start
7:54	3329							230.6	0.2	Dredge on surface
8:06	3323	02-39.3277N	129-57.8023E	0	-	0	4	352.7	0.1	Wire length reset
8:16	3335			500	↓	58	7	92.8	0.4	
8:29	3339			1200	↓	56	10	76.7	0.2	
8:35	3336			1500	↓	56	12	264.9	0.2	
8:45	3335			2000	↓	54	14	53.1	0.2	
8:55	3349			2500	↓	53	16	187.2	0.1	
9:05	3340			3000	↓	51	18	70.6	0.5	
9:09	3343			3150	↓	34	19	74.7	0.6	Wire speed down
9:10	3339	02-39.1876N	129-57.8179E	3210	↓	34	15	28.6	0.2	Dredge on bottom
9:12	3336			3245	-	0	16	341.0	0.3	Winch Stop,Ship start
9:59	2961			3245	-	0	18	23.0	0.3	Ship stop
10:01	2963			3245	↑	10	18	71.8	0.2	Wire in
10:09	2974			3167	↑	10	27	63.0	0.8	Bite!
10:28	2953			3000	↑	10	25	51.6	0.6	Bite!
10:33	2955			2960	↑	10	25	267.5	0.3	Bite!
10:34	2967			2947	↑	10	26	55.7	0.2	Bite!
10:44	2961			2840	↑	15	19	61.3	0.4	Wire speed up
10:45	2961			2825	↑	20	19	50.4	0.6	Wire speed up
10:45	2965	02-39.7704N	129-57.4530E	2825	↑	20	19	63.8	0.6	Dredge off bottom
10:48	2975			2750	↑	40	19	245.1	0.5	Wire speed up
10:54	2913			2500	↑	46	17	255.7	0.5	
11:05	2958			2000	↑	47	15	257.1	0.3	
11:14	2946			1736	-	0	13	204.3	0.4	Winch Stop
11:19	2917			1736	↑	20	14	281.5	0.4	Wire in
11:25	2917			1500	↑	49	13	53.7	0.4	
11:35	2881			1000	↑	50	10	47.0	0.7	
11:45	2871			500	↑	50	7	45.9	0.4	
11:55	2854	02-39.9421N	129-57.3170E	0	↑	20	5	309.0	1.1	Wire length zero
12:07	2829							317.4	1.4	Dredge off surface
12:10	2838							292.0	1.6	Dredge on deck

Cruise Name: YK10-14
Date: 2010/11/8
Area: Kyushu Palau Ridge
DR Number: D11
Weather: fine
Wind Direction: 353.0 deg
Wind Speed: 2.5 m/s
Current Direction: 347 deg
Current Speed: 0.5 knt

Time (JST)	Depth (m)	Lat.	Long.	Wire Length (m)	Wire in/out (↑/↓)	Wire Speed (m/min)	Tension (kN)	Ship Direction (deg)	Ship Speed (knt)	Remarks
7:01	3939							43.9	0.6	Winch operation start
7:04	3929							10.4	0.7	Dredge on surface
7:17	3900	08-55.5833N	134-44.6943E	0			5	167.6	0.5	Wire length reset
7:27	3859			500	↓	58	7	352.6	0.3	Wire speed up ~58m/min
7:36	3884			1000	↓	57	9	9.6	0.6	
7:46	3897			1500	↓	56	12	24.5	0.5	
7:56	3939			2000	↓	54	14	293.9	0.1	
8:06	3908			2500	↓	53	16	51.9	0.2	
8:17	3900			3000	↓	52	18	232.3	0.9	
8:27	3836			3500	↓	50	21	47.0	0.6	
8:30	3854			3640	↓	30	22	40.4	1.2	Wire speed down
8:32	3828	08-55.6404N	134-44.6824E	3705	↓	30	18	145.5	0.3	Dredge on bottom
8:34	3878			3745	-	0	18	227.5	1.1	Winch Stop
9:08	3208			3745	↑	10	21	269.3	0.2	Ship Stop, Wire in
9:13	3206			3701	↑	10	27	50.6	0.3	Bite!
9:14	3227			3690	↑	10	30	149.5	0.7	Bite!
9:18	3251			3665	↑	5	50	113.3	0.1	Wire speed down
9:19	3228			3659	-	0	52	121.2	0.2	Bite! Winch Stop
9:20	3256			3659	↑	5	43	175.3	0.6	Wire in
9:21	3244			3657	-	0	52	350.3	0.6	Winch Stop
9:22	3222			3657	↑	5	40	12.5	0.1	Wire in
9:23	3200			3655	-	0	50	352.6	0.3	Winch Stop
9:24	3235			3657	↓	20	41	117.0	0.1	Wire out
9:25	3243			3678	-	0	20	178.8	0.7	Winch Stop
9:25	3251			3678	↑	5	22	342.6	0.5	Wire in
9:27	3232			3661	↑	10	22	222.8	0.5	Wire speed up
9:32	3199			3622	↑	10	27	200.6	0.6	Bite!
9:41	3218			3540	↑	10	28	97.8	0.3	Bite!
9:44	3175			3513	↑	10	28	314.3	0.1	Bite!
9:46	3190			3495	↑	10	30	341.2	0.4	Bite!
9:47	3195			3488	↑	10	33	200.0	0.5	Bite!
9:49	3198			3470	↑	5	43	29.4	0.8	Wire speed down
9:51	3172			3461	-	0	50	137.7	0.6	Winch Stop
9:53	3210			3461	↑	5	46	177.4	0.4	Wire in
9:54	3191			3462	-	0	51	309.3	0.1	Winch Stop
9:55	3211			3463	↑	5	40	245.2	0.2	Wire in
9:56	3212			3463	-	0	51	309.6	0.8	Winch Stop
9:56	3212			3464	↓	10	40	308.9	0.7	Wire out
9:58	3206			3482	-	0	21	359.6	0.4	Winch Stop
9:58	3206			3482	↑	10	21	39.0	0.7	Wire in
9:59	3181			3471	↑	5	42	25.9	0.6	Wire speed down
10:00	3206			3469	-	0	51	235.1	0.6	Winch Stop
10:00	3176			3469	↓	10	30	44.3	1.4	Wire out
10:01	3179			3486	-	0	20	346.2	0.1	Winch Stop
10:01	3179			3486	↑	10	20	281.4	0.2	Wire in
10:03	3181			3472	↑	5	46	20.3	0.2	Wire speed down
10:04	3184			3471	-	0	48	238.9	1.1	Winch Stop
10:04	3184			3471	↓	25	48	44.3	1.4	Wire out
10:05	3186			3500	-	0	20	233.2	0.7	Winch Stop
10:06	3171			3500	↑	10	20	69.8	0.5	Wire in
10:08	3173			3474	↑	5	40	353.9	0.1	Wire speed down
10:08	3171			3471	-	0	50	60.6	0.0	Winch Stop
10:09	3187			3471	↓	25	50	242.6	1.1	Wire out
10:09	3195			3495	-	0	20	249.8	0.1	Winch Stop
10:10	3175			3495	↑	10	20	244.2	0.8	Wire in
10:11	3177			3477	↑	5	48	59.1	0.7	Wire speed down
10:12	3169			3475	-	0	52	245.6	1.2	Winch Stop
10:12	3171			3475	↓	25	50	261.1	0.7	Wire out

10:13	3191		3504	-	0	20	272.2	1.1	Winch Stop
10:13	3191		3504	↑	10	20	279.6	1.0	Wire in
10:15	3174		3491	↑	5	42	50.3	0.5	Wire speed down
10:18	3190		3484	-	0	49	350.3	1.3	Winch Stop
10:18	3190		3484	↓	25	43	64.0	0.5	Wire out
10:19	3307		3511	-	0	20	80.6	0.4	Winch Stop
10:19	3307		3511	↑	10	20	67.5	0.7	Wire in
10:25	3288		3464	-	0	52	54.7	0.6	Winch Stop
10:26	3294		3464	↑	5	44	103.8	0.8	Wire in
10:28	3328		3459	-	0	52	117.4	1.1	Winch Stop
10:29	3323		3460	↑	5	40	56.5	0.8	Wire in
10:31	3327		3453	-	0	52	74.8	0.4	Winch Stop
10:31	3344		3453	↓	25	52	64.8	0.5	Wire out
10:32	3349		3475	-	0	22	133.7	0.8	Winch Stop
10:32	3349		3475	↑	10	22	74.7	0.5	Wire in
10:35	3376		3449	↑	5	49	34.5	0.3	Wire speed down
10:36	3362		3444	-	0	53	26.6	0.5	Bite! Winch Stop
10:38	3370		3446	↑	5	40	112.8	0.7	Wire in
10:39	3374		3440	-	0	52	36.0	0.8	Winch Stop
10:39	3403		3440	↓	25	43	105.0	0.7	Wire out
10:40	3408		3464	-	0	21	117.8	0.6	Winch Stop
10:40	3383		3464	↑	10	21	52.5	0.4	Wire in
10:45	3411		3414	↑	10	33	242.2	0.2	Bite!
10:46	3439		3402	↑	10	36	146.9	0.9	Bite!
10:51	3439		3352	↑	10	29	11.9	0.4	Bite!
10:52	3418		3331	↑	12	21	141.6	0.5	Wire speed up
10:53	3431		3322	↑	15	21	146.9	0.3	Wire speed up
10:54	3381	08-55.6814N 134-44.4159E	3305	↑	15	21	128.9	0.6	Dredge off bottom
10:55	3458		3283	↑	20	21	157.8	0.2	Wire speed up
10:59	3455		3200	↑	48	21	97.9	0.1	Wire speed up ~48m/min
11:04	3458		3000	↑	45	20	325.4	0.2	
11:15	3495		2500	↑	47	18	138.0	0.4	
11:26	3429		2000	↑	47	15	294.7	0.3	
11:37	3435		1500	↑	48	13	230.3	0.3	
11:47	3428		1000	↑	50	10	240.1	0.1	
11:57	3453		500	↑	51	8	315.1	0.4	
12:07	3476	08-55.6121N 134-44.4255E	0	↑	30	5	314.8	0.2	Wire length zero
12:19	3423						239.6	0.5	Dredge off surface
12:21	3457						210.1	0.4	Dredge on deck

Cruise Name : YK10-14
Date : 2010/11/8
Area : Kyushu Palau Ridge
DR Number : D12
Weather : fine
Wind Direction : 7.0 deg
Wind Speed : 2.4 m/s
Current Direction : 264 deg
Current Speed : 0.8 knt

Time (JST)	Depth (m)	Lat.	Long.	Wire Length (m)	Wire in/out (↑/↓)	Wire Speed (m/min)	Tension (kN)	Ship Direction (deg)	Ship Speed (knt)	Remarks
13:27	2512							167.9	0.5	Winch operation start
13:29	2507							179.2	0.3	Dredge on surface
13:42	2478	08-57.1516N	134-36.1716E	0	↓	58	5	197.4	0.3	Wire length reset, Wire speed up
13:52	2533			500	↓	58	7	43.6	0.6	
14:01	2553			1000	↓	57	9	167.7	0.4	
14:11	2531			1500	↓	56	11	309.1	0.4	
14:21	2530			2000	↓	54	13	173.3	0.7	
14:27	2518			2300	↓	31	16	258.3	0.5	Wire speed down
14:28	2493	08-57.2317N	134-36.2068E	2337	↓	31	11	217.1	0.3	Dredge on bottom, Ship start
14:29	2466			2375	-	0	11	297.2	1.2	Winch Stop
14:54	2017			2375	-	0	25	258.9	0.6	Bite!
14:56	2067			2375	↑	10	16	325.9	0.6	Ship stop, Wire in
15:00	2054			2334	↑	10	23	106.9	0.1	Bite!
15:03	2032			2305	↑	10	26	320.4	0.8	Bite!
15:04	2017			2289	↑	10	24	229.6	0.4	Bite!
15:05	2010			2280	↑	10	25	208.6	0.2	Bite!
15:16	2019			2165	↑	10	22	342.3	0.5	Bite!
15:25	2024			2063	↑	10	22	344.2	0.3	Bite!
15:25	2010			2058	↑	10	21	189.3	0.2	Bite!
15:26	2029			2050	↑	10	21	189.6	0.2	Bite!
15:35	1986			1960	↑	12	15	338.0	0.1	Wire speed up
15:35	1990			1953	↑	10	15	162.5	0.6	Wire speed down
15:37	2014			1939	↑	12	15	102.7	0.8	Wire speed up
15:38	2005			1918	↑	15	15	331.4	0.1	Wire speed up
15:39	2004	08-57.2266N	134-35.7483E	1910	↑	15	15	135.2	0.2	Dredge off bottom
15:40	1992			1899	↑	20	15	325.4	0.8	Wire speed up
15:41	1999			1882	↑	25	15	171.2	0.1	Wire speed up
15:42	1999			1847	↑	30	15	130.9	0.5	Wire speed up
15:44	1996			1800	↑	50	15	135.2	0.2	Wire speed up
15:50	2008			1500	↑	50	13	183.9	0.1	
16:00	2008			1000	↑	50	11	348.6	0.5	
16:10	1991			500	↑	51	8	5.2	0.3	
16:20	1987	08-57.3894N	134-35.7186E	0	↑	30	5	281.3	1.1	Wire length zero
16:33	1950							235.2	0.7	Dredge off surface
16:35	1936							277.9	1.2	Dredge on deck

Appendix B. YK10-14 dredge sample distribution list

YK10-14 D01

sample No.	GSJ	IFREE (Tamura)	Kanaza wa	IFREE (Tani)	Tokai	Archive
R01	A					
R02	A					
R03	A					
R04	A					
R05	A					
R06	A					
S01	A					

A: all, B: Block, S: Slab, TS: thin section chip

YK10-14 D02

sample No.	GSJ	IFREE (Tamura)	Kanaza wa	IFREE (Tani)	Tokai	Archive
R01	A					
R02	A					
R03	A					
R04	A					
R05	A					
R06	A					
R07	A					
R08	A					
R09	A					
R10	A					
R11	A					
R12	A					
S01	A					

YK10-14 D03

sample No.	GSJ	IFREE (Tamura)	Kanaza wa	IFREE (Tani)	Tokai	Archive
R01	B	B	B		B	
R02	S, TS	S, TS	S, TS		S, TS	
R03	S, TS	S, TS	S, TS		S, TS	
R04	B	B	B		B	
R05	S, TS	S, TS	S, TS		S, TS	
R06	B	B	B		B	
R07	S, TS	S, TS	S, TS		S, TS	
R08	S, TS	S, TS	S, TS		S, TS	
R09	S, TS	S, TS	S, TS		S, TS	
R10	S, TS	S, TS	S, TS		S, TS	
R11	S, TS	S, TS	S, TS		S, TS	
R12	S, TS	S, TS	S, TS		S, TS	
R13	S, TS	S, TS	S, TS		S, TS	
R14	S, TS	S, TS	S, TS		S, TS	
R15	S, TS	S, TS	S, TS		S, TS	
R16	S	S	S		S	
R17	S, TS	S, TS	S, TS		S, TS	
R18	S, TS	S, TS	S, TS		S, TS	
R19	S, TS	S, TS	S, TS		S, TS	
R20	S	S	S		S	
R21	S	S	S		S	
R22	S, TS	S, TS	S, TS		S, TS	
R23	S	S	S		S	
R24	S	S	S		S	
R25	S	S	S		S	
R26	B	B	B		B	
R27	All	All	All		All	
R28	All	All	All		All	
others					All	

YK10-14 D04

sample No.	GSJ	IFREE (Tamura)	Kanaza wa	IFREE (Tani)	Tokai	Archive
R01	S, TS, relict	S, TS			Bx2	
R02						All
R03						All
R04	S, TS, relict					
R05	S, TS, relict					
R06	S, TS, relict					
R07	S, TS, relict	S, TS				
R08	S, TS, relict					
R09	S, TS, relict	S, TS				
R10	S, TS, relict	S, TS			B (relict all)	
R11	S, TS, relict					
R12	S, TS, relict					
R13	S, TS, relict					
R14	S, TS, relict	S, TS				
R15	S, TS, relict	S, TS				
R16	S, TS, relict	S, TS				
R17	S, TS, relict				B	
R18	S, TS, relict					
R19	S, TS, relict				B	
R20	S, TS, relict					
R21	TS				B	
R22						All
R23						All
S01					All	
others					All	

YK10-14 D05

sample No.	GSJ	IFREE (Tamura)	Kanaza wa	IFREE (Tani)	Tokai	Archive
S01					All	

YK10-14 D06

sample No.	GSJ	IFREE (Tamura)	Kanaza wa	IFREE (Tani)	Tokai	Archive
R01					All	
R02					All	
R03					All	
R04						All
R05	All					
R06	All					
R07						All
S01					All	
Others					All	

YK10-14 D07

sample No.	GSJ	IFREE (Tamura)	Kanaza wa	IFREE (Tani)	Tokai	Archive
R01	S, TS, relict				B, Mn-oxide, relict	
R02	S, TS, relict				B	
R03	S, TS, relict				B	
R04	S, TS, relict					
R05	S, TS, relict					
R06	S, TS, relict				B	
R07	S, TS, relict				B	
R08	S, TS, relict				B	
R09	S, TS, relict				B	
R10	S, TS, relict				B	
R11	S, TS, relict				B	
R12	S, TS, relict				B	
R13	S, TS, relict					
R14	S, TS, relict					
R15	S, TS, relict				B	
R16	S					
R17					All	
R18					B	relict
R19	S					
R20					All	
R21					All	
S01					All	
others					All	

YK10-14 D08

sample No.	GSJ	IFREE (Tamura)	Kanaza wa	IFREE (Tani)	Tokai	Archive
R01	S, TS, relict	TS			TS	
R02	TS, relict				B	
R03					All	
R04					All	
R05	All				TS After GSJ	
R06	All					
R07	All					
S01					All	
others					All	

YK10-14 D09

sample No.	GSJ	IFREE (Tamura)	Kanaza wa	IFREE (Tani)	Tokai	Archive
R01				B	B	
R02				B	B	
R03					B	relict
R04					B	relict
R05					B	relict
R06					B	relict
R07					B	relict
R08	All					
S01					All	
others					All	

YK10-14 D10

sample No.	GSJ	IFREE (Tamura)	Kanaza wa	IFREE (Tani)	Tokai	Archive
R01	S, relict	S		B	B	
R02	S, relict			B	B	
R03	S			B	B	
R04	S			B	B	
R05	S, relict				B	
R06	S, relict				B	
R07	S, relict				B	
R08	S, relict				B	
R09	S, relict				B	
R10	S, relict				B	
R11	S, relict				B	
R12	S, relict				B	
R13	S, relict				B	
R14	S, relict				B	
R15	S, relict				B	
R16	S, relict				B	
R17					B	relict
R18					B	relict
R19	S			B	B	
R20					B	relict
S01					All	
others					All	

YK10-14 D11

sample No.	GSJ	IFREE (Tamura)	Kanaza wa	IFREE (Tani)	Tokai	Archive
R01	B		B	relict	TS	
R02			B	relict	TS	
R03			B	relict	TS	
R04			B	relict	TS	
R05			B	relict	TS	
R06			B	relict	TS	
R07			B	relict	TS	
R08	TS		B	relict	TS	
R09			B	relict	TS	
R10			B	relict	TS	
R11	TS		B	relict	TS	
R12			B	relict	TS	
R13			B	relict	TS	
R14			B	relict	TS	
Others				All		

YK10-14 D012

sample No.	GSJ	IFREE (Tamura)	Kanaza wa	IFREE (Tani)	Tokai	Archive
R01		B, relict			B	
R02		B, relict			B	
R03		B, relict			B	
R04		B, relict			B	
R05		B, relict			B	
R06		B, relict			B	
R07		B, relict			B	
R08		B, relict			B	
R09		B, relict			B	
R10		B, relict			B	
R11		B, relict			B	
R12		B, relict			B	
R13	B	B, relict			B	
R14		B, relict			B	
R15		B, relict			B	
R16		B, relict			B	
R17		B, relict			B	
R18		B, relict			B	
R19		B, relict			B	
R20		B, relict			B	
R21	B	B, relict			B	
R22		B, relict			B	
R23	B	B, relict			B	
R24		B, relict			B	
R25		B, relict			B	
R26		B, relict			B	
R27		B, relict			B	
R28		B, relict			B	
Others					All(Box)	