Preliminary Report
of
The Hakuho Maru Cruise KH-02-4
(The Sulu Sea and the Western Pacific)

November 7—December 18, 2002

Studies on Biodiversity and Geochemical Cycles in the Sulu Sea and its Adjacent Waters

Ocean Research Institute
University of Tokyo
2004

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by
The scientific Members of the Expedition

Edited by
Shuhei NISHIDA
and
Toshitaka GAMO

Contents

1. Introduction

The *Hakuho Maru* KH-02-4 Cruise was conducted by the Ocean Research Institute, University of Tokyo, from 7 November to 18 December 2002 (42 days) in the Sulu Sea and its adjacent waters (equatorial Pacific, Celebes Sea and South China Sea).

The Sulu Sea is located approximately in the center of the Indo-Pacific Biogeographic Region, and is surrounded by many islands and sills shallower than 420 m. The water temperature in the meso- and bathypelalgic zones is fairly high (ca. 10°C) and homogeneous through to the bottom of ca. 5000-m depth. Hence the area is interesting in terms of biodiversity and biogeochemical cycles. While fragmentary knowledge has been obtained on the fauna and flora of the area through historical expeditions, still little is known on the details of the biological assemblages, ecosystem dynamics, water circulation, and biogeochemical cycles including those from paleoceanographic viewpoints.

Under such circumstances, the present cruise was conducted to investigate the distribution and dynamics of (1) pelagic and benthic organisms, (2) environmental variables, (3) chemical tracers such as trace metals, and (4) particulate organic matters, sediment and other related components in the Sulu Sea and its adjacent waters. For these purposes, biological- and sediment sampling by using various types of plankton nets, beam trawls and corers, and general observation and water sampling with a CTD-Carousel system were conducted successfully as detailed in this report.

Besides thirty-six scientists from various universities and institutes in Japan, we were fortunate to have three scientists from the Philippines, one from India, and the other from Taiwan to participate in the cruise. The Government of the Philippines gave us permissions to carry out the oceanographic research in the present areas. We sincerely thank *Monbukagakusho* (The Ministry of Education, Culture, Sports, Science and Technology) and the Ministry of Foreign Affairs for their official efforts to get the permission in time.

Special thanks are due to the Captain Setsuo Hayashikawa, the officers, and crew members of *Hakuho Maru* for their collaboration in the successful conduct of all shipboard operations.

Shuhei Nishida (Chief Scientist)
and
The Shipboard Scientific Party

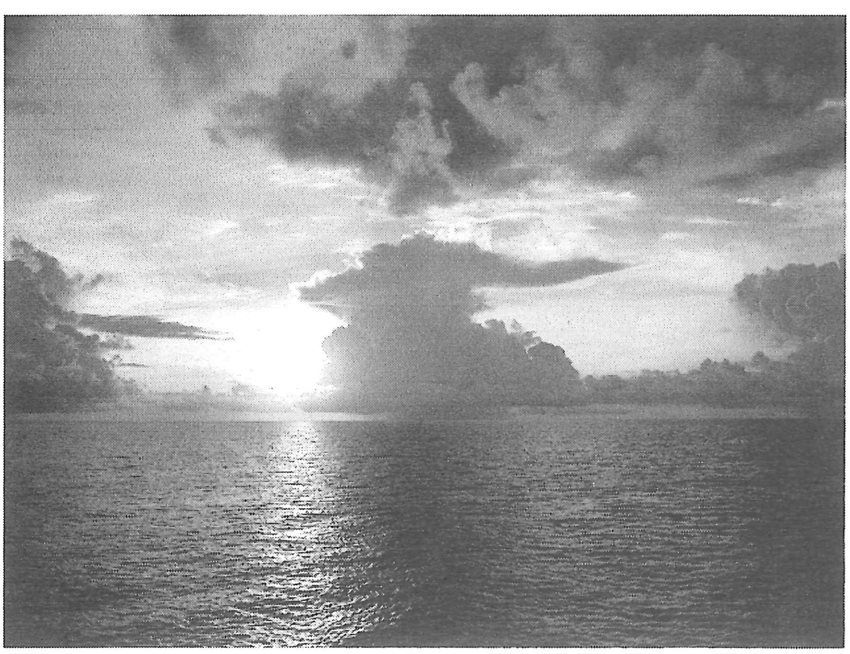


Photo : One day we had a very beautiful sunset in the Sulu Sea showing all weather, fine, cloudy, and rainy, in a small area. (Taken by J. Nishikawa.)

2. Caution with the data included in this report

Data in this preliminary report should be treated as carefully as possible, in order to protect the priority of the cruise participants. Confidential and publication policies are as follows.

1) Although all data included in this report is common to the cruise participants, primary investigator of each study item have higher priority to use the data.
2) Any questions or problems on the publication policy should be forwarded to the chief scientist.

KH-02-4 Leg II
Cebu-Tokyo
Dec. 2 - 18, 2002

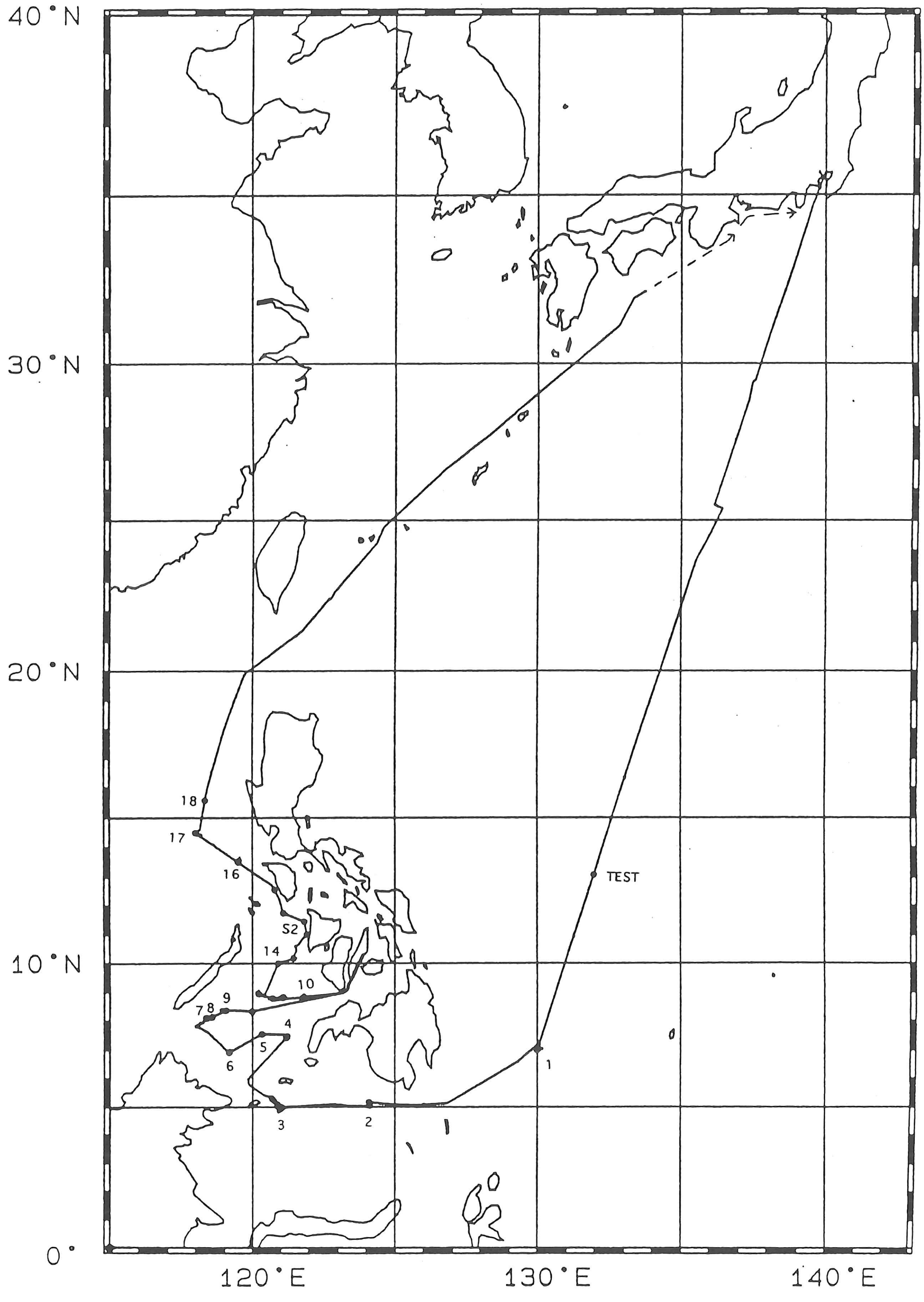
3. List of Scientists

(Family name)	(First name)	(Affiliation)	Leg-1	Leg-2
AKIYAMA	Tadashi	Okayama University	○	○
ALIBO	Dia Sotto	University of San Carlos	○	
ARII	Yasuhito	Kinki University	○	○
CAMPOS	Wilfredo L.	University of the Philippines		○
CASTILLO	Lourdes V.	University of the Philippines	○	○
DOI	Takashi	University of Shiga Prefecture		○
GAMO	Toshitaka	Hokkaido University		○
HASUMOTO	Hiroshi	University of Tokyo	○	○
INAGAKI	Tadashi	University of Tokyo	○	○
KATO	Yoshihisa	Tokai University		○
KOJIMA	Shigeaki	University of Tokyo	○	
KONDO	Yoshiko	University of Tokyo	○	○
KURIIWA	Kaoru	University of Tokyo	○	○
MACHIDA	Ryuji	University of Tokyo	○	○
MATSUURA	Hiroyuki	University of Tokyo	○	○
MIKI	Meguru	University of Toko	○	○
MILLER	Michael J.	University of Tokyo	○	○
MINAMI	Hideki	Hokkaido Tokai University	○	
MIURA	Toshiaki	University of Tokyo	○	○
MURAYAMA	Masafumi	Kochi University	○	○
NAGAO	Seiya	Hokkaido University	○	○
NAKAMURA	Kouichiro	Japan Women's College of Physical Education	○	
NISHIDA*	Shuhei	University of Tokyo	○	○
NISHIKAWA	Jun	University of Tokyo	○	○
NISHIMURA	Masahiko	University of Tokyo		○
NOMAKI	Hidetaka	University of Tokyo	○	○
NOMURA	Hideaki	University of Tokyo	○	○
NORISUYE	Kazuhiro	Kyoto University		○
OBATA	Hajime	University of Tokyo	○	○
OHTA	Suguru	University of Tokyo	○	○
OHTSUKA	Susumu	Hiroshima University		○
OKUBO	Ayako	University of Tokyo	○	○
RAMAIAH	Neelam	University of Tokyo	○	○
SHIMANAGA	Motohiro	University of Tokyo	○	○
SUETSUGU	Kishiko	University of Tokyo	○	
TAKEDA	Shigenobu	University of Tokyo	○	
YAMAGUCHI	Motoomi	University of Tokyo	○	○
YAMAGUCHI	Yoshitaka	Kinki University	○	○
YEH	Hsin-ming	Academia Sinica, Taiwan	○	○
YOSHIDA	Akihiro	University of Tokyo	○	○
YOSHIDA	Keisuke	University of Tokyo	○	○

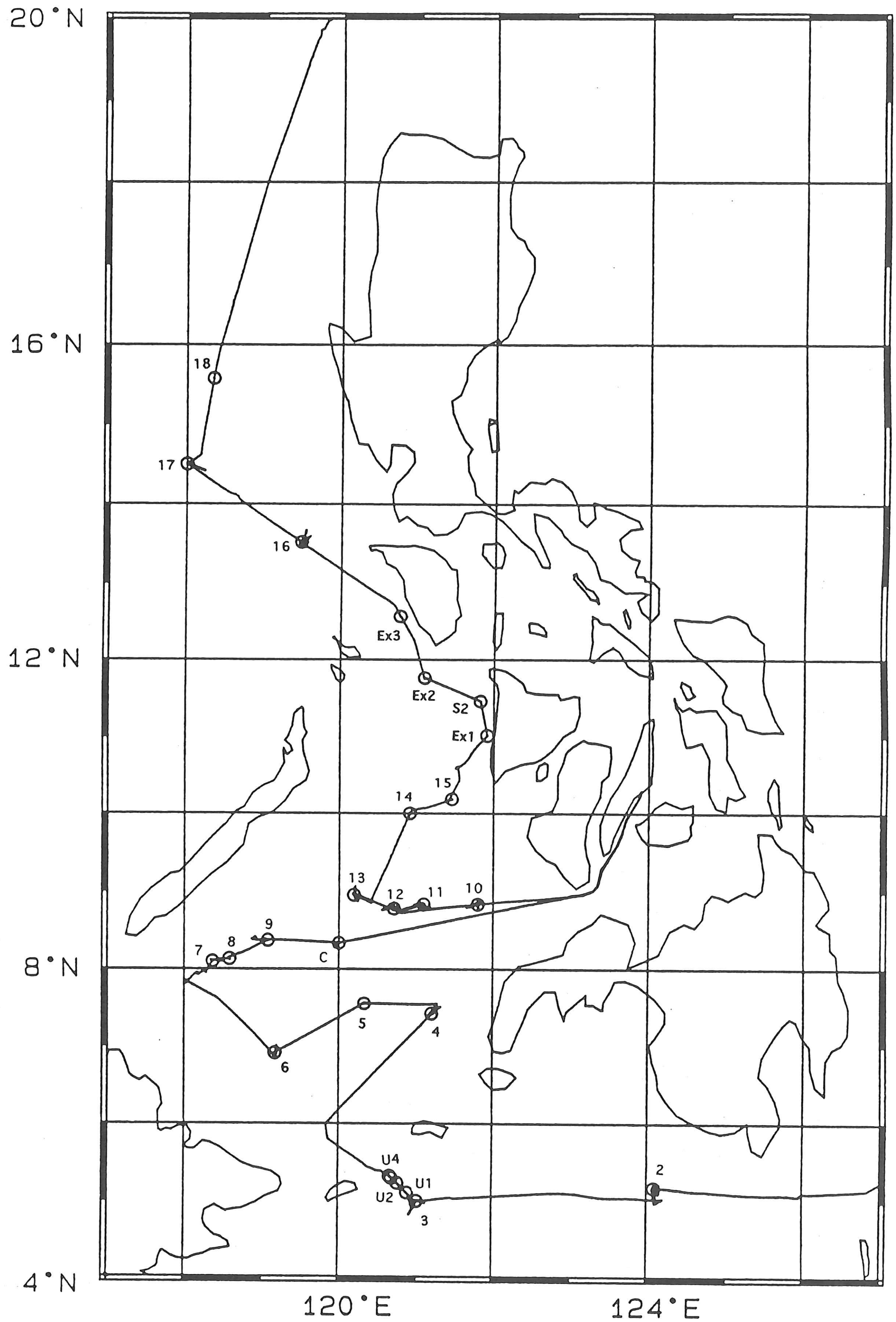
(* Chief Scientist)

4. Track and drift charts

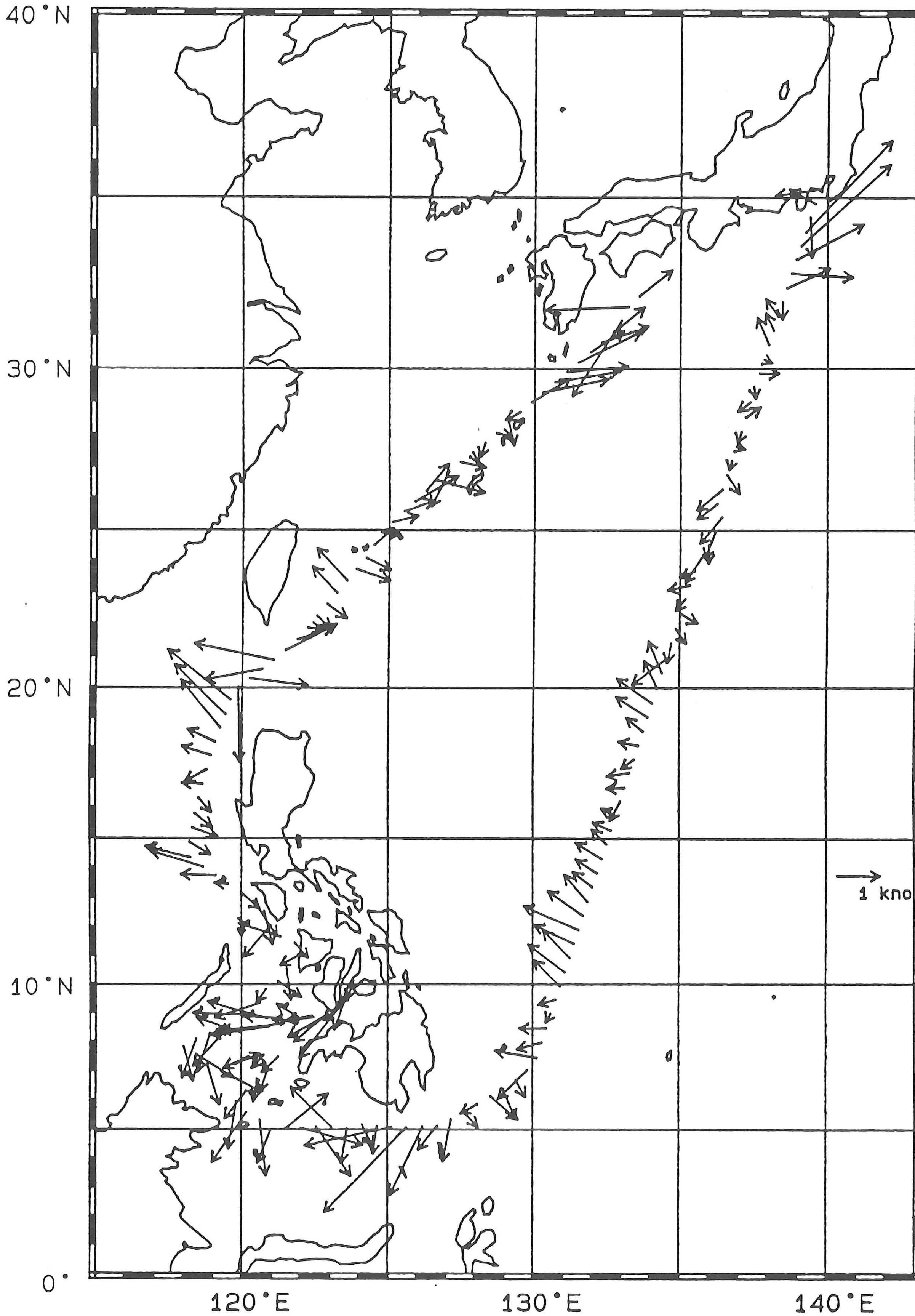
4-1. Track chart for the whole cruise



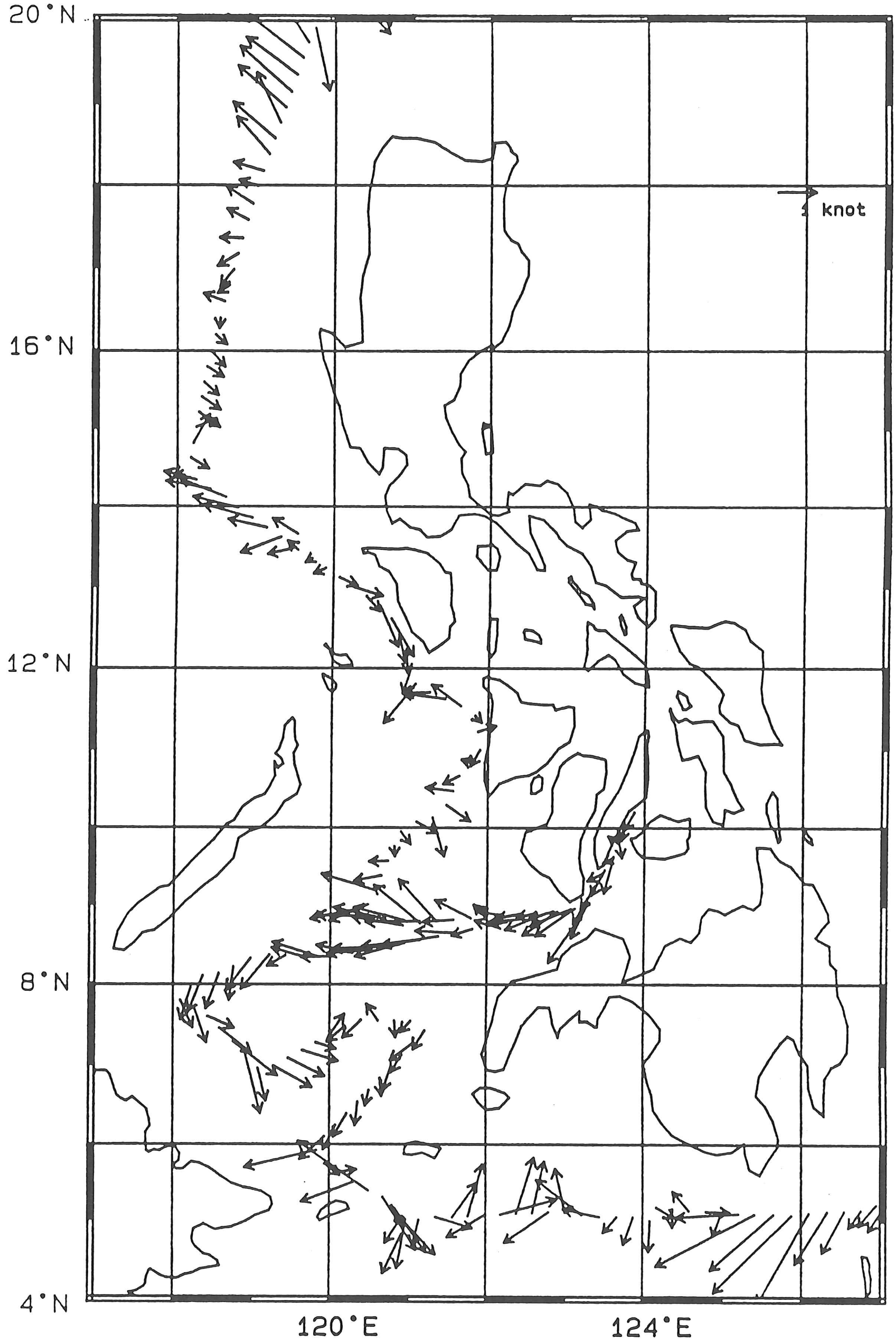
4-2. Track chart for the Celebes, Sulu and South China Seas



4-3. Drift chart for the whole cruise



4-4. Drift chart for the Celebes, Sulu and South China Seas



5. Working Log

Leg 1

	----- 07 NOV.02 (GMT) -----				
	07:42	35° 03.115N	139° 41.776E	820m	SUNSET & TURNED ON REGULATION LIGHTS
	21:08	31° 45.595N	138° 24.968E	3540m	SUNRISE & TURNED OFF REGULATION LIGHTS
	----- 08 NOV.02 (GMT) -----				
	08:00	29° 02.210N	137° 23.458E	4164m	SUNSET & TURNED ON REGULATION LIGHTS
	21:09	25° 39.508N	136° 11.797E	3156m	SUNRISE & TURNED OFF REGULATION LIGHTS
	----- 09 NOV.02 (GMT) -----				
	21:09	19° 52.128N	134° 12.254E	5808m	SUNRISE & TURNED OFF REGULATION LIGHTS
	----- 10 NOV.02 (GMT) -----				
E-01	11:05	16° 19.481N	133° 01.804E	6103m	IKMT-NET STARTED (W.O. 500m)
E-01	11:22	16° 19.935N	133° 02.446E	6014m	IKMT-NET DEEPEST
E-01	11:24	16° 19.988N	133° 02.516E	6068m	ORI SIDE NET STARTED
E-01	11:34	16° 20.188N	133° 02.814E	6070m	ORI SIDE NET FINISHED
E-01	11:53	16° 20.530N	133° 03.265E	5518m	IKMT-NET FINISHED
	21:10	14° 03.704N	132° 16.941E	5721m	SUNRISE & TURNED OFF REGULATION LIGHTS
	----- 11 NOV.02 (GMT) -----				
TEST	01:10	13° 04.183N	131° 57.604E	6434m	CTD-CMS STARTED
TEST	01:42	13° 04.458N	131° 57.451E	6000m	CTD-CMS DEEPEST
TEST	02:18	13° 04.767N	131° 57.329E	5548m	CTD-CMS FINISHED
	08:48	11° 28.227N	131° 26.228E	6216m	SUNSET & TURNED ON REGULATION LIGHTS
E-02	11:03	10° 55.264N	131° 15.652E	5807m	IKMT-NET STARTED (W.O. 500m)
E-02	11:16	10° 55.570N	131° 16.163E	5700m	IKMT-NET DEEPEST
E-02	11:18	10° 55.613N	131° 16.223E	5750m	ORI SIDE NET STARTED
E-02	11:27	10° 55.773N	131° 16.453E	5760m	ORI SIDE NET FINISHED
E-02	11:45	10° 56.083N	131° 16.894E	5748m	IKMT-NET FINISHED
	16:00	09° 54.324N	130° 55.902E	6098m	PUT CLOCK ABACK 1H FOR PHILIPPINES TIME
	21:10	08° 33.470N	130° 29.940E	5865m	SUNRISE & TURNED OFF REGULATION LIGHTS
	----- 12 NOV.02 (GMT) -----				
ST-01	03:20	06° 59.884N	129° 59.843E	5504m	CTD-CMS STARTED
ST-01	04:22	07° 00.357N	129° 59.264E	5490m	NORPAC NET STARTED (DAY-1)
ST-01	04:40	07° 00.557N	129° 59.144E	5493m	NORPAC NET FINISHED
ST-01	04:46	07° 00.547N	129° 59.218E	5493m	NORPAC NET STARTED (DAY-2)
ST-01	04:58	07° 00.567N	129° 59.086E	5490m	NORPAC NET FINISHED
ST-01	05:04	07° 00.594N	129° 59.088E	5488m	CTD-CMS DEEPEST
ST-01	07:23	07° 01.756N	129° 59.145E	5503m	CTD-CMS FINISHED
ST-01	07:44	07° 02.181N	129° 58.908E	5504m	MULTIPUL CORER STARTED (1)
	09:00	07° 02.698N	129° 58.921E	5503m	SUNSET & TURNED ON REGULATION LIGHTS
ST-01	09:38	07° 02.665N	129° 59.113E	5510m	MULTIPUL CORER HIT BOTTOM
ST-01	11:16	07° 02.098N	129° 59.063E	5511m	MULTIPUL CORER ON DECK
ST-01	11:44	07° 00.191N	129° 59.723E	5502m	CTD-CMS STARTED
ST-01	11:56	07° 00.240N	129° 59.550E	5492m	CTD-CMS DEEPEST
ST-01	12:19	07° 00.539N	129° 59.382E	5485m	CTD-CMS FINISHED
ST-01	12:28	07° 00.685N	129° 59.226E	5489m	ORI NET(OBL.) STARTED (W.O.2000m)
ST-01	13:06	07° 00.538N	129° 59.875E	5495m	ORI NET(OBL.) DEEPEST
ST-01	13:57	07° 00.421N	130° 00.574E	5508m	ORI NET(OBL.) FINISHED
ST-01	14:23	07° 00.536N	130° 00.424E	5504m	VMPS NET STARTED (NIGHT)
ST-01	15:42	07° 01.081N	130° 00.294E	5512m	VMPS NET DEEPEST
ST-01	16:55	07° 01.203N	130° 00.734E	5517m	VMPS NET FINISHED
ST-01	17:57	07° 01.596N	130° 01.261E	5513m	ORI NET(HOR.) STARTED (W.O.5000m)
ST-01	19:29	07° 02.135N	130° 05.126E	5487m	ORI NET(HOR.) DEEPSEST
ST-01	19:31	07° 02.158N	130° 05.175E	5489m	LET GO MESSENGER
ST-01	20:10	07° 02.820N	130° 06.828E	5511m	LET GO MESSENGER
	21:10	07° 02.392N	130° 09.094E	5515m	SUNRISE & TURNED OFF REGULATION LIGHTS
ST-01	21:55	07° 01.874N	130° 10.819E	5517m	ORI NET(HOR.) FINISHED
ST-01	23:45	06° 59.948N	129° 59.704E	5504m	MULTIPUL CORER STARTED (2)
	----- 13 NOV.02 (GMT) -----				
ST-01	01:30	06° 59.501N	129° 59.149E	5501m	MULTIPUL CORER HIT BOTTOM
ST-01	03:07	06° 58.864N	129° 59.175E	5504m	MULTIPUL CORER ON DECK
ST-01	03:19	06° 58.754N	129° 59.048E	5511m	VMPS NET STARTED (DAY)
ST-01	04:38	06° 59.134N	129° 58.699E	5499m	VMPS NET DEEPEST
ST-01	05:50	06° 59.358N	129° 58.389E	5497m	VMPS NET FINISHED
ST-01	06:44	07° 00.411N	129° 58.938E	5488m	MOCNESS NET STARTED (DEEP)
ST-01	07:45	07° 02.377N	130° 00.261E	5512m	MOCNESS NET DEEPEST
	09:00	07° 04.411N	130° 01.597E	5482m	SUNSET & TURNED ON REGULATION LIGHTS
ST-01	10:36	07° 07.367N	130° 03.341E	5461m	MOCNESS NET FINISHED
ST-01	11:00	07° 07.685N	130° 03.314E	5453m	MOCNESS NET STARTED (SHALLOW)
ST-01	11:16	07° 08.081N	130° 03.473E	5457m	MOCNESS NET DEEPEST
ST-01	12:44	07° 10.936N	130° 05.393E	5426m	MOCNESS NET FINISHED
ST-01	14:06	06° 59.956N	130° 00.138E	5469m	CTD-CMS STARTED
ST-01	15:02	07° 00.128N	129° 59.766E	0m	NORPAC NET STARTED (NIGHT-1)
ST-01	15:14	07° 00.185N	129° 59.761E	4804m	NORPAC NET FINISHED
ST-01	15:21	07° 00.231N	129° 59.772E	5009m	NORPAC NET STARTED (NIGHT-2)

ST-01 15:30 07° 00.210N 129° 59.787E 5276m NORPAC NET FINISHED
ST-01 15:33 07° 00.199N 129° 59.788E 5369m NORPAC NET STARTED (NIGHT-3)
ST-01 15:37 07° 00.193N 129° 59.788E 5478m CTD-CMS DEEPEST
ST-01 15:44 07° 00.151N 129° 59.776E 5466m NORPAC NET FINISHED
ST-01 15:47 07° 00.123N 129° 59.775E 5464m NORPAC NET STARTED (NIGHT-4)
ST-01 15:51 07° 00.098N 129° 59.770E 5468m NORPAC NET FINISHED
ST-01 17:26 07° 00.398N 129° 59.551E 5451m CTD-CMS FINISHED
E-03 17:36 07° 00.589N 129° 59.561E 5450m IKMT-NET STARTED (W.O. 500m)
E-03 17:52 07° 01.498N 129° 59.754E 5472m IKMT-NET DEEPEST
E-03 18:25 07° 02.649N 129° 59.955E 5477m IKMT-NET FINISHED
E-04 18:31 07° 02.908N 130° 00.001E 5478m IKMT-NET STARTED (W.O.4000m)
E-04 18:35 07° 03.070N 130° 00.031E 5478m ORI SIDE NET STARTED
E-04 18:46 07° 03.494N 130° 00.143E 5479m ORI SIDE NET FINISHED
E-04 19:46 07° 06.301N 130° 00.561E 5422m IKMT-NET DEEPEST
21:10 07° 09.763N 130° 00.583E 5477m SUNRISE & TURNED OFF REGULATION LIGHTS
E-04 21:23 07° 10.328N 130° 00.599E 5476m IKMT-NET FINISHED
----- 14 NOV.02 (GMT) -----
09:11 05° 26.620N 127° 20.635E 5757m SUNSET & TURNED ON REGULATION LIGHTS
E-05 14:12 05° 06.335N 125° 59.717E 2896m IKMT-NET STARTED (W.O. 500m)
E-05 14:26 05° 05.521N 125° 58.559E 2784m IKMT-NET DEEPEST
E-05 14:26 05° 05.492N 125° 58.522E 2779m ORI SIDE NET STARTED
E-05 14:36 05° 05.050N 125° 57.867E 2788m ORI SIDE NET FINISHED
E-05 14:55 05° 04.150N 125° 56.680E 2527m IKMT-NET FINISHED
ST-02 21:43 05° 10.890N 124° 04.800E 5090m CTD-CMS STARTED
ST-02 21:54 05° 10.802N 124° 04.870E 5090m CTD-CMS DEEPEST
ST-02 22:15 05° 10.788N 124° 04.922E 5090m CTD-CMS FINISHED
ST-02 23:58 05° 10.980N 124° 05.134E 5096m STARTED TO LAUNCH SEDIMENT-TRAP
----- 15 NOV.02 (GMT) -----
ST-02 00:31 05° 10.702N 124° 05.602E 5108m FINISHED TO LAUNCH SEDIMENT-TRAP
ST-02 00:44 05° 10.448N 124° 05.851E 5114m ORI NET(OBL.) STARTED (W.O.2000m)
ST-02 01:24 05° 09.067N 124° 07.379E 5140m ORI NET(OBL.) DEEPEST
ST-02 02:18 05° 06.966N 124° 09.248E 5151m ORI NET(OBL.) FINISHED
ST-02 03:49 05° 10.213N 124° 07.055E 5138m LAUNCHED SEDIMENT-TRAP
ST-02 04:15 05° 10.108N 124° 07.115E 5137m MOCNESS NET STARTED (DAY SHALLOW)
ST-02 04:31 05° 09.518N 124° 07.549E 5149m MOCNESS NET DEEPEST
ST-02 06:03 05° 05.844N 124° 08.686E 5124m MOCNESS NET FINISHED
ST-02 06:28 05° 06.905N 124° 08.446E 5134m MOCNESS NET STARTED (DAY DEEP)
ST-02 07:12 05° 08.483N 124° 07.978E 5144m MOCNESS NET DEEPEST
09:25 05° 13.306N 124° 06.092E 5141m SUNSET & TURNED ON REGULATION LIGHTS
ST-02 09:52 05° 13.994N 124° 05.729E 5137m MOCNESS NET FINISHED
ST-02 10:14 05° 13.301N 124° 05.816E 5134m MOCNESS NET STARTED (NIGHT DEEP)
ST-02 11:12 05° 11.246N 124° 06.508E 5134m MOCNESS NET DEEPEST
ST-02 13:41 05° 06.469N 124° 08.398E 5132m MOCNESS NET FINISHED
ST-02 13:59 05° 06.749N 124° 08.462E 5137m MOCNESS NET STARTED (NIGHT SHALLOW)
ST-02 14:10 05° 07.024N 124° 08.364E 5134m MOCNESS NET DEEPEST
ST-02 15:17 05° 09.084N 124° 07.772E 5144m MOCNESS NET FINISHED
E-06 15:42 05° 09.185N 124° 07.684E 5142m IKMT-NET STARTED (W.O. 500m)
E-06 15:54 05° 09.729N 124° 07.410E 5147m IKMT-NET DEEPEST
E-06 15:56 05° 09.794N 124° 07.374E 5144m ORI SIDE NET STARTED
E-06 16:05 05° 10.020N 124° 07.215E 5144m ORI SIDE NET FINISHED
E-06 16:21 05° 10.419N 124° 06.916E 5142m IKMT-NET FINISHED
ST-02 16:44 05° 11.003N 124° 04.974E 5094m CTD-CMS STARTED
ST-02 16:59 05° 10.945N 124° 04.835E 5091m CTD-CMS DEEPEST
ST-02 17:13 05° 10.833N 124° 04.747E 5088m CTD-CMS FINISHED
ST-02 17:24 05° 10.800N 124° 04.657E 5088m CTD-CMS STARTED
ST-02 19:03 05° 11.181N 124° 04.795E 6430m CTD-CMS DEEPEST
ST-02 20:54 05° 11.188N 124° 05.029E 5097m CTD-CMS FINISHED
ST-02 21:06 05° 11.098N 124° 04.999E 5095m MULTIPUL CORER STARTED (1)
ST-02 22:43 05° 11.026N 124° 04.878E 4491m MULTIPUL CORER HIT BOTTOM
----- 16 NOV.02 (GMT) -----
ST-02 00:14 05° 10.903N 124° 05.291E 5098m MULTIPUL CORER ON DECK
ST-02 01:37 05° 10.802N 124° 04.796E 5088m VMPS NET STARTED (DAY)
ST-02 02:42 05° 10.429N 124° 04.918E 5088m VMPS NET DEEPEST
ST-02 03:44 05° 10.259N 124° 05.000E 5087m VMPS NET FINISHED
ST-02 04:05 05° 09.940N 124° 05.115E 5091m NORPAC NET STARTED (DAY)
ST-02 04:15 05° 09.783N 124° 05.173E 5088m NORPAC NET FINISHED
ST-02 04:38 05° 09.421N 124° 05.223E 5068m ORI NET(HOR.) STARTED (W.O.5000m)
ST-02 06:25 05° 05.364N 124° 05.778E 5041m ORI NET(HOR.) DEEPEST
ST-02 06:35 05° 05.075N 124° 05.847E 5045m LET'S GO MESSENGER
ST-02 07:04 05° 04.231N 124° 05.956E 5038m LET'S GO MESSENGER
ST-02 09:02 04° 59.736N 124° 06.919E 4931m ORI NET(HOR.) FINISHED
ST-02 09:12 04° 59.959N 124° 06.879E 4932m IKMT-NET STARTED (W.O.4000m)
09:26 05° 00.596N 124° 06.794E 4951m SUNSET & TURNED ON REGULATION LIGHTS
ST-02 10:25 05° 03.375N 124° 06.466E 5024m IKMT-NET DEEPEST
ST-02 12:03 05° 06.589N 124° 05.884E 5063m IKMT-NET FINISHED
ST-02 12:45 05° 10.966N 124° 04.985E 5094m NORPAC NET STARTED (NIGHT-1)
ST-02 12:57 05° 10.859N 124° 04.925E 5091m NORPAC NET FINISHED

ST-02	13:00	05° 10.842N	124° 04.901E	5090m	NORPAC NET STARTED (NIGHT-2)
ST-02	13:08	05° 10.736N	124° 04.855E	5088m	NORPAC NET FINISHED
ST-02	13:10	05° 10.712N	124° 04.846E	5086m	NORPAC NET STARTED (NIGHT-3)
ST-02	13:19	05° 10.579N	124° 04.792E	5086m	NORPAC NET FINISHED
ST-02	13:22	05° 10.530N	124° 04.780E	5086m	NORPAC NET STARTED (NIGHT-4)
ST-02	13:25	05° 10.496N	124° 04.771E	5087m	NORPAC NET FINISHED
ST-02	13:33	05° 10.393N	124° 04.746E	5084m	VMPS NET STARTED (NIGHT)
ST-02	14:39	05° 10.259N	124° 04.585E	5084m	VMPS NET DEEPEST
ST-02	15:43	05° 10.127N	124° 04.078E	5055m	VMPS NET FINISHED
ST-02	16:04	05° 10.942N	124° 04.949E	5092m	MULTIPUL CORER STARTED (2)
ST-02	17:45	05° 11.845N	124° 04.641E	4730m	MULTIPUL CORER HIT BOTTOM
ST-02	19:18	05° 12.752N	124° 04.664E	5100m	MULTIPUL CORER ON DECK
ST-02	19:36	05° 11.839N	124° 04.487E	5087m	IKMT-NET STARTED (W.O.5000m)
ST-02	21:05	05° 06.314N	124° 04.596E	5031m	IKMT-NET DEEPEST
	21:26	05° 05.093N	124° 04.745E	5031m	SUNRISE & TURNED OFF REGULATION LIGHTS
ST-02	23:30	04° 58.781N	124° 05.907E	4934m	IKMT-NET FINISHED
----- 17 NOV.02 (GMT) -----					
ST-02	00:31	05° 02.024N	124° 12.110E	5019m	STARTED TO RETRIEVE SEDIMENT-TRAP
ST-02	01:01	05° 01.815N	124° 11.981E	5014m	FINISHED TO RETRIEVE SEDIMENT-TRAP
E-07	12:35	05° 00.001N	121° 03.860E	4129m	IKMT-NET STARTED (W.O. 500m)
E-07	12:46	05° 00.125N	121° 03.179E	4148m	IKMT-NET DEEPEST
E-07	12:47	05° 00.133N	121° 03.119E	4150m	ORI SIDE NET STARTED
E-07	12:58	05° 00.202N	121° 02.654E	4135m	ORI SIDE NET FINISHED
E-07	13:15	05° 00.382N	121° 01.866E	4133m	IKMT-NET FINISHED
ST-03	13:38	04° 59.929N	121° 00.920E	4152m	CTD-CMS STARTED
ST-03	14:58	05° 00.167N	121° 00.698E	4306m	CTD-CMS DEEPEST
ST-03	16:41	05° 00.285N	121° 00.790E	4154m	CTD-CMS FINISHED
ST-03	16:54	05° 00.217N	121° 00.761E	4160m	MULTIPUL CORER STARTED
ST-03	18:19	05° 00.379N	121° 01.321E	3580m	MULTIPUL CORER HIT BOTTOM
ST-03	19:34	05° 00.662N	121° 01.871E	4124m	MULTIPUL CORER ON DECK
ST-03	19:51	05° 00.666N	121° 02.012E	4122m	ORI NET(OBL.) STARTED (W.O.3000m)
ST-03	20:51	04° 59.900N	121° 04.637E	4121m	ORI NET(OBL.) DEEPEST
	21:43	04° 59.222N	121° 06.492E	4082m	SUNRISE & TURNED OFF REGULATION LIGHTS
ST-03	22:16	04° 58.619N	121° 07.565E	4156m	ORI NET(OBL.) FINISHED
----- 18 NOV.02 (GMT) -----					
ST-03	00:10	05° 00.079N	120° 59.917E	4126m	VMPS NET STARTED (DAY)
ST-03	01:17	04° 59.882N	120° 59.551E	4122m	VMPS NET DEEPEST
ST-03	02:21	04° 59.798N	120° 59.362E	4120m	VMPS NET FINISHED
ST-03	02:30	04° 59.661N	120° 59.272E	4120m	NORPAC NET STARTED (DAY)
ST-03	02:40	04° 59.534N	120° 59.171E	4120m	NORPAC NET FINISHED
U-4	04:54	05° 19.418N	120° 39.979E	3890m	CTD-CMS STARTED
U-4	05:11	05° 19.133N	120° 40.310E	502m	CTD-CMS DEEPEST
U-4	05:39	05° 18.705N	120° 40.619E	693m	CTD-CMS FINISHED
U-3	06:05	05° 17.201N	120° 42.097E	1388m	CTD-CMS STARTED
U-3	06:17	05° 17.081N	120° 42.340E	1457m	CTD-CMS DEEPEST
U-3	06:39	05° 16.929N	120° 42.617E	1490m	CTD-CMS FINISHED
U-2	07:08	05° 13.545N	120° 46.067E	2570m	CTD-CMS STARTED
U-2	07:24	05° 13.335N	120° 46.286E	2665m	CTD-CMS DEEPEST
U-2	07:47	05° 13.162N	120° 46.601E	2779m	CTD-CMS FINISHED
U-1	08:34	05° 06.405N	120° 53.197E	3466m	CTD-CMS STARTED
U-1	08:46	05° 06.269N	120° 53.217E	3472m	CTD-CMS DEEPEST
U-1	09:06	05° 06.214N	120° 53.376E	3486m	CTD-CMS FINISHED
ST-03	10:34	05° 00.189N	121° 00.151E	4126m	IKMT-NET STARTED (W.O.5000m)
ST-03	12:01	04° 54.886N	120° 58.113E	4154m	IKMT-NET DEEPEST
ST-03	13:47	04° 49.462N	120° 55.082E	4159m	IKMT-NET FINISHED
ST-03	15:04	04° 58.594N	120° 59.988E	4150m	VMPS NET STARTED (NIGHT)
ST-03	16:06	04° 58.570N	120° 59.845E	4148m	VMPS NET DEEPEST
ST-03	17:13	04° 58.625N	120° 59.832E	4147m	VMPS NET FINISHED
ST-03	17:21	04° 58.395N	120° 59.794E	4150m	NORPAC NET STARTED (NIGHT-1)
ST-03	17:31	04° 58.241N	120° 59.787E	4152m	NORPAC NET FINISHED
ST-03	17:34	04° 58.246N	120° 59.796E	4152m	NORPAC NET STARTED (NIGHT-2)
ST-03	17:40	04° 58.188N	120° 59.770E	4152m	NORPAC NET FINISHED
ST-03	17:43	04° 58.133N	120° 59.771E	4152m	NORPAC NET STARTED (NIGHT-3)
ST-03	17:52	04° 58.013N	120° 59.682E	4154m	NORPAC NET FINISHED
E-08	18:04	04° 57.527N	120° 59.443E	4159m	IKMT-NET STARTED (W.O. 600m)
E-08	18:18	04° 56.538N	120° 59.035E	4161m	IKMT-NET DEEPEST
E-08	18:18	04° 56.518N	120° 59.027E	4161m	ORI SIDE NET STARTED
E-08	18:29	04° 55.987N	120° 58.850E	4151m	ORI SIDE NET FINISHED
E-08	18:54	04° 54.608N	120° 58.412E	4164m	IKMT-NET FINISHED
	21:44	05° 12.452N	120° 46.994E	2784m	SUNRISE & TURNED OFF REGULATION LIGHTS
----- 19 NOV.02 (GMT) -----					
	09:34	07° 23.349N	121° 10.549E	4470m	SUNSET & TURNED ON REGULATION LIGHTS
ST-04	09:56	07° 25.115N	121° 12.201E	4478m	STARTED TO LAUNCH SEDIMENT-TRAP
ST-04	10:20	07° 25.148N	121° 12.229E	4479m	FINISHED TO LAUNCH SEDIMENT-TRAP
ST-04	10:34	07° 24.922N	121° 12.568E	4496m	CTD-CMS STARTED
ST-04	10:55	07° 24.944N	121° 12.484E	4491m	NORPAC NET STARTED (NIGHT-1)
ST-04	11:05	07° 25.003N	121° 12.467E	4491m	NORPAC NET FINISHED

ST-04 11:08 07° 25.007N 121° 12.452E 4488m NORPAC NET STARTED (NIGHT-2)
ST-04 11:16 07° 25.031N 121° 12.425E 4488m NORPAC NET FINISHED
ST-04 11:20 07° 25.062N 121° 12.419E 4486m NORPAC NET STARTED (NIGHT-3)
ST-04 11:24 07° 25.083N 121° 12.420E 4486m NORPAC NET FINISHED
ST-04 11:57 07° 25.058N 121° 12.473E 4199m CTD-CMS DEEPEST
ST-04 13:34 07° 25.199N 121° 12.123E 4475m CTD-CMS FINISHED
E-09 13:43 07° 25.218N 121° 12.196E 4476m IKMT-NET STARTED (W.O. 500m)
E-09 13:56 07° 25.635N 121° 12.706E 4488m IKMT-NET DEEPEST
E-09 14:24 07° 26.221N 121° 13.331E 4496m IKMT-NET FINISHED
E-09 14:44 07° 26.180N 121° 13.249E 4498m ORI SIDE NET STARTED
E-09 14:55 07° 26.398N 121° 13.535E 4487m ORI SIDE NET FINISHED
ST-04 15:32 07° 25.288N 121° 12.451E 4490m VMPS NET STARTED
ST-04 16:35 07° 25.364N 121° 12.198E 4471m VMPS NET DEEPEST
ST-04 17:40 07° 25.768N 121° 11.909E 4452m VMPS NET FINISHED
ST-04 17:48 07° 25.814N 121° 11.962E 4452m IKMT-NET STARTED (W.O.4000m)
ST-04 18:59 07° 28.312N 121° 14.293E 4444m IKMT-NET DEEPEST
ST-04 20:36 07° 30.833N 121° 16.630E 4489m IKMT-NET FINISHED
ST-04 21:38 07° 25.467N 121° 12.603E 4488m MULTIPUL CORER STARTED
21:48 07° 25.490N 121° 12.610E 4486m SUNRISE & TURNED OFF REGULATION LIGHTS
ST-04 23:06 07° 25.508N 121° 12.639E 4134m MULTIPUL CORER HIT BOTTOM
----- 20 NOV.02 (GMT) -----
ST-04 00:29 07° 25.580N 121° 12.909E 4505m MULTIPUL CORER ON DECK
ST-04 00:50 07° 25.282N 121° 12.502E 4490m VMPS NET STARTED (DAY)
ST-04 01:06 07° 25.158N 121° 12.356E 4486m NORPAC NET STARTED (DAY)
ST-04 01:18 07° 25.170N 121° 12.260E 4481m NORPAC NET FINISHED
ST-04 01:58 07° 25.150N 121° 12.142E 4477m VMPS NET DEEPEST
ST-04 03:02 07° 25.207N 121° 12.129E 4474m VMPS NET FINISHED
ST-04 03:39 07° 25.182N 121° 12.167E 4476m MOCNESS NET STARTED (DAY SHALLOW)
ST-04 03:50 07° 25.360N 121° 12.346E 4479m MOCNESS NET DEEPEST
ST-04 05:09 07° 27.413N 121° 14.248E 4459m MOCNESS NET FINISHED
ST-04 05:28 07° 26.178N 121° 12.999E 4497m MOCNESS NET STARTED (DAY DEEP)
ST-04 05:58 07° 26.641N 121° 13.571E 4474m MOCNESS NET DEEPEST
ST-04 08:15 07° 30.180N 121° 16.408E 4471m MOCNESS NET FINISHED
09:36 07° 25.222N 121° 12.263E 4478m SUNSET & TURNED ON REGULATION LIGHTS
ST-04 09:56 07° 25.158N 121° 12.220E 4478m MOCNESS NET STARTED (NIGHT DEEP)
ST-04 10:36 07° 26.299N 121° 13.555E 4491m MOCNESS NET DEEPEST
ST-04 13:03 07° 29.248N 121° 17.336E 4516m MOCNESS NET FINISHED
ST-04 13:30 07° 28.664N 121° 16.701E 4481m MOCNESS NET STARTED (NIGHT SHALLOW)
ST-04 13:44 07° 28.301N 121° 16.338E 4478m MOCNESS NET DEEPEST
ST-04 14:49 07° 26.520N 121° 14.616E 4502m MOCNESS NET FINISHED
E-10 15:09 07° 26.203N 121° 14.483E 4534m IKMT-NET STARTED (W.O. 600m)
E-10 15:23 07° 25.890N 121° 13.838E 4533m IKMT-NET DEEPEST
E-10 15:26 07° 25.832N 121° 13.728E 4527m ORI SIDE NET STARTED
E-10 15:36 07° 25.669N 121° 13.429E 4525m ORI SIDE NET FINISHED
E-10 15:57 07° 25.281N 121° 12.741E 4496m IKMT-NET FINISHED
ST-04 16:05 07° 25.288N 121° 12.572E 4492m CTD-CMS STARTED
ST-04 17:28 07° 25.412N 121° 12.343E 3927m CTD-CMS DEEPEST
ST-04 19:05 07° 25.704N 121° 12.050E 4457m CTD-CMS FINISHED
ST-04 19:24 07° 25.901N 121° 12.234E 4460m 4m BEAM-TRAWL STARTED
ST-04 21:24 07° 28.482N 121° 15.454E 4462m 4m BEAM-TRAWL ON BOTTOM
21:48 07° 28.835N 121° 15.982E 4462m SUNRISE & TURNED OFF REGULATION LIGHTS
ST-04 23:00 07° 29.751N 121° 17.202E 4504m 4m BEAM-TRAWL OFF BOTTOM
----- 21 NOV.02 (GMT) -----
ST-04 00:56 07° 30.417N 121° 19.184E 4544m 4m BEAM-TRAWL ON DECK
ST-04 02:09 07° 25.342N 121° 12.569E 4492m CTD-CMS STARTED
ST-04 02:20 07° 25.278N 121° 12.544E 4490m CTD-CMS DEEPEST
ST-04 02:42 07° 25.259N 121° 12.494E 4489m CTD-CMS FINISHED
ST-04 02:52 07° 25.238N 121° 12.543E 4489m ORI NET(OBL.) STARTED (W.O.3000m)
ST-04 03:47 07° 26.489N 121° 13.824E 4484m ORI NET(OBL.) DEEPEST
ST-04 05:27 07° 28.799N 121° 16.247E 4468m ORI NET(OBL.) FINISHED
ST-04 07:02 07° 23.238N 121° 09.125E 4442m STARTED TO RETRIEVE SEDIMENT-TRAP
ST-04 07:24 07° 22.884N 121° 08.830E 4438m FINISHED TO RETRIEVE SEDIMENT-TRAP
ST-04 07:41 07° 22.711N 121° 08.680E 4436m IKMT-NET STARTED (W.O.7000m)
09:34 07° 27.185N 121° 12.296E 4447m SUNSET & TURNED ON REGULATION LIGHTS
ST-04 09:41 07° 27.459N 121° 12.514E 4442m IKMT-NET DEEPEST
ST-04 12:34 07° 32.800N 121° 16.733E 4493m IKMT-NET FINISHED
E-11 16:12 07° 33.291N 120° 21.494E 3972m IKMT-NET STARTED (W.O. 500m)
E-11 16:26 07° 33.431N 120° 20.720E 3967m IKMT-NET DEEPEST
E-11 16:27 07° 33.439N 120° 20.666E 3966m ORI SIDE NET STARTED
E-11 16:37 07° 33.499N 120° 20.306E 3964m ORI SIDE NET FINISHED
E-11 16:55 07° 33.622N 120° 19.659E 3959m IKMT-NET FINISHED
ST-05 17:12 07° 32.981N 120° 19.497E 3962m CTD STARTED
ST-05 17:27 07° 33.214N 120° 19.463E 3960m NORPAC NET STARTED (1)
ST-05 17:37 07° 33.275N 120° 19.436E 3959m NORPAC NET FINISHED
ST-05 17:39 07° 33.286N 120° 19.429E 3958m NORPAC NET STARTED (2)
ST-05 17:48 07° 33.357N 120° 19.418E 3958m NORPAC NET FINISHED
ST-05 18:34 07° 33.482N 120° 19.295E 3751m CTD DEEPEST

ST-05	19:49	07° 33.815N	120° 19.275E	3955m	CTD FINISHED
ST-05	19:59	07° 33.830N	120° 19.300E	3954m	MULTIPUL CORER STARTED
ST-05	21:19	07° 33.815N	120° 19.479E	3510m	MULTIPUL CORER HIT BOTTOM
	21:52	07° 33.686N	120° 19.488E	3956m	SUNRISE & TURNED OFF REGULATION LIGHTS
ST-05	22:32	07° 33.483N	120° 19.522E	3958m	MULTIPUL CORER ON DECK
----- 22 NOV.02 (GMT) -----					
ST-06	03:54	06° 54.403N	119° 10.082E	2967m	MULTIPUL CORER STARTED
ST-06	05:05	06° 54.481N	119° 10.305E	3029m	MULTIPUL CORER HIT BOTTOM
ST-06	06:04	06° 54.421N	119° 10.731E	0m	MULTIPUL CORER ON DECK
ST-06	06:13	06° 54.432N	119° 10.798E	0m	CTD-CMS STARTED
ST-06	06:23	06° 54.358N	119° 10.897E	4536m	NORPAC NET STARTED (1)
ST-06	06:31	06° 54.333N	119° 10.939E	4784m	NORPAC NET FINISHED
ST-06	06:35	06° 54.326N	119° 10.947E	4753m	NORPAC NET STARTED (2)
ST-06	06:42	06° 54.267N	119° 10.967E	0m	NORPAC NET FINISHED
ST-06	06:44	06° 54.257N	119° 10.972E	2976m	NORPAC NET STARTED (3)
ST-06	06:53	06° 54.216N	119° 10.995E	2975m	NORPAC NET FINISHED
ST-06	07:22	06° 54.081N	119° 11.075E	2976m	CTD-CMS DEEPEST
ST-06	08:25	06° 53.677N	119° 11.220E	2966m	CTD-CMS FINISHED
ST-06	08:50	06° 53.424N	119° 11.347E	2967m	4m BEAM-TRAWL STARTED
ST-06	10:01	06° 55.491N	119° 11.101E	3009m	4m BEAM-TRAWL ON BOTTOM
ST-06	11:29	06° 57.580N	119° 11.043E	3000m	4m BEAM-TRAWL OFF BOTTOM
ST-06	12:51	06° 58.937N	119° 11.068E	2992m	4m BEAM-TRAWL ON DECK
E-12	14:02	06° 59.122N	119° 11.457E	3010m	IKMT-NET STARTED (W.O. 500m)
E-12	14:15	06° 59.556N	119° 11.474E	3010m	IKMT-NET DEEPEST
E-12	14:15	06° 59.586N	119° 11.474E	3010m	ORI SIDE NET STARTED
E-12	14:26	06° 59.785N	119° 11.508E	3014m	ORI SIDE NET FINISHED
E-12	14:42	07° 00.129N	119° 11.525E	3016m	IKMT-NET FINISHED
ST-06	14:48	07° 00.057N	119° 11.420E	3013m	IKMT-NET STARTED (W.O.4000m)
ST-06	15:58	06° 55.241N	119° 11.394E	3017m	IKMT-NET DEEPEST
ST-06	17:37	06° 51.111N	119° 10.871E	2956m	IKMT-NET FINISHED
S1-A	23:53	07° 50.861N	118° 00.039E	213m	3m BEAM-TRAWL STARTED
----- 23 NOV.02 (GMT) -----					
S1-A	00:08	07° 50.217N	118° 00.289E	214m	3m BEAM-TRAWL ON BOTTOM
S1-A	00:50	07° 49.186N	118° 00.683E	216m	3m BEAM-TRAWL OFF BOTTOM
S1-A	01:06	07° 48.714N	118° 00.821E	216m	3m BEAM-TRAWL ON DECK
S1-B	02:13	07° 57.121N	118° 09.825E	299m	3m BEAM-TRAWL STARTED
S1-B	02:30	07° 56.455N	118° 10.111E	296m	3m BEAM-TRAWL ON BOTTOM
S1-B	03:17	07° 55.360N	118° 10.335E	292m	3m BEAM-TRAWL OFF BOTTOM
S1-B	03:25	07° 55.173N	118° 10.366E	291m	3m BEAM-TRAWL ON DECK
S1-C	04:15	07° 58.899N	118° 16.016E	367m	3m BEAM-TRAWL STARTED
S1-C	04:32	07° 58.383N	118° 16.280E	368m	3m BEAM-TRAWL ON BOTTOM
S1-C	05:12	07° 57.489N	118° 16.695E	368m	3m BEAM-TRAWL OFF BOTTOM
S1-C	05:22	07° 57.213N	118° 16.626E	365m	3m BEAM-TRAWL ON DECK
ST-07	06:20	08° 05.965N	118° 21.944E	529m	CTD-CMS STARTED
ST-07	06:23	08° 05.952N	118° 21.941E	528m	NORPAC NET STARTED (1)
ST-07	06:33	08° 05.914N	118° 21.881E	545m	NORPAC NET FINISHED
ST-07	06:35	08° 05.895N	118° 21.875E	617m	CTD-CMS DEEPEST
ST-07	06:36	08° 05.893N	118° 21.874E	619m	NORPAC NET STARTED (2)
ST-07	06:43	08° 05.874N	118° 21.877E	526m	NORPAC NET FINISHED
ST-07	06:57	08° 05.815N	118° 21.788E	524m	CTD-CMS FINISHED
ST07A	07:09	08° 05.687N	118° 21.749E	522m	MULTIPUL CORER STARTED
ST07A	07:30	08° 05.749N	118° 21.658E	520m	MULTIPUL CORER HIT BOTTOM
ST07A	07:43	08° 05.808N	118° 21.568E	519m	MULTIPUL CORER ON DECK
ST07A	07:53	08° 05.835N	118° 21.499E	518m	UNDERWATER-CAMERA STARTED
ST07A	08:16	08° 05.765N	118° 21.339E	461m	UNDERWATER-CAMERA FILM STARTED
ST07A	09:20	08° 05.555N	118° 21.216E	279m	UNDERWATER-CAMERA FILM END
ST07A	09:32	08° 05.516N	118° 21.202E	0m	UNDERWATER-CAMERA ON DECK
	09:45	08° 05.451N	118° 21.132E	0m	SUNSET & TURNED ON REGULATION LIGHTS
ST07A	09:52	08° 05.522N	118° 21.061E	515m	3m BEAM-TRAWL STARTED
ST07A	09:58	08° 05.584N	118° 21.008E	514m	3m BEAM-TRAWL ON DECK
ST07A	10:09	08° 05.603N	118° 20.916E	513m	3m BEAM-TRAWL STARTED
ST07A	10:28	08° 05.942N	118° 20.759E	515m	3m BEAM-TRAWL ON BOTTOM
ST07A	11:03	08° 06.746N	118° 20.423E	516m	3m BEAM-TRAWL OFF BOTTOM
ST07A	11:22	08° 06.963N	118° 20.249E	515m	3m BEAM-TRAWL ON DECK
ST07B	12:19	08° 05.875N	118° 26.926E	699m	3m BEAM-TRAWL STARTED
ST07B	12:44	08° 06.379N	118° 26.487E	692m	3m BEAM-TRAWL ON BOTTOM
ST07B	13:25	08° 07.155N	118° 26.022E	689m	3m BEAM-TRAWL OFF BOTTOM
ST07B	13:45	08° 07.411N	118° 25.476E	672m	3m BEAM-TRAWL ON DECK
E-13	14:04	08° 07.118N	118° 25.845E	680m	IKMT-NET STARTED (W.O. 500m)
E-13	14:17	08° 07.033N	118° 26.307E	699m	IKMT-NET DEEPEST & ORI SIDE NET STARTED
E-13	14:27	08° 06.851N	118° 26.605E	709m	ORI SIDE NET FINISHED
E-13	14:44	08° 06.463N	118° 27.222E	724m	IKMT-NET FINISHED
ST08A	15:14	08° 06.074N	118° 29.323E	803m	3m BEAM-TRAWL STARTED
ST08A	15:37	08° 06.421N	118° 29.184E	804m	3m BEAM-TRAWL ON BOTTOM
ST08A	16:22	08° 07.321N	118° 28.454E	796m	3m BEAM-TRAWL OFF BOTTOM
ST08A	16:51	08° 07.569N	118° 27.982E	781m	3m BEAM-TRAWL ON DECK
ST08B	17:52	08° 07.976N	118° 34.950E	1034m	CTD STARTED

ST08B	18:17	08° 07.828N	118° 35.009E	1034m	CTD DEEPEST
ST08B	18:38	08° 07.828N	118° 35.021E	1036m	CTD FINISHED
ST08B	18:46	08° 07.769N	118° 35.064E	1036m	MULTIPUL CORER STARTED
ST08B	19:18	08° 07.653N	118° 35.173E	1041m	MULTIPUL CORER HIT BOTTOM
ST08B	19:38	08° 07.712N	118° 35.205E	1045m	MULTIPUL CORER ON DECK
ST08B	19:47	08° 07.678N	118° 35.247E	1046m	UNDERWATER-CAMERA STARTED
ST08B	20:31	08° 07.493N	118° 35.238E	1038m	UNDERWATER-CAMERA FILM STARTED
ST08B	21:40	08° 07.109N	118° 35.357E	1033m	UNDERWATER-CAMERA FILM END
ST08B	21:59	08° 07.006N	118° 35.341E	1026m	UNDERWATER-CAMERA ON DECK
	22:01	08° 06.988N	118° 35.338E	1026m	SUNRISE & TURNED OFF REGULATION LIGHTS
ST08B	22:19	08° 07.113N	118° 34.896E	998m	3m BEAM-TRAWL STARTED
ST08B	22:47	08° 07.725N	118° 34.770E	1012m	3m BEAM-TRAWL ON BOTTOM
ST08B	23:21	08° 08.511N	118° 34.452E	1016m	3m BEAM-TRAWL OFF BOTTOM
ST08B	23:48	08° 08.923N	118° 34.183E	1001m	3m BEAM-TRAWL ON DECK
----- 24 NOV.02 (GMT) -----					
ST-09	02:36	08° 22.026N	119° 04.821E	2030m	CTD-CMS STARTED
ST-09	02:43	08° 21.951N	119° 04.752E	2029m	NORPAC NET STARTED (1)
ST-09	02:52	08° 21.912N	119° 04.623E	2032m	NORPAC NET FINISHED
ST-09	02:55	08° 21.919N	119° 04.589E	2030m	NORPAC NET STARTED (2)
ST-09	03:04	08° 21.955N	119° 04.473E	2029m	NORPAC NET FINISHED
ST-09	03:08	08° 21.968N	119° 04.433E	2029m	NORPAC NET STARTED (3)
ST-09	03:16	08° 21.987N	119° 04.364E	2029m	NORPAC NET FINISHED
ST-09	03:19	08° 21.994N	119° 04.373E	2030m	CTD-CMS DEEPEST
ST-09	04:18	08° 22.162N	119° 04.474E	2030m	CTD-CMS FINISHED
ST-09	04:57	08° 23.066N	119° 02.996E	2027m	MULTIPUL CORER STARTED
ST-09	05:44	08° 23.264N	119° 03.003E	2028m	MULTIPUL CORER HIT BOTTOM
ST-09	06:22	08° 23.112N	119° 03.011E	2025m	MULTIPUL CORER ON DECK
ST-09	06:35	08° 22.992N	119° 02.993E	2028m	UNDERWATER-CAMERA STARTED
ST-09	07:20	08° 22.882N	119° 02.804E	2025m	UNDERWATER-CAMERA FILM STARTED
ST-09	08:40	08° 22.843N	119° 02.417E	2026m	UNDERWATER-CAMERA FILM END
ST-09	09:15	08° 22.764N	119° 02.200E	2028m	UNDERWATER-CAMERA ON DECK
ST-09	10:00	08° 22.192N	118° 56.999E	1988m	3m BEAM-TRAWL STARTED
ST-09	10:44	08° 22.784N	118° 56.153E	1986m	3m BEAM-TRAWL ON BOTTOM
ST-09	11:57	08° 24.360N	118° 55.543E	2016m	3m BEAM-TRAWL OFF BOTTOM
ST-09	12:41	08° 24.782N	118° 55.097E	2004m	3m BEAM-TRAWL ON DECK
E-14	13:00	08° 24.515N	118° 54.572E	2007m	IKMT-NET STARTED (W.O. 500m)
E-14	13:10	08° 24.077N	118° 53.964E	1994m	IKMT-NET DEEPEST & ORI SIDE NET STARTED
E-14	13:20	08° 23.718N	118° 53.524E	1993m	ORI SIDE NET FINISHED
E-14	13:38	08° 23.106N	118° 52.729E	1969m	IKMT-NET FINISHED
ST-C	18:24	08° 20.024N	119° 59.931E	3222m	CTD-CMS STARTED
ST-C	18:32	08° 20.047N	119° 59.852E	3229m	NORPAC NET STARTED (1)
ST-C	18:41	08° 20.135N	119° 59.749E	3238m	NORPAC NET FINISHED
ST-C	18:45	08° 20.153N	119° 59.712E	3235m	NORPAC NET STARTED (2)
ST-C	18:52	08° 20.211N	119° 59.650E	3232m	NORPAC NET FINISHED
ST-C	19:28	08° 20.357N	119° 59.710E	3201m	CTD-CMS DEEPEST
ST-C	20:46	08° 20.627N	119° 59.699E	3169m	CTD-CMS FINISHED
	21:55	08° 20.713N	119° 59.440E	3201m	SUNRISE & TURNED OFF REGULATION LIGHTS
----- 25 NOV.02 (GMT) -----					
	09:34	08° 30.563N	120° 52.390E	3944m	SUNSET & TURNED ON REGULATION LIGHTS
	21:44	09° 33.403N	123° 34.122E	780m	SUNRISE & TURNED OFF REGULATION LIGHTS

Leg 2

----- 02 DEC.02 (GMT) -----					
	09:26	09° 31.620N	123° 32.865E	758m	SUNSET & TURNED ON REGULATION LIGHTS
E-15	16:29	08° 50.428N	121° 50.690E	4811m	IKMT-NET STARTED (W.O 500m)
E-15	16:41	08° 50.385N	121° 49.877E	4811m	IKMT-NET DEEPEST
E-15	16:43	08° 50.383N	121° 49.798E	4811m	ORI SIDE NET STARTED
E-15	16:57	08° 50.358N	121° 49.099E	4810m	ORI NET FINISHED
E-15	17:10	08° 50.371N	121° 48.444E	4810m	IKMT-NET FINISHED
ST-10	17:34	08° 50.095N	121° 48.016E	4809m	CTD-CMS STARTED
ST-10	19:04	08° 50.004N	121° 47.678E	5432m	CTD-CMS DEEPEST
ST-10	20:52	08° 49.780N	121° 47.297E	4807m	CTD-CMS FINISHED
ST-10	21:14	08° 50.091N	121° 48.177E	4809m	UNDERWATER-CAMERA STARTED
	21:52	08° 50.098N	121° 47.858E	4809m	SUNRISE & TURNED OFF REGULATION LIGHTS
ST-10	22:50	08° 49.947N	121° 47.727E	4536m	UNDERWATER-CAMERA FILM STARTED
----- 03 DEC.02 (GMT) -----					
ST-10	00:10	08° 49.911N	121° 47.506E	4155m	UNDERWATER-CAMERA FILM END
ST-10	01:37	08° 49.651N	121° 47.293E	4808m	UNDERWATER-CAMERA ON DECK
ST-10	02:13	08° 50.088N	121° 48.134E	4810m	CTD-CMS STARTED
ST-10	02:18	08° 50.060N	121° 48.048E	4810m	NORPAC NET STARTED (DAY-1)
ST-10	02:25	08° 50.015N	121° 47.996E	4810m	CTD-CMS DEEPEST
ST-10	02:27	08° 49.999N	121° 47.989E	4810m	NORPAC NET FINISHED
ST-10	02:30	08° 49.980N	121° 47.979E	4814m	NORPAC NET STARTED (DAY-2)
ST-10	02:36	08° 49.932N	121° 47.960E	4809m	NORPAC NET FINISHED
ST-10	02:40	08° 49.907N	121° 47.950E	4809m	NORPAC NET STARTED (DAY-3)

ST-10	02:49	08° 49.840N	121° 47.888E	4810m	NORPAC NET FINISHED
ST-10	02:50	08° 49.832N	121° 47.876E	4810m	CTD-CMS FINISHED
ST-10	03:32	08° 46.269N	121° 48.612E	4810m	4m BEAM-TRAWL STARTED
ST-10	05:34	08° 50.275N	121° 48.671E	4810m	4m BEAM-TRAWL ON BOTTOM
ST-10	07:13	08° 52.340N	121° 49.156E	4810m	4m BEAM-TRAWL OFF BOTTOM
ST-10	09:16	08° 53.558N	121° 50.168E	4805m	4m BEAM-TRAWL ON DECK
	09:40	08° 53.378N	121° 50.170E	4805m	SUNSET & TURNED ON REGULATION LIGHTS
ST-10	09:46	08° 53.205N	121° 49.884E	4809m	IKMT-NET STARTED (W.O.4000m)
ST-10	10:57	08° 51.063N	121° 46.349E	4805m	IKMT-NET DEEPEST
ST-10	12:33	08° 48.435N	121° 41.593E	4777m	IKMT-NET FINISHED
E-16	12:40	08° 48.304N	121° 41.292E	4762m	IKMT-NET STARTED (W.O. 500m)
E-16	12:52	08° 47.957N	121° 40.570E	4710m	IKMT-NET DEEPEST
E-16	12:53	08° 47.936N	121° 40.523E	4706m	ORI SIDE NET STARTED
E-16	13:08	08° 47.738N	121° 39.882E	4665m	ORI SIDE NET FINISHED
E-16	13:20	08° 47.582N	121° 39.397E	4633m	IKMT-NET FINISHED
ST-10	14:44	08° 50.126N	121° 48.320E	4811m	CTD-CMS STARTED
ST-10	14:50	08° 50.118N	121° 48.255E	4810m	NORPAC NET STARTED (NIGHT-1)
ST-10	14:58	08° 50.122N	121° 48.139E	4810m	NORPAC NET FINISHED
ST-10	15:01	08° 50.103N	121° 48.120E	4810m	NORPAC NET STARTED (NIGHT-2)
ST-10	15:07	08° 50.054N	121° 48.087E	4810m	NORPAC NET FINISHED
ST-10	15:10	08° 50.036N	121° 48.080E	4810m	NORPAC NET STARTED (NIGHT-3)
ST-10	15:19	08° 49.971N	121° 48.052E	4810m	NORPAC NET FINISHED
ST-10	16:15	08° 50.220N	121° 48.049E	4314m	CTD-CMS DEEPEST
ST-10	17:52	08° 50.668N	121° 47.730E	4809m	CTD-CMS FINISHED
ST-10	18:01	08° 50.645N	121° 47.630E	4809m	ORI NET(OBL.) STARTED (W.O.2500m)
ST-10	18:48	08° 50.932N	121° 49.594E	4810m	ORI NET(OBL.) DEEPEST
ST-10	20:13	08° 51.043N	121° 52.168E	4803m	ORI NET(OBL.) FINISHED
ST-10	20:51	08° 50.105N	121° 48.201E	4809m	CTD-CMS STARTED
ST-10	21:14	08° 49.923N	121° 48.076E	4809m	CTD-CMS DEEPEST
ST-10	21:42	08° 49.928N	121° 48.086E	4809m	CTD-CMS FINISHED
	21:54	08° 49.896N	121° 48.060E	4809m	SUNRISE & TURNED OFF REGULATION LIGHTS
ST-10	22:34	08° 50.092N	121° 48.288E	4809m	CTD-CMS STARTED
ST-10	22:53	08° 50.026N	121° 48.263E	4809m	CTD-CMS DEEPEST
ST-10	23:09	08° 49.963N	121° 48.223E	4809m	CTD-CMS FINISHED

----- 04 DEC.02 (GMT) -----

ST-11	03:02	08° 50.014N	121° 05.499E	3668m	CTD-CMS STARTED
ST-11	04:13	08° 50.368N	121° 05.356E	4149m	CTD-CMS DEEPEST
ST-11	04:20	08° 50.412N	121° 05.350E	4294m	NORPAC NET STARTED (DAY)
ST-11	04:30	08° 50.473N	121° 05.231E	3790m	NORPAC NET FINISHED
ST-11	05:35	08° 50.874N	121° 05.174E	0m	CTD-CMS FINISHED
ST-11	05:47	08° 50.904N	121° 04.918E	3667m	STARTED TO SET BAITE TRAP
ST-11	05:59	08° 50.952N	121° 04.768E	3663m	FINISHED TO SET BAITE TRAP
ST-11	06:25	08° 49.806N	121° 06.018E	3666m	MULTIPUL CORER STARTED
ST-11	07:39	08° 49.998N	121° 05.729E	4265m	MULTIPUL CORER HIT BOTTOM
ST-11	08:48	08° 50.424N	121° 05.542E	4457m	MULTIPUL CORER ON DECK
ST-11	09:01	08° 50.543N	121° 05.171E	3669m	IKMT-NET STARTED (W.O.7000m)
	09:32	08° 50.168N	121° 02.942E	2977m	SUNSET & TURNED ON REGULATION LIGHTS
ST-11	11:00	08° 48.475N	120° 56.795E	3609m	IKMT-NET DEEPEST
ST-11	13:49	08° 45.510N	120° 47.691E	2880m	IKMT-NET FINISHED
E-17	13:55	08° 45.416N	120° 47.458E	2916m	IKMT-NET STARTED (W.O. 500m)
E-17	14:06	08° 45.112N	120° 46.661E	2842m	ORI SIDE NET STARTED
E-17	14:07	08° 45.095N	120° 46.618E	2844m	IKMT-NET DEEPEST
E-17	14:22	08° 44.773N	120° 45.854E	2918m	ORI SIDE NET FINISHED
E-17	14:37	08° 44.478N	120° 45.118E	2920m	IKMT-NET FINISHED
ST-11	16:28	08° 50.064N	121° 05.406E	3672m	VMPS NET STARTED (NIGHT)
ST-11	16:42	08° 50.040N	121° 05.072E	3668m	NORPAC NET STARTED (NIGHT-1)
ST-11	16:53	08° 50.014N	121° 04.971E	3667m	NORPAC NET FINISHED
ST-11	16:56	08° 50.003N	121° 04.944E	3667m	NORPAC NET STARTED (NIGHT-2)
ST-11	17:04	08° 49.981N	121° 04.883E	3667m	NORPAC NET FINISHED
ST-11	17:07	08° 49.971N	121° 04.859E	3667m	NORPAC NET STARTED (NIGHT-3)
ST-11	17:17	08° 49.923N	121° 04.757E	3665m	NORPAC NET FINISHED
ST-11	17:37	08° 49.921N	121° 04.691E	3665m	VMPS NET DEEPEST
ST-11	18:40	08° 49.498N	121° 04.125E	3605m	VMPS NET FINISHED
ST-11	19:03	08° 50.022N	121° 05.402E	3668m	CTD-CMS STARTED
ST-11	20:08	08° 50.332N	121° 05.132E	3668m	CTD-CMS DEEPEST
ST-11	21:28	08° 50.529N	121° 05.216E	3668m	CTD-CMS FINISHED
ST-11	21:39	08° 50.509N	121° 04.766E	3666m	ORI NET(OBL.) STARTED (W.O.2000m)
	21:57	08° 50.375N	121° 03.409E	3121m	SUNRISE & TURNED OFF REGULATION LIGHTS
ST-11	22:24	08° 50.116N	121° 01.601E	2770m	ORI NET(OBL.) DEEPEST
ST-11	23:32	08° 49.577N	120° 58.146E	3707m	ORI NET(OBL.) FINISHED

----- 05 DEC.02 (GMT) -----

ST-11	00:33	08° 49.994N	121° 05.690E	3668m	PISTON CORER STARTED
ST-11	02:12	08° 49.999N	121° 05.600E	3169m	PISTON CORER LANDED
ST-11	03:25	08° 49.990N	121° 05.646E	3668m	PISTON CORER FINISHED
ST-11	03:41	08° 50.114N	121° 05.394E	3668m	VMPS NET STARTED (DAY-1)
ST-11	04:44	08° 50.241N	121° 05.139E	3668m	VMPS NET DEEPEST
ST-11	05:56	08° 50.485N	121° 05.019E	3668m	VMPS NET FINISHED

ST-11	06:00	08° 50.479N	121° 04.932E	3669m	RELEASED BAITE TRAP
ST-11	06:11	08° 50.443N	121° 04.598E	3659m	VMPS NET STARTED (DAY-2)
ST-11	06:25	08° 50.462N	121° 04.356E	3646m	VMPS NET DEEPEST
ST-11	06:37	08° 50.503N	121° 04.276E	3648m	VMPS NET FINISHED
ST-11	07:28	08° 50.875N	121° 04.455E	3652m	POPPED UP BAITE TRAP
ST-11	07:37	08° 50.978N	121° 04.558E	3657m	STARTED TO RETRIEVE BAITE TRAP
ST-11	07:43	08° 51.053N	121° 04.467E	3654m	FINISHED TO RETRIEVE BAITE TRAP
ST-11	07:56	08° 51.053N	121° 04.137E	3668m	UNDERWATER-CAMERA STARTED
ST-11	09:10	08° 51.127N	121° 03.699E	3159m	UNDERWATER-CAMERA FILM STARTED
	09:36	08° 51.165N	121° 03.630E	3054m	SUNSET & TURNED ON REGULATION LIGHTS
ST-11	10:30	08° 51.210N	121° 03.500E	2882m	UNDERWATER-CAMERA FILM END
ST-11	11:29	08° 51.484N	121° 03.207E	2950m	UNDERWATER-CAMERA ON DECK
E-18	11:40	08° 51.513N	121° 02.765E	2759m	IKMT-NET STARTED (W.O. 500m)
E-18	11:53	08° 51.194N	121° 01.846E	3011m	IKMT-NET DEEPEST & ORI SIDE NET STARTED
E-18	12:09	08° 50.902N	121° 00.888E	3410m	ORI SIDE NET FINISHED
E-18	12:22	08° 50.622N	121° 00.022E	3413m	IKMT-NET FINISHED
ST-11	13:24	08° 46.061N	121° 03.838E	3976m	4m BEAM-TRAWL STARTED
ST-11	15:11	08° 46.891N	121° 06.855E	4022m	4m BEAM-TRAWL ON BOTTOM
ST-11	15:26	08° 47.013N	121° 07.359E	4031m	COM'CED TOWING
ST-11	16:23	08° 47.468N	121° 08.700E	4019m	FINISHED TOWING
ST-11	16:37	08° 47.540N	121° 08.907E	4020m	4m BEAM-TRAWL OFF BOTTOM
ST-11	18:32	08° 47.876N	121° 10.720E	3640m	4m BEAM-TRAWL ON DECK
	21:59	08° 46.847N	120° 42.657E	2908m	SUNRISE & TURNED OFF REGULATION LIGHTS
ST-12	22:06	08° 46.822N	120° 42.524E	2906m	CTD-CMS STARTED
ST-12	22:12	08° 46.803N	120° 42.428E	2907m	NORPAC NET STARTED (1)
ST-12	22:21	08° 46.767N	120° 42.298E	2907m	NORPAC NET FINISHED
ST-12	22:24	08° 46.764N	120° 42.275E	2906m	NORPAC NET STARTED (2)
ST-12	22:31	08° 46.760N	120° 42.226E	2906m	NORPAC NET FINISHED
ST-12	22:33	08° 46.761N	120° 42.207E	2907m	NORPAC NET STARTED (3)
ST-12	22:42	08° 46.772N	120° 42.130E	2905m	NORPAC NET FINISHED
ST-12	23:06	08° 46.820N	120° 42.179E	3221m	CTD-CMS DEEPEST

----- 06 DEC. 02 (GMT) -----

ST-12	00:13	08° 46.784N	120° 42.098E	2904m	CTD-CMS FINISHED
ST-12	00:38	08° 46.836N	120° 43.042E	2912m	PISTON CORER STARTED
ST-12	01:50	08° 46.892N	120° 43.007E	2958m	PISTON CORER LANDED
ST-12	03:00	08° 47.253N	120° 42.948E	0m	PISTON CORER FINISHED
ST-12	03:22	08° 46.912N	120° 42.991E	0m	MULTIPUL CORER STARTED
ST-12	04:23	08° 46.896N	120° 43.008E	2786m	MULTIPUL CORER HIT BOTTOM
ST-12	05:18	08° 46.920N	120° 43.004E	2911m	MULTIPUL CORER ON DECK
ST-12	05:29	08° 46.975N	120° 42.882E	2909m	IKMT-NET STARTED (W.O.4000m)
ST-12	06:41	08° 47.203N	120° 39.334E	2590m	IKMT-NET DEEPEST
ST-12	07:40	08° 46.432N	120° 36.685E	2265m	FINISHED TOWING
ST-12	08:49	08° 45.692N	120° 33.346E	2461m	IKMT-NET FINISHED
	09:38	08° 50.027N	120° 40.957E	2793m	SUNSET & TURNED ON REGULATION LIGHTS
ST-12	09:52	08° 50.283N	120° 41.170E	2834m	4m BEAM-TRAWL STARTED
ST-12	11:14	08° 48.578N	120° 42.794E	2892m	4m BEAM-TRAWL ON BOTTOM
ST-12	12:51	08° 46.875N	120° 44.298E	2912m	4m BEAM-TRAWL OFF BOTTOM
ST-12	15:01	08° 45.005N	120° 44.868E	2896m	4m BEAM-TRAWL ON DECK
E-19	16:02	08° 49.328N	120° 33.761E	2080m	IKMT-NET STARTED (W.O. 500m)
E-19	16:12	08° 49.528N	120° 33.060E	2056m	IKMT-NET DEEPEST
E-19	16:13	08° 49.538N	120° 33.025E	2056m	ORI SIDE NET STARTED
E-19	16:29	08° 49.796N	120° 32.137E	2196m	ORI SIDE NET FINISHED
E-19	16:41	08° 50.045N	120° 31.391E	2213m	IKMT-NET FINISHED
ST-13	19:38	08° 57.250N	120° 11.268E	1846m	CTD-CMS STARTED
ST-13	19:49	08° 57.119N	120° 11.165E	1847m	NORPAC NET STARTED (1)
ST-13	19:58	08° 57.101N	120° 11.095E	1846m	NORPAC NET FINISHED
ST-13	20:01	08° 57.088N	120° 11.079E	1848m	NORPAC NET STARTED (2)
ST-13	20:08	08° 57.068N	120° 11.061E	1850m	NORPAC NET FINISHED
ST-13	20:12	08° 57.069N	120° 11.045E	4869m	NORPAC NET STARTED (3)
ST-13	20:21	08° 57.124N	120° 10.969E	3626m	CTD-CMS DEEPEST
ST-13	20:22	08° 57.127N	120° 10.965E	3627m	NORPAC NET FINISHED
ST-13	20:24	08° 57.160N	120° 10.932E	3634m	NORPAC NET STARTED (4)
ST-13	20:33	08° 57.290N	120° 10.834E	3681m	NORPAC NET FINISHED
ST-13	21:20	08° 57.137N	120° 10.818E	1844m	CTD-CMS FINISHED
ST-13	21:42	08° 57.507N	120° 11.546E	1846m	MULTIPUL CORER STARTED
	22:01	08° 57.382N	120° 11.510E	1846m	SUNRISE & TURNED OFF REGULATION LIGHTS
ST-13	22:26	08° 57.399N	120° 11.552E	3804m	MULTIPUL CORER HIT BOTTOM
ST-13	23:03	08° 57.425N	120° 11.594E	1846m	MULTIPUL CORER ON DECK
ST-13	23:18	08° 57.305N	120° 11.309E	1848m	IKMT-NET STARTED (W.O.3600m)

----- 07 DEC. 02 (GMT) -----

ST-13	00:23	09° 00.107N	120° 11.907E	1516m	IKMT-NET DEEPEST
ST-13	02:11	09° 03.820N	120° 12.352E	1792m	IKMT-NET FINISHED
ST-13	03:10	08° 57.519N	120° 11.560E	1848m	PISTON CORER STARTED
ST-13	04:01	08° 57.492N	120° 11.476E	3163m	PISTON CORER LANDED
ST-13	04:52	08° 57.323N	120° 11.457E	1848m	PISTON CORER FINISHED
ST-13	06:17	08° 50.836N	120° 24.769E	2396m	3m BEAM-TRAWL STARTED
ST-13	07:28	08° 52.902N	120° 25.382E	4418m	3m BEAM-TRAWL ON BOTTOM

ST-13	09:00	08° 53.994N	120° 25.510E	5461m	3m BEAM-TRAWL OFF BOTTOM
	09:40	08° 54.392N	120° 25.779E	4850m	SUNSET & TURNED ON REGULATION LIGHTS
ST-13	09:52	08° 54.478N	120° 25.768E	4566m	3m BEAM-TRAWL ON DECK
E-20	14:56	09° 57.663N	120° 53.726E	1488m	IKMT-NET STARTED (W.O. 500m)
E-20	15:09	09° 58.259N	120° 53.983E	1489m	IKMT-NET DEEPEST
E-20	15:09	09° 58.279N	120° 53.992E	1490m	ORI SIDE NET STARTED
E-20	15:25	09° 58.771N	120° 54.224E	1492m	ORI SIDE NET FINISHED
E-20	15:37	09° 59.159N	120° 54.399E	1492m	IKMT-NET FINISHED
ST-14	15:58	09° 59.868N	120° 54.543E	1491m	CTD-CMS STARTED
ST-14	16:02	09° 59.790N	120° 54.546E	1493m	NORPAC NET STARTED (1)
ST-14	16:13	09° 59.589N	120° 54.558E	1492m	NORPAC NET FINISHED
ST-14	16:16	09° 59.534N	120° 54.558E	1490m	NORPAC NET STARTED (2)
ST-14	16:25	09° 59.364N	120° 54.560E	1156m	NORPAC NET FINISHED
ST-14	16:30	09° 59.281N	120° 54.578E	6m	NORPAC NET STARTED (3)
ST-14	16:37	09° 59.169N	120° 54.555E	2720m	CTD-CMS DEEPEST
ST-14	16:39	09° 59.132N	120° 54.536E	2521m	NORPAC NET FINISHED
ST-14	16:43	09° 59.092N	120° 54.516E	3201m	NORPAC NET STARTED (4)
ST-14	16:48	09° 59.038N	120° 54.474E	2931m	NORPAC NET FINISHED
ST-14	17:23	09° 58.847N	120° 54.182E	6m	CTD-CMS FINISHED
ST-14	17:34	09° 58.826N	120° 54.066E	6m	MULTIPUL CORER STARTED
ST-14	18:12	09° 58.913N	120° 53.736E	1651m	MULTIPUL CORER HIT BOTTOM
ST-14	18:43	09° 58.993N	120° 53.581E	6m	MULTIPUL CORER ON DECK
ST-14	19:03	10° 00.092N	120° 54.594E	6m	3m BEAM-TRAWL STARTED
ST-14	19:19	10° 00.636N	120° 55.121E	1486m	3m BEAM-TRAWL ON DECK
ST-14	19:30	10° 00.608N	120° 55.246E	1486m	3m BEAM-TRAWL STARTED
ST-14	20:16	09° 59.171N	120° 54.420E	1490m	3m BEAM-TRAWL ON BOTTOM
ST-14	21:03	09° 58.720N	120° 54.174E	1490m	3m BEAM-TRAWL OFF BOTTOM
ST-14	21:33	09° 58.717N	120° 54.022E	1491m	3m BEAM-TRAWL ON DECK
	22:01	09° 58.636N	120° 54.052E	1491m	SUNRISE & TURNED OFF REGULATION LIGHTS
ST-14	22:27	09° 58.683N	120° 54.002E	1491m	3m BEAM-TRAWL STARTED
ST-14	22:45	09° 59.098N	120° 53.965E	1492m	3m BEAM-TRAWL ON DECK
ST-14	23:15	09° 59.277N	120° 53.922E	1494m	3m BEAM-TRAWL STARTED

----- 08 DEC.02 (GMT) -----

ST-14	00:03	10° 00.707N	120° 54.718E	1486m	3m BEAM-TRAWL ON BOTTOM
ST-14	00:47	10° 01.624N	120° 55.270E	1482m	3m BEAM-TRAWL OFF BOTTOM
ST-14	01:43	10° 02.328N	120° 55.798E	1480m	3m BEAM-TRAWL ON DECK
ST-15	04:05	10° 11.120N	121° 27.292E	1050m	CTD-CMS STARTED
ST-15	04:08	10° 11.105N	121° 27.307E	1050m	NORPAC NET STARTED (1)
ST-15	04:16	10° 11.068N	121° 27.345E	1051m	NORPAC NET FINISHED
ST-15	04:19	10° 11.049N	121° 27.334E	1060m	NORPAC NET STARTED (2)
ST-15	04:28	10° 11.004N	121° 27.334E	1061m	NORPAC NET FINISHED
ST-15	04:30	10° 10.995N	121° 27.341E	1061m	CTD-CMS DEEPEST
ST-15	04:30	10° 10.993N	121° 27.342E	1062m	NORPAC NET STARTED (3)
ST-15	04:38	10° 10.957N	121° 27.370E	1063m	NORPAC NET FINISHED
ST-15	04:40	10° 10.947N	121° 27.364E	1064m	NORPAC NET STARTED (4)
ST-15	04:49	10° 10.921N	121° 27.357E	1064m	NORPAC NET FINISHED
ST-15	05:04	10° 10.859N	121° 27.411E	1066m	FLOWMETER CALIBRATION STARTED
ST-15	05:06	10° 10.846N	121° 27.429E	1069m	CTD-CMS FINISHED
ST-15	05:36	10° 10.812N	121° 27.720E	1073m	FLOWMETER CALIBRATION FINISHED
ST-15	05:36	10° 10.811N	121° 27.722E	1074m	MULTIPUL CORER STARTED
ST-15	06:04	10° 10.728N	121° 27.689E	1076m	MULTIPUL CORER HIT BOTTOM
ST-15	06:25	10° 10.623N	121° 27.563E	1083m	MULTIPUL CORER ON DECK
ST-15	06:43	10° 11.020N	121° 27.339E	1061m	3m BEAM-TRAWL STARTED
ST-15	07:19	10° 10.978N	121° 26.272E	1056m	3m BEAM-TRAWL ON BOTTOM
ST-15	08:12	10° 10.735N	121° 25.129E	1052m	3m BEAM-TRAWL OFF BOTTOM
ST-15	09:21	10° 09.898N	121° 24.596E	1079m	3m BEAM-TRAWL ON DECK
	09:33	10° 10.150N	121° 24.752E	1070m	SUNSET & TURNED ON REGULATION LIGHTS
STS2A	11:36	10° 36.751N	121° 31.772E	372m	3m BEAM-TRAWL STARTED
STS2A	11:47	10° 36.476N	121° 31.564E	372m	3m BEAM-TRAWL ON BOTTOM
STS2A	12:25	10° 35.742N	121° 30.900E	363m	3m BEAM-TRAWL OFF BOTTOM
STS2A	12:36	10° 35.542N	121° 30.838E	365m	3m BEAM-TRAWL ON DECK
STEX1	15:21	11° 00.686N	121° 54.729E	2376m	CTD STARTED
STEX1	15:48	11° 00.546N	121° 54.836E	1208m	CTD DEEPEST
STEX1	16:20	11° 00.503N	121° 54.965E	1186m	CTD FINISHED
E-21	18:07	11° 25.046N	121° 50.130E	702m	IKMT-NET STARTED (W.O. 500m)
E-21	18:19	11° 25.725N	121° 49.967E	865m	IKMT-NET DEEPEST
E-21	18:23	11° 25.854N	121° 49.922E	937m	ORI SIDE NET STARTED
E-21	18:35	11° 26.330N	121° 49.774E	1083m	ORI SIDE NET FINISHED
E-21	18:47	11° 26.855N	121° 49.659E	1074m	IKMT-NET FINISHED
ST-S2	19:15	11° 27.512N	121° 49.381E	1049m	CTD-CMS STARTED
ST-S2	19:20	11° 27.568N	121° 49.301E	1042m	NORPAC NET STARTED (1)
ST-S2	19:30	11° 27.630N	121° 49.127E	1034m	NORPAC NET FINISHED
ST-S2	19:42	11° 27.613N	121° 49.171E	1044m	CTD-CMS DEEPEST
ST-S2	19:51	11° 27.643N	121° 49.278E	1051m	NORPAC NET STARTED (2)
ST-S2	19:58	11° 27.669N	121° 49.284E	1050m	NORPAC NET FINISHED
ST-S2	20:00	11° 27.674N	121° 49.284E	1048m	NORPAC NET STARTED (3)
ST-S2	20:09	11° 27.678N	121° 49.285E	1055m	NORPAC NET FINISHED

ST-S2 20:22 11° 27.737N 121° 49.270E 6m CTD-CMS FINISHED
22:02 11° 37.847N 121° 24.894E 502m SUNRISE & TURNED OFF REGULATION LIGHTS
STEX2 23:23 11° 45.853N 121° 05.368E 616m CTD STARTED
STEX2 23:45 11° 45.606N 121° 05.292E 623m CTD DEEPEST
----- 09 DEC.02 (GMT) -----
STEX2 00:01 11° 45.470N 121° 05.275E 625m CTD FINISHED
STEX3 03:49 12° 33.910N 120° 45.920E 831m CTD STARTED
STEX3 04:10 12° 33.615N 120° 46.074E 822m CTD DEEPEST
STEX3 04:26 12° 33.444N 120° 46.224E 821m CTD FINISHED
09:35 13° 22.650N 119° 41.050E 4950m SUNSET & TURNED ON REGULATION LIGHTS
E-22 11:00 13° 29.230N 119° 28.019E 5001m IKMT-NET STARTED (W.O. 500m)
E-22 11:14 13° 29.979N 119° 28.319E 5005m IKMT-NET DEEPEST
E-22 11:15 13° 30.030N 119° 28.333E 5006m ORI SIDE NET STARTED
E-22 11:31 13° 30.653N 119° 28.493E 5007m ORI SIDE NET FINISHED
E-22 11:44 13° 31.125N 119° 28.605E 5007m IKMT-NET FINISHED
ST-16 12:20 13° 31.905N 119° 28.362E 5003m MOCNESS NET STARTED (NIGHT-DEEP)
ST-16 13:21 13° 33.614N 119° 29.372E 5m MOCNESS NET DEEPEST
ST-16 16:00?13° 38.???N 119° 32.???E 3???m MOCNESS FINISHED
ST-16 16:28 13° 38.611N 119° 32.076E 3910m MOCNESS NET STARTED (NIGHT-SHALLOW)
ST-16 16:46 13° 38.970N 119° 32.148E 3855m MOCNESS NET DEEPEST
ST-16 17:45 13° 40.255N 119° 32.455E 3764m MOCNESS NET FINISHED
ST-16 18:48 13° 29.889N 119° 29.904E 5005m CTD-CMS STARTED
ST-16 20:20 13° 30.267N 119° 29.762E 5005m CTD-CMS DEEPEST
ST-16 22:09 13° 30.373N 119° 29.797E 5003m CTD-CMS FINISHED
22:12 13° 30.372N 119° 29.789E 5006m SUNRISE & TURNED OFF REGULATION LIGHTS
----- 10 DEC.02 (GMT) -----
ST-16 00:59 13° 29.970N 119° 30.038E 5016m VMPS NET STARTED (DAY)
ST-16 01:08 13° 29.991N 119° 29.824E 5002m NORPAC NET STARTED (DAY-1)
ST-16 01:20 13° 30.137N 119° 29.707E 5002m NORPAC NET FINISHED
ST-16 01:23 13° 30.165N 119° 29.686E 5002m NORPAC NET STARTED (DAY-2)
ST-16 01:35 13° 30.297N 119° 29.617E 5003m NORPAC NET FINISHED
ST-16 01:40 13° 30.342N 119° 29.602E 5002m NORPAC NET STARTED (DAY-3)
ST-16 01:54 13° 30.508N 119° 29.557E 5003m NORPAC NET FINISHED
ST-16 02:12 13° 30.535N 119° 29.600E 5003m VMPS NET DEEPEST
ST-16 03:15 13° 30.900N 119° 29.109E 5003m VMPS NET FINISHED
ST-16 03:25 13° 30.905N 119° 28.893E 5004m MOCNESS NET STARTED (DAY-SHALLOW)
ST-16 03:46 13° 31.273N 119° 29.523E 5004m MOCNESS NET DEEPEST
ST-16 04:43 13° 32.346N 119° 31.185E 4981m MOCNESS NET FINISHED
ST-16 05:03 13° 32.554N 119° 31.139E 4975m MOCNESS NET STARTED (DAY-DEEP)
ST-16 05:58 13° 33.810N 119° 32.572E 4789m MOCNESS NET DEEPEST
ST-16 08:01 13° 35.858N 119° 35.803E 3861m MOCNESS NET FINISHED
ST-16 08:56 13° 30.012N 119° 29.993E 5005m CTD-CMS STARTED
ST-16 09:11 13° 30.107N 119° 29.910E 5002m CTD-CMS DEEPEST
ST-16 09:34 13° 30.308N 119° 29.879E 5002m CTD-CMS FINISHED
09:36 13° 30.321N 119° 29.857E 5005m SUNSET & TURNED ON REGULATION LIGHTS
E-23 10:58 13° 28.279N 119° 28.498E 4999m IKMT-NET STARTED (W.O. 600m)
E-23 11:11 13° 28.675N 119° 29.104E 5000m IKMT-NET DEEPEST
E-23 11:12 13° 28.694N 119° 29.130E 5001m ORI SIDE NET STARTED
E-23 11:27 13° 29.061N 119° 29.566E 4998m ORI SIDE NET FINISHED
E-23 11:44 13° 29.461N 119° 30.037E 4993m IKMT-NET FINISHED
ST-16 13:05 13° 30.103N 119° 30.017E 5006m VMPS NET STARTED (NIGHT)
ST-16 13:12 13° 30.178N 119° 29.924E 5003m NORPAC NET STARTED (NIGHT-1)
ST-16 13:27 13° 30.410N 119° 29.800E 5002m NORPAC NET FINISHED
ST-16 13:28 13° 30.423N 119° 29.789E 5006m NORPAC NET STARTED (NIGHT-2)
ST-16 13:39 13° 30.568N 119° 29.761E 5004m NORPAC NET FINISHED
ST-16 13:42 13° 30.614N 119° 29.758E 5003m NORPAC NET STARTED (NIGHT-3)
ST-16 13:52 13° 30.734N 119° 29.666E 5004m NORPAC NET FINISHED
ST-16 13:55 13° 30.769N 119° 29.645E 5007m NORPAC NET STARTED (NIGHT-4)
ST-16 14:07 13° 30.895N 119° 29.571E 5006m NORPAC NET FINISHED
ST-16 14:10 13° 30.925N 119° 29.566E 5002m NORPAC NET STARTED (NIGHT-5)
ST-16 14:16 13° 31.014N 119° 29.559E 5006m VMPS NET DEEPEST
ST-16 14:23 13° 31.097N 119° 29.550E 5006m NORPAC NET FINISHED
ST-16 15:24 13° 31.431N 119° 29.248E 5005m VMPS NET FINISHED
ST-17 22:19 14° 30.028N 117° 59.994E 3727m CTD-CMS STARTED
22:22 14° 30.042N 117° 59.982E 3719m SUNRISE & TURNED OFF REGULATION LIGHTS
ST-17 23:30 14° 30.180N 118° 00.090E 3749m CTD-CMS DEEPEST
----- 11 DEC.02 (GMT) -----
ST-17 00:52 14° 30.634N 118° 00.032E 3864m CTD-CMS FINISHED
ST-17 01:55 14° 30.221N 117° 59.839E 3815m VMPS NET STARTED (DAY)
ST-17 02:13 14° 30.429N 117° 59.789E 3863m NORPAC NET STARTED (DAY-1)
ST-17 02:26 14° 30.573N 117° 59.840E 3863m NORPAC NET FINISHED
ST-17 02:28 14° 30.599N 117° 59.833E 3860m NORPAC NET STARTED (DAY-2)
ST-17 02:41 14° 30.759N 117° 59.861E 3858m NORPAC NET FINISHED
ST-17 03:00 14° 30.855N 117° 59.933E 3852m VMPS NET DEEPEST
ST-17 04:05 14° 31.175N 117° 59.975E 3841m VMPS NET FINISHED
ST-17 04:25 14° 31.322N 118° 00.183E 3846m MULTIPUL CORER STARTED
ST-17 05:42 14° 31.504N 118° 00.354E 3839m MULTIPUL CORER HIT BOTTOM

ST-17	06:54	14° 31.641N	118° 00.766E	3808m	MULTIPUL CORER ON DECK
ST-17	07:37	14° 30.012N	118° 00.037E	3673m	CTD-CMS STARTED
ST-17	07:46	14° 30.075N	118° 00.044E	3674m	CTD-CMS DEEPEST
ST-17	08:10	14° 30.151N	118° 00.002E	3691m	CTD-CMS FINISHED
ST-17	08:18	14° 30.154N	118° 00.058E	3678m	IKMT-NET STARTED (W.O.7000m)
ST-17	10:29	14° 28.156N	118° 05.863E	4183m	IKMT-NET DEEPEST
ST-17	13:28	14° 24.996N	118° 13.890E	4061m	IKMT-NET FINISHED
ST-17	14:50	14° 29.940N	117° 59.960E	4137m	VMPS NET STARTED (NIGHT)
ST-17	14:59	14° 29.966N	117° 59.851E	3677m	NORPAC NET STARTED (NIGHT-1)
ST-17	15:11	14° 30.014N	117° 59.863E	3670m	NORPAC NET FINISHED
ST-17	15:13	14° 30.026N	117° 59.861E	3678m	NORPAC NET STARTED (NIGHT-2)
ST-17	15:22	14° 30.084N	117° 59.837E	3672m	NORPAC NET FINISHED
ST-17	15:25	14° 30.084N	117° 59.812E	3672m	NORPAC NET STARTED (NIGHT-3)
ST-17	15:38	14° 30.166N	117° 59.836E	3691m	NORPAC NET FINISHED
ST-17	15:40	14° 30.174N	117° 59.833E	3689m	NORPAC NET STARTED (NIGHT-4)
ST-17	15:55	14° 30.232N	117° 59.801E	3755m	NORPAC NET FINISHED
ST-17	15:56	14° 30.232N	117° 59.803E	3800m	VMPS NET DEEPEST
ST-17	16:59	14° 30.530N	117° 59.978E	3830m	VMPS NET FINISHED
E-24	17:08	14° 30.582N	118° 00.106E	0m	IKMT-NET STARTED (W.O. 500m)
E-24	17:24	14° 30.562N	118° 00.984E	3791m	IKMT-NET DEEPEST
E-24	17:27	14° 30.566N	118° 01.074E	3798m	ORI SIDE NET STARTED
E-24	17:41	14° 30.597N	118° 01.540E	3806m	ORI SIDE NET FINISHED
E-24	17:54	14° 30.614N	118° 02.011E	3609m	IKMT-NET FINISHED
ST-17	18:20	14° 29.877N	118° 00.004E	3690m	CTD-CMS STARTED
ST-17	18:46	14° 29.918N	118° 00.021E	3680m	CTD-CMS DEEPEST
ST-17	19:13	14° 30.069N	118° 00.012E	3668m	CTD-CMS FINISHED
ST-17	19:17	14° 30.100N	118° 00.077E	3677m	IKMT-NET STARTED (W.O.5000m)
ST-17	20:50	14° 32.027N	118° 03.200E	4180m	IKMT-NET DEEPEST
ST-17	22:19	14° 34.187N	118° 06.451E	4187m	IKMT-NET FINISHED
	22:22	14° 34.240N	118° 06.532E	4187m	SUNRISE & TURNED OFF REGULATION LIGHTS
ST-17	22:32	14° 34.444N	118° 06.819E	4188m	ORI NET(OBL.) STARTED (W.O.2000m)
ST-17	23:12	14° 35.470N	118° 08.344E	4190m	ORI NET(OBL.) DEEPEST
----- 12 DEC.02 (GMT) -----					
ST-17	00:11	14° 37.176N	118° 10.659E	4200m	ORI NET(OBL.) FINISHED
ST-18	04:35	15° 34.601N	118° 20.722E	4179m	MULTIPUL CORER STARTED
ST-18	05:55	15° 34.388N	118° 20.281E	3713m	MULTIPUL CORER HIT BOTTOM
ST-18	07:14	15° 34.811N	118° 20.373E	0m	MULTIPUL CORER ON DECK
	09:35	16° 07.782N	118° 28.452E	3570m	SUNSET & TURNED ON REGULATION LIGHTS
E-25	11:03	16° 30.159N	118° 34.843E	4000m	IKMT-NET STARTED (W.O. 500m)
E-25	11:16	16° 30.920N	118° 34.932E	3879m	IKMT-NET DEEPEST
E-25	11:16	16° 30.949N	118° 34.934E	3876m	ORI SIDE NET STARTED
E-25	11:31	16° 31.593N	118° 34.960E	3546m	ORI SIDE NET FINISHED
E-25	11:43	16° 32.004N	118° 34.959E	3240m	IKMT-NET FINISHED
	22:26	18° 58.666N	119° 22.295E	6789m	SUNRISE & TURNED OFF REGULATION LIGHTS
----- 13 DEC.02 (GMT) -----					
	09:23	20° 18.920N	120° 17.852E	4156m	SUNSET & TURNED ON REGULATION LIGHTS
	17:00	21° 03.401N	121° 19.598E	2998m	PUT CLOCKS AHAED 1 HOUR FOR J.S.T.
----- 14 DEC.02 (GMT) -----					
	08:59	23° 51.937N	123° 59.983E	3003m	SUNSET & TURNED ON REGULATION LIGHTS
	22:14	26° 36.359N	126° 40.428E	1623m	SUNRISE & TURNED OFF REGULATION LIGHTS
----- 15 DEC.02 (GMT) -----					
	08:29	28° 22.429N	129° 05.231E	821m	SUNSET & TURNED ON REGULATION LIGHTS
	22:00	30° 53.598N	132° 27.693E	2748m	SUNRISE & TURNED OFF REGULATION LIGHTS

6. Routine seawater measurement

6-1. CTD-Water Sampling System

The CTD-Water sampling system (CTD-Carousel system) used during the KH-02-4 cruise consists of the following instruments.

CTD fish (SEA-BIRD, Model 9-plus, 6800m) with a DO sensor
Transmissiometer (SeaTech, 25cm light path, 5000m)
Fluorometer (Chelsea, AQUATRACKA III)
Carousel sampling system (SEA-BIRD, Carousel-32)
Niskin-X samplers (General Oceanics, 12-liter type)
Pinger (Benthos, Model 2216)

The CTD-Carousel system, attached at the end of the titanium armored cable (8mm o.d.) from the No.2 winch of R.V. *Hakuho Maru*, was controlled on board the ship by a CTD deck unit (Seabird, Model 11-plus) connected with an IBM compatible desktop computer. The Carousel array frame has a capability to hold 36 water samplers with a volume of 12 liters. A pinger was installed inside the frame to monitor the distance between the system and the sea bottom. The ship stayed at a fixed position, where the system was lowered to a depth of ~10 m above the bottom. Water samples were taken by triggering the samplers at appropriate depths while the system was coming up to the surface.

We used 36 Niskin-X bottles (12-liter type) for seawater sampling. In order to reduce the contamination level as low as possible, all the samplers had been completely coated with teflon paint on their inside walls before the cruise. At the beginning of the cruise, the samplers were cleaned thoroughly using 2% Extran MA01 (Merck) solution, 0.1M HCl solution and Milli-Q pure water.

Collected samples were split for routine analyses of salinity, dissolved oxygen, nutrients (Si, PO_4, NO_3), and chlorophyll *a*. In addition to these routine measurements, various chemical components in seawater were or will be measured by responsible scientists on board the ship or in shorebased laboratories in charge.

6-2. Salinity

Hiroshi Hasumoto and Salinity-measurement Group

Salinity was measured with a salinometer, (Portasal, Model 8410A) installed in the 6-th laboratory (during the first leg) and in the dark room (during the second leg). The cell temperature was adjusted to 28, 26 and 23℃. IAPSO standard seawater (Ocean Scientific International Ltd., Batch : P141, Date12-Jun-2002, K15=0.99993) was used for calibration.

6-3. Dissolved oxygen

Hajime Obata & DO-measurement Group

Each seawater is collected to an oxygen bottle with a volume of 100 cm^3, avoiding the introduction of air bubbles. After the collection, 0.5 ml of $MnCl_2$ solution and 0.5 ml of KI-NaOH solution are successively added to the bottle. This procedure quantitatively fixes dissolved oxygen in seawater sample as $MnO(OH)_2$. After standstill for a day or so for the precipitate to settling down to the bottom of the bottle, the supernatant (10-20 ml) is removed to reduce the sample volume. Then, 5 ml of 6M HCl is added for dissolving the precipitation to release I_2. The color of the solution in the bottle turns into yellow. Then, I_2 is titrated by 0.05 M sodium thiosulfate ($Na_2S_2O_3$) standard solution using an automatic titrating machine (Hirama, Model ART-3) which was installed in the 6-th laboratory. The sodium thiosulfate standard solution is calibrated by using CSK standard of 0.0100M potassium iodate (KIO_3) solution (WAKO Pure

Chemical Industries, LTD., LOT No.TCK8678).

6-4. Nutrients

Yoshitaka Yamaguchi, Yasuhito Arii and Yuzuru Nakaguchi

Seawater samples were collected with CTD-CMS system and surface seawater samples were collected with bucket. These samples were collected directly to 10 ml polyethylene tube.

Nitrate + Nitrite: Nitrate is reduced quantitatively to nitrite with open tubular cadmium reactor. The nitrite thus formed plus any originally present in the sample is determined as an azo dye following is diazotization with sulfanilamide and subsequent coupling with N-1-naphthylethylenediamine. The absorbance of it is determined at 550 nm.

Phosphate: Phosphate reacts with molybdenium (VI) and antimony (III) in an acid medium to form a phosphoantimonymolybdenum complex which is subsequently reduced by ascorbic acid to a heteropolyblue. The absorbance of it is determined at 880 nm.

Silicate: B-molybdosilicic acid is formed by the reaction of silicate with molybdate at a pH of 1 to 1.8. The B-molybdosilicic acid is reduced by ascorbic acid to form molybdenum blue. The absorbance of it is determined at 630 nm.

Apparatus: Nitrate + nitrite, phosphate and silicate are analyzed by continuous flow system (BRAN + LUEBBE; AACSII).

6-5. Chlorophyll *a*

Shigenobu Takeda, Masahiko Nishimura and Chlorophyll-measurement Group

The fluorometric method was used for the quantitative analysis of chlorophyll *a*. Water samples were collected from Niskin bottles into 250 ml amber polyethylene bottles. Samples (200 ml) are immediately filtered through 25 mm Whatman GF/F glass fiber filters maintaining vacuum levels of 0.02 MPa or less. Filters were placed in polypropylene vials and extracted in 6.0 ml N, N-dimethylformamide. The samples are allowed to extract for 24 hours in the refrigerator (4°C). After removal from the cold, extracted samples were placed in a 13 mm glass cuvette and read on the Turner Designs 10-AU field fluorometer with a chlorophyll optical kit for extractive analysis (10-037R). A second reading was taken after acidification with 2-3 drops of 1.2 N HCl and the reading had stabilized. The concentrations of chlorophyll *a* in the sample ($\mu g\ l^{-1}$) were calculated from the reading before and after acidification using the calibration and scaling factors. The fluorometer was calibrated at the beginning and the end of the cruise with a commercially available chlorophyll *a* standard (from *Anacystis nidulans* algae, Sigma Chemical Co.). Serial dilutions are prepared and linear calibration factors are calculated for each analytical range.

6-6. Routine data from CTD hydrocasts

6-6-1. CTD casts with routine seawater analyses

KH-02-4 St.01-1 | Date: 12 Nov. 2002 (GMT) | Time: 03:20 – 07:22 | Lat. 7 0.71 N | Long. 129 59.18 E | Depth 5492 m | B-P ? m

Bottle No.		Depth m	Pres. db	Temp. °C	Sal. (psu)	DO ml·l^{-1}	Sal. (psu)	DO ml·l^{-1}	SiO2 µM	PO4 µM	NO2 µM	NO2+NO3 µM	Chl-a µg·l^{-1}	Pres. db	Temp. °C	P.Temp. °C	Sal. (psu)	DO ml·l^{-1}	FIS
		CTD DATA (BTL)												CTD DATA (DOWN CAST LAY)					
Sur.		0		30.2	****	****								2	30.140	30.139	34.146	4.09	0.02
36	R	250	251	9.132	34.506	2.23		2.34	38.76	2.07		29.83		10	30.107	30.104	34.145	4.06	0.02
35		300	301	8.739	34.538	1.74								20	29.185	29.180	34.118	4.26	0.03
34	R	299	301	8.746	34.537	1.74		1.88	38.34	2.25		32.39		30	28.239	28.232	34.777	4.39	0.03
33	R	398	400	7.961	34.546	1.89		2.05	40.96	2.33		34.02		50	25.097	25.086	35.053	4.17	0.06
32		496	499	7.223	34.533	2.07								75	19.666	19.653	34.930	3.83	0.26
31	R	497	500	7.223	34.532	2.07		2.20	45.61	2.38		34.71		100	16.527	16.511	34.713	3.78	0.15
30	R	596	600	6.736	34.526	2.10		2.24	50.33	2.45		35.62		125	13.866	13.848	34.552	3.29	0.07
29		745	750	5.840	34.519	1.98								150	12.517	12.497	34.526	2.91	0.04
28	R	744	749	5.833	34.519	1.98		2.13	64.91	2.60		37.24		175	11.262	11.240	34.495	2.49	0.03
27		990	998	4.871	34.544	1.88								200	10.169	10.145	34.458	2.37	0.02
26		991	999	4.862	34.544	1.88								250	9.026	8.999	34.519	2.54	0.02
25	R	991	999	4.859	34.544	1.88		2.07	81.73	2.74		39.16		300	8.587	8.556	34.540	2.01	0.03
24		1239	1250	3.937	34.568	2.00								400	7.845	7.804	34.553	2.16	0.03
23	R	1239	1250	3.931	34.568	2.00		2.20	101.67	2.74		39.42		500	7.122	7.074	34.532	2.28	0.03
22		1485	1499	3.088	34.590	2.10								600	6.620	6.564	34.526	2.31	0.03
21	R	1485	1499	3.083	34.590	2.10		2.31	121.08	2.75		40.11		700	5.957	5.895	34.522	2.27	0.02
20		1980	2000	2.283	34.628	2.41								800	5.474	5.406	34.530	2.21	0.03
19		1979	2000	2.283	34.628	2.41								1000	4.674	4.593	34.549	2.06	0.03
18	R	1979	2000	2.283	34.628	2.41		2.63	137.15	2.74		39.36		1250	3.576	3.483	34.575	2.12	0.03
17		2472	2501	1.861	34.652	2.72								1500	2.999	2.891	34.596	2.29	0.02
16	R	2472	2500	1.861	34.652	2.72		2.95	144.05	2.68		38.78		1750	2.548	2.425	34.615	2.43	0.02
15		2963	3001	1.629	34.667	3.01								2000	2.204	2.065	34.634	2.60	0.02
14		2963	3001	1.629	34.667	3.01								2500	1.852	1.675	34.653	2.86	0.02
13	R	2962	3000	1.629	34.667	3.01		3.24	146.11	2.59		38.24		3000	1.626	1.407	34.667	3.14	0.02
12		3451	3499	1.550	34.675	3.20								3500	1.555	1.288	34.675	3.31	0.02
11	R	3451	3499	1.550	34.675	3.20		3.43	143.75	2.55		37.67		4000	1.569	1.248	34.678	3.38	0.02
10		3942	4002	1.569	34.678	3.28								4500	1.622	1.243	34.678	3.39	0.02
9		3941	4001	1.569	34.678	3.28								5000	1.682	1.241	34.678	3.41	0.02
8	R	3941	4001	1.568	34.678	3.28		3.48	144.34	2.51		37.21		5453	1.739	1.240	34.678	3.39	0.02
7		4429	4501	1.621	34.678	3.31													
6	R	4428	4500	1.621	34.678	3.31		3.49	144.26	2.50		37.09							
5		4915	5000	1.681	34.678	3.34													
4	R	4915	5000	1.681	34.678	3.34		3.54	143.66	2.53		37.17							
3		5358	5457	1.740	34.678	3.38													
2		5357	5456	1.740	34.678	3.39													
1	R	5357	5456	1.740	34.678	3.39		3.50	143.97	2.54		36.99							

KH-02-4 St.01-2 | Date: 12 Nov. 2002 (GMT) | Time: 11:45 – 12:18 | Lat. 7 0.24 N | Long. 129 59.55 E | Depth 5492 m

Bottle No.		Depth m	Pres. db	Temp. °C	Sal. (psu)	DO ml·l^{-1}	Sal. (psu)	DO ml·l^{-1}	SiO2 µM	PO4 µM	NO2 µM	NO2+NO3 µM	Chl-a µg·l^{-1}	Pres. db	Temp. °C	P.Temp. °C	Sal. (psu)	DO ml·l^{-1}	FIS
		CTD DATA (BTL)												CTD DATA (DOWN CAST LAY)					
Sur.	R	0		30.0	****	****		4.64	N.D.	0.02	N.D.	0.07	0.08	2	30.016	30.015	34.078	4.04	0.03
36		5	5	29.982	34.075	3.98								10	30.005	30.003	34.080	4.01	0.04
35		11	11	29.891	34.070	3.99								20	29.263	29.258	34.080	4.18	0.04
34		10	10	29.866	34.071	4.03								30	28.828	28.821	34.258	4.21	0.05
33		11	11	29.841	34.071	4.00								50	27.550	27.539	34.867	4.27	0.05
32		11	11	29.841	34.071	4.00								75	23.181	23.165	35.051	4.06	0.15
31		10	10	29.909	34.072	3.97								100	16.738	16.721	34.727	3.62	0.15
30		10	10	29.886	34.072	3.98								125	13.747	13.729	34.551	3.25	0.08
27		10	10	29.884	34.071	4.00								150	12.321	12.301	34.524	2.78	0.04
26		10	10	29.872	34.071	3.99								175	10.759	10.737	34.474	2.42	0.03
25		10	10	29.868	34.070	4.00								200	9.600	9.577	34.463	2.26	0.03
24	R	10	10	29.770	34.068	4.01		4.63	N.D.	N.D.	N.D.	N.D.	0.08	204	9.525	9.502	34.459	2.26	0.03
23		19	19	29.235	34.084	4.12													
22	R	20	20	29.207	34.090	4.12		4.65	N.D.	0.01	N.D.	N.D.	0.10						
21		30	30	28.706	34.308	4.14													
20	R	30	31	28.686	34.321	4.16		4.70	N.D.	0.03	N.D.	N.D.	0.12						
19		50	50	26.973	34.912	4.24													
18		50	50	27.151	34.895	4.25													
17	R	50	50	26.977	34.907	4.25		4.61	N.D.	0.04	N.D.	N.D.	0.14						
16		74	75	22.197	34.998	3.97													
15	R	74	75	22.203	34.997	3.97		4.19	N.D.	0.17	N.D.	0.65	0.46						
29		81	82	21.026	34.959	3.85													
28		80	81	21.311	34.960	3.84													
14		99	100	16.137	34.667	3.53													
13		99	100	16.124	34.667	3.53													
12		99	99	16.100	34.663	3.54													
11	R	99	99	16.061	34.660	3.54		3.50	7.00	0.89	0.01	12.11	0.17						
10		125	125	13.440	34.526	2.97													
9	R	124	125	13.445	34.525	2.96		2.95	15.96	1.34	N.D.	18.95	0.06						
8		150	151	12.220	34.509	2.60													
7	R	149	150	12.233	34.507	2.59		2.54	22.53	1.63	N.D.	23.63	0.02						
6		173	174	10.761	34.464	2.33													
5	R	174	175	10.772	34.462	2.32		2.27	28.35	1.86	N.D.	26.67	0.01						
4		198	199	9.591	34.458	2.19													
3		198	199	9.603	34.458	2.20													
2		197	199	9.576	34.457	2.21													
1	R	197	199	9.571	34.457	2.20		2.09	35.02	2.07	N.D.	29.50	0.00						

KH-02-4 St.02-1 | Date: 15 Nov. 2002 (GMT) | Time: 17:24 - 20:53 | Lat. 5 11.16 N | Long. 124 4.78 E | Depth 5094 m | B-P 17 m

CTD DATA (BTL)

Bottle No.		Depth m	Pres. db	Temp. °C	Sal. (psu)	DO ml·l⁻¹	Sal. (psu)	DO ml·l⁻¹	SiO_2 μM	PO_4 μM	NO_2 μM	NO_2+NO_3 μM	Chl-a μg·l⁻¹
Sur.		0		29.9	****	****							
36		299	301	10.275	34.410	2.56							
35		299	301	10.274	34.410	2.56							
34	R	299	301	10.246	34.408	2.55		2.50	30.86	1.85		26.00	
33	R	397	400	8.884	34.421	2.13		2.14	39.29	2.17		30.48	
32		497	500	7.790	34.492	2.12							
31	R	497	500	7.774	34.493	2.12		2.13	46.71	2.35		33.17	
30	R	596	600	6.721	34.524	2.20		2.20	54.13	2.48		35.44	
29		745	750	5.466	34.543	2.09							
28	R	745	750	5.466	34.543	2.10		2.12	74.23	2.65		37.61	
27		992	1000	4.402	34.567	2.01							
26		992	1000	4.398	34.567	2.00							
25	R	992	1000	4.399	34.567	2.01		2.04	98.96	2.78		39.08	
24		1238	1249	3.908	34.579	2.03							
23	R	1238	1249	3.907	34.578	2.02		2.04	108.41	2.82		39.42	
22		1486	1500	3.736	34.583	2.03							
21	R	1486	1500	3.736	34.583	2.03		2.12	112.30	2.82		39.38	
20		1980	2001	3.609	34.585	2.10							
19		1980	2000	3.609	34.585	2.10							
18	R	1980	2000	3.609	34.585	2.10		2.15	113.68	2.79		39.37	
17		2472	2500	3.592	34.588	2.08							
16	R	2472	2500	3.592	34.588	2.08		2.12	115.54	2.81		39.42	
15		2963	3000	3.597	34.589	2.01							
14		2963	3000	3.597	34.589	2.01							
13	R	2962	3000	3.597	34.589	2.01		2.12	118.57	2.83		39.49	
12		3452	3500	3.634	34.590	1.94							
11	R	3452	3499	3.634	34.590	1.94		2.10	121.73	2.82		39.54	
10		3940	3999	3.691	34.590	1.92							
9		3940	4000	3.691	34.590	1.92							
8	R	3940	3999	3.691	34.590	1.92		2.03	122.08	2.84		39.59	
7		4428	4500	3.753	34.590	1.94							
6	R	4428	4500	3.752	34.590	1.94		2.05	122.12	2.84		39.71	
5		4914	4999	3.817	34.590	1.99							
4	R	4914	4999	3.817	34.590	1.99		2.07	121.47	2.83		39.53	
3		5155	5247	3.852	34.590	2.00							
2		5155	5247	3.852	34.590	2.00							
1	R	5155	5247	3.852	34.590	2.00		2.07	120.56	2.83		39.69	

CTD DATA (DOWN CAST LAY)

Pres. db	Temp. °C	P.Temp. °C	Sal. (psu)	DO ml·l⁻¹	FIS
1	29.795	29.795	34.280	4.14	0.04
10	29.799	29.797	34.280	4.13	0.04
20	29.812	29.807	34.302	4.14	0.04
30	29.690	29.683	34.404	4.15	0.04
50	29.626	29.614	34.429	4.19	0.06
75	26.478	26.461	34.065	3.90	0.35
100	24.681	24.659	34.898	4.10	0.20
125	20.480	20.457	34.856	3.95	0.07
150	15.655	15.631	34.647	3.67	0.02
175	14.671	14.645	34.593	3.95	0.02
200	12.709	12.682	34.482	3.78	0.02
250	11.782	11.749	34.427	3.76	0.02
300	10.803	10.767	34.430	3.20	0.02
400	9.085	9.041	34.424	2.51	0.03
500	7.709	7.659	34.500	2.39	0.03
600	6.523	6.468	34.533	2.46	0.02
700	5.778	5.717	34.538	2.38	0.02
800	5.065	4.999	34.553	2.27	0.03
1000	4.349	4.270	34.569	2.14	0.03
1250	3.948	3.851	34.578	2.13	0.03
1500	3.776	3.659	34.582	2.11	0.03
1750	3.671	3.533	34.584	2.11	0.03
2000	3.614	3.453	34.586	2.18	0.02
2500	3.597	3.387	34.587	2.15	0.02
3000	3.603	3.341	34.589	2.09	0.02
3500	3.634	3.316	34.590	2.04	0.03
4000	3.692	3.313	34.590	1.98	0.03
4500	3.753	3.310	34.590	1.98	0.03
5000	3.817	3.307	34.590	2.01	0.03
5238	3.851	3.306	34.590	2.01	0.03

KH-02-4 St.02-2 | Date: 14 Nov. 2002 (GMT) | Time: 21:43 - 22:14 | Lat. 5 10.81 N | Long. 124 4.86 E | Depth 5090 m

CTD DATA (BTL)

Bottle No.		Depth m	Pres. db	Temp. °C	Sal. (psu)	DO ml·l⁻¹	Sal. (psu)	DO ml·l⁻¹	SiO_2 μM	PO_4 μM	NO_2 μM	NO_2+NO_3 μM	Chl-a μg·l⁻¹
Sur.	R	0		29.8	****	****		4.32	N.D.	0.04	N.D.	N.D.	0.19
32		5	5	29.699	34.048	4.09							
31		5	5	29.699	34.048	4.09							
30		5	5	29.698	34.044	4.09							
36		10	10	29.695	34.040	4.08							
35		10	10	29.693	34.048	4.09							
34		10	10	29.695	34.038	4.07							
33		10	10	29.695	34.038	4.08							
28		10	10	29.694	34.050	4.09							
27		10	10	29.694	34.062	4.07							
26		10	10	29.689	34.081	4.08							
25	R	10	10	29.692	34.079	4.08		4.31	N.D.	0.04	N.D.	N.D.	0.14
24		20	20	29.621	34.219	4.09							
23	R	20	20	29.624	34.215	4.08		4.43	N.D.	0.03	N.D.	N.D.	0.11
22		30	31	29.196	34.498	4.17							
21	R	30	30	29.132	34.481	4.17		4.46	N.D.	0.04	N.D.	N.D.	0.14
29		50	50	26.347	34.029	3.70							
20		50	50	26.351	34.027	3.67							
19		50	50	26.346	34.041	3.67							
18	R	50	50	26.356	34.028	3.69		3.98	N.D.	0.23	0.44	2.54	0.45
17		75	75	25.788	34.767	4.04							
16	R	75	75	25.863	34.778	4.05		4.10	N.D.	0.20	0.14	1.77	0.33
15		100	100	23.609	34.883	4.00							
14		99	100	23.618	34.881	4.00							
13		99	100	23.598	34.883	4.02							
12	R	99	100	23.675	34.877	4.03		4.29	N.D.	0.24	0.08	2.47	0.26
11		125	125	21.451	34.860	3.98							
10	R	125	125	21.332	34.849	3.98		3.67	4.18	0.55	N.D.	7.22	0.08
9		150	151	16.575	34.641	3.61							
8	R	149	150	16.500	34.641	3.61		3.46	9.83	0.87	N.D.	12.18	0.01
7		174	175	14.931	34.591	3.92							
6	R	174	175	14.922	34.591	3.93		3.61	10.58	0.92	N.D.	13.13	0.01
5		199	200	13.956	34.539	3.98							
4		199	200	13.953	34.538	3.99							
3		199	200	13.953	34.538	4.00							
2	R	199	200	13.951	34.537	4.00		3.62	12.71	1.01	N.D.	14.46	0.01
1	R	248	250	11.742	34.419	3.65		3.24	21.56	1.41		19.77	

CTD DATA (DOWN CAST LAY)

Pres. db	Temp. °C	P.Temp. °C	Sal. (psu)	DO ml·l⁻¹	FIS
1	29.712	29.712	34.051	4.21	0.05
10	29.696	29.694	34.097	4.20	0.04
20	29.624	29.619	34.253	4.18	0.04
30	29.323	29.316	34.503	4.26	0.04
50	26.634	26.623	33.977	3.89	0.23
75	25.769	25.753	34.666	4.09	0.19
100	24.356	24.335	34.859	4.04	0.15
125	22.948	22.923	34.891	4.04	0.11
150	17.348	17.323	34.660	3.51	0.03
175	14.987	14.960	34.609	3.70	0.02
200	14.446	14.416	34.574	3.95	0.02
250	11.924	11.892	34.437	3.80	0.02
268	11.375	11.341	34.404	3.65	0.02

KH-02-4 St.03-1 | Date: 17 Nov. 2002 (GMT) | Time: 13:38 – 16:41 | Lat. 5 0.16 N, Long. 121 0.69 E | Depth 4154 m | B-P 17 m

Bottle No.		Depth m	Pres. db	Temp. °C	Sal. (psu)	DO ml·l^{-1}	Sal. (psu)	DO ml·l^{-1}	SiO_2 μM	PO_4 μM	NO_2 μM	NO_2+NO_3 μM	Chl-a μg·l^{-1}	Pres. db	Temp. °C	P.Temp. °C	Sal. (psu)	DO ml·l^{-1}	FIS
		CTD DATA (BTL)												CTD DATA (DOWN CAST LAY)					
Sur.	R	0		28.6	****	****		4.77	N.D.	N.D.	N.D.	N.D.	0.18	1	28.435	28.435	33.958	4.51	0.13
32		5	5	28.782	33.964	4.35								10	27.780	27.777	33.971	4.35	0.26
31		5	5	28.768	33.960	4.36								20	27.196	27.191	34.101	4.16	0.45
36		10	10	28.063	33.944	4.34								30	27.120	27.113	34.151	4.09	0.30
35		10	10	28.078	33.944	4.33								50	26.411	26.400	34.153	4.21	0.11
34		10	10	28.085	33.943	4.34								75	24.232	24.216	34.578	3.70	0.10
30		10	10	28.047	33.944	4.32								100	20.284	20.266	34.596	3.09	0.04
29	R	10	10	28.055	33.942	4.31		4.59	N.D.	0.01	N.D.	N.D.	0.43	125	17.642	17.621	34.504	2.74	0.04
33		18	18	27.709	33.972	4.21								150	16.920	16.896	34.690	3.87	0.02
28		20	20	27.697	33.972	4.21								175	16.200	16.172	34.654	3.84	0.02
27	R	20	20	27.691	33.973	4.21		4.52	N.D.	0.04	0.02	N.D.	0.62	200	15.798	15.767	34.641	4.02	0.02
26		30	30	27.516	34.006	4.06								250	13.983	13.947	34.549	3.56	0.02
25	R	30	30	27.489	34.003	4.06		4.40	N.D.	0.10	0.20	0.64	1.42	300	11.139	11.102	34.461	3.08	0.02
24		50	50	26.906	34.178	3.90								400	8.596	8.554	34.497	2.52	0.02
23	R	50	50	26.917	34.176	3.90		4.17	N.D.	0.20	0.51	1.58	0.61	500	7.454	7.405	34.525	2.40	0.03
22	R	74	75	25.492	34.623	3.81		4.04	0.63	0.30	0.37	2.70	0.16	600	6.463	6.408	34.537	2.36	0.03
21		100	100	22.114	34.571	3.29								700	5.805	5.744	34.543	2.30	0.02
20	R	99	100	22.019	34.540	3.17		3.23	10.69	0.76	0.10	10.01	0.07	800	5.179	5.113	34.552	2.23	0.02
19	R	124	125	17.634	34.539	3.25		3.43	9.70	0.81	0.05	10.94	0.02	1000	4.333	4.255	34.570	2.18	0.03
18		149	149	16.898	34.681	3.59								1250	3.925	3.829	34.579	2.16	0.03
17	R	148	149	16.819	34.678	3.60		3.63	7.60	0.81	0.04	10.83	0.01	1500	3.767	3.650	34.583	2.14	0.03
16	R	173	175	16.106	34.643	3.58		3.65	8.64	0.87	0.04	11.68	0.01	1750	3.679	3.541	34.585	2.18	0.03
15		198	200	14.923	34.577	3.26								2000	3.643	3.482	34.586	2.14	0.03
14	R	199	200	14.898	34.575	3.25		3.27	14.77	1.08	0.02	15.35	0.01	2500	3.607	3.397	34.588	2.10	0.03
13	R	248	249	13.182	34.500	3.27		3.27	18.01	1.28		17.96		3000	3.602	3.340	34.589	2.08	0.03
12	R	298	300	10.889	34.438	2.71		2.73	28.36	1.68		24.05		3500	3.638	3.319	34.590	2.01	0.03
11	R	496	500	7.533	34.503	2.11		2.14	48.33	2.35		33.73		4000	3.694	3.314	34.590	1.98	0.03
10	R	744	750	5.722	34.542	2.08		2.16	70.82	2.61		36.95		4239	3.723	3.314	34.591	1.96	0.03
9	R	992	1000	4.428	34.567	2.01		2.07	97.89	2.75		38.70							
8	R	1239	1250	4.000	34.576	2.02		2.11	107.72	2.81		39.09							
7	R	1486	1500	3.810	34.582	2.02		2.11	113.05	2.81		39.29							
6	R	1979	2000	3.648	34.586	2.05		2.15	114.78	2.81		39.37							
5	R	2472	2501	3.604	34.588	2.03		2.13	117.44	2.83		39.47							
4	R	2962	3000	3.601	34.589	2.02		2.11	119.23	2.81		39.91							
3	R	3453	3501	3.637	34.590	1.97		2.07	122.06	2.85		39.71							
2	R	3942	4001	3.693	34.591	1.96		2.08	122.86	2.87		39.72							
1	R	4187	4253	3.725	34.591	1.95		2.07	123.66	2.86		39.72							

KH-02-4 St.04-1 | Date: 19 Nov. 2002 (GMT) | Time: 10:34 – 13:33 | Lat. 7 25.05 N, Long. 121 12.47 E | Depth 4476 m | B-P 17 m

Bottle No.		Depth m	Pres. db	Temp. °C	Sal. (psu)	DO ml·l^{-1}	Sal. (psu)	DO ml·l^{-1}	SiO_2 μM	PO_4 μM	NO_2 μM	NO_2+NO_3 μM	Chl-a μg·l^{-1}	Pres. db	Temp. °C	P.Temp. °C	Sal. (psu)	DO ml·l^{-1}	FIS
		CTD DATA (BTL)												CTD DATA (DOWN CAST LAY)					
Sur.		0		29.7	****	****								1	29.655	29.655	33.286	4.20	0.04
36		299	301	12.686	34.468	1.49								10	29.663	29.661	33.288	4.23	0.03
35		299	300	12.684	34.467	1.50								20	28.637	28.632	34.247	4.31	0.05
34		299	300	12.668	34.467	1.50								30	28.281	28.274	34.364	4.14	0.08
33		298	300	12.663	34.467	1.52								50	27.244	27.233	34.333	3.73	0.46
32	R	298	300	12.670	34.467	1.52	34.541	1.61	47.66	1.82		27.36		75	23.652	23.637	34.358	2.66	0.13
31	R	398	401	11.668	34.465	1.59	34.554	1.68	50.28	1.88		28.22		100	21.018	20.999	34.359	2.18	0.07
30		498	501	10.990	34.460	1.65								125	18.252	18.231	34.421	1.99	0.04
29		497	501	10.990	34.460	1.65								150	16.767	16.743	34.470	2.00	0.03
28	R	497	501	10.989	34.460	1.64	34.539	1.71	54.55	1.94		28.93		175	15.681	15.654	34.484	2.04	0.03
27	R	597	601	10.500	34.457	1.61	34.528	1.66	58.46	2.02		29.80		200	14.927	14.897	34.477	2.00	0.03
26		745	751	10.270	34.457	1.49								250	13.298	13.263	34.479	1.82	0.03
25	R	745	751	10.269	34.457	1.49	34.529		64.62	2.16		30.33		300	12.788	12.747	34.472	1.65	0.03
24		993	1001	10.126	34.455	1.54								400	11.962	11.910	34.471	1.76	0.03
23		993	1001	10.126	34.455	1.54								500	11.175	11.113	34.468	1.92	0.03
22	R	993	1000	10.126	34.455	1.54	34.554	1.59	65.26	2.16		30.52		600	10.588	10.515	34.461	1.71	0.03
21		1240	1251	10.101	34.457	1.42								700	10.355	10.270	34.459	1.64	0.03
20	R	1240	1251	10.100	34.457	1.42	34.575	1.52	70.25	2.20		30.60		800	10.258	10.162	34.458	1.60	0.03
19		1487	1500	10.107	34.459	1.28								1000	10.130	10.010	34.456	1.62	0.03
18	R	1486	1500	10.107	34.459	1.28	34.596	1.37	74.68	2.23		30.83		1250	10.101	9.949	34.457	1.48	0.03
17		1979	2000	10.155	34.463	1.18								1500	10.108	9.922	34.459	1.36	0.03
16		1979	2000	10.155	34.463	1.19								1750	10.130	9.911	34.461	1.30	0.03
15	R	1979	2000	10.155	34.463	1.18	34.629	1.28	80.66	2.25		31.20		2000	10.155	9.901	34.463	1.24	0.03
14		2471	2500	10.211	34.469	1.10								2500	10.211	9.887	34.469	1.15	0.03
13	R	2471	2500	10.211	34.469	1.10	34.658	1.23	86.20	2.26		31.07		3000	10.286	9.888	34.474	1.05	0.03
12		2962	2999	10.286	34.474	1.01								3500	10.365	9.889	34.475	1.00	0.03
11		2962	2999	10.286	34.474	1.01								4000	10.445	9.889	34.475	1.01	0.03
10	R	2961	2999	10.286	34.474	1.01	34.667	1.17	93.22	2.28		30.95		4500	10.528	9.889	34.476	1.02	0.04
9		3452	3500	10.364	34.475	0.99								4670	10.557	9.889	34.476	0.97	0.04
8	R	3452	3500	10.364	34.475	0.99	34.675	1.15	93.77	2.27		30.81							
7		3941	4000	10.445	34.475	0.98													
6	R	3940	4000	10.445	34.475	0.98	34.682	1.14	94.07	2.29		30.90							
5		4427	4499	10.528	34.476	1.00													
4	R	4427	4499	10.528	34.476	1.00	34.680	1.12	93.54	2.30		30.78							
3		4603	4679	10.559	34.476	0.97													
2		4603	4679	10.559	34.476	0.97													
1	R	4603	4679	10.559	34.476	0.97	34.684	1.14	93.79	2.32		30.85							

KH-02-4 St.04-2 | Date: 21 Nov. 2002 (GMT) | Time: 02:09 – 02:41 | Lat. 7 25.27 N | Long. 121 12.54 E | Depth 4490 m

CTD DATA (BTL)

Bottle No.		Depth m	Pres. db	Temp. °C	Sal. (psu)	DO ml·l⁻¹	Sal. (psu)	DO ml·l⁻¹	SiO_2 μM	PO_4 μM	NO_2 μM	NO_2+NO_3 μM	Chl-a μg·l⁻¹
Sur.	R	0		29.5	****	****		4.42	0.91	0.05	N.D.	0.01	0.11
33		6	6	29.458	33.483	4.09							
32		6	6	29.457	33.483	4.06							
31		6	6	29.457	33.483	4.09							
30		5	6	29.456	33.483	4.08							
36		10	10	29.448	33.483	4.06							
35		10	10	29.447	33.483	4.06							
34		10	10	29.446	33.483	4.07							
27		10	10	29.447	33.483	4.07							
26		10	10	29.441	33.485	4.07							
25	R	10	10	29.444	33.485	4.07		4.44	0.97	0.01	N.D.	N.D.	0.12
24		20	20	29.207	33.782	4.17							
23	R	20	20	29.217	33.761	4.14		4.56	0.67	N.D.	N.D.	N.D.	0.12
22		30	31	28.655	34.105	4.14							
21	R	30	30	28.657	34.098	4.16		4.43	0.87	0.04	N.D.	N.D.	0.19
29		40	40	27.271	33.998	3.93							
28		40	40	27.296	34.013	3.94							
20		50	51	27.398	34.329	3.92							
19		50	51	27.399	34.328	3.92							
18	R	50	51	27.389	34.327	3.92		3.96	2.14	0.12	0.20	0.71	0.67
17		75	75	24.999	34.404	2.96							
16	R	75	75	24.920	34.395	2.90		2.69	12.18	0.70	0.05	10.85	0.17
15		100	101	18.799	34.384	2.03							
14		100	101	18.778	34.384	2.03							
13		100	101	18.786	34.380	2.03							
12	R	100	101	18.461	34.388	1.99		2.01	25.21	1.30	N.D.	19.55	0.02
11		124	125	16.734	34.441	1.83							
10	R	124	125	16.655	34.446	1.84		1.82	28.45	1.41	0.02	21.43	0.01
9		150	151	15.621	34.468	1.90							
8	R	150	151	15.621	34.468	1.90		1.86	31.87	1.51	N.D.	22.58	0.00
7		174	175	14.842	34.466	1.81							
6	R	174	175	14.787	34.468	1.81		1.76	36.21	1.63	N.D.	23.98	0.00
5		199	200	14.299	34.472	1.80							
4		199	200	14.293	34.472	1.80							
3		199	200	14.291	34.471	1.81							
2	R	199	200	14.201	34.474	1.80		1.73	38.80	1.69	0.01	24.85	0.01
1	R	248	250	13.253	34.471	1.75		1.67	43.24	1.80		26.10	

CTD DATA (DOWN CAST LAY)

Pres. db	Temp. °C	P.Temp. °C	Sal. (psu)	DO ml·l⁻¹	FIS
1	29.448	29.447	33.489	4.15	0.04
10	29.444	29.441	33.491	4.15	0.03
20	29.211	29.206	33.815	4.26	0.04
30	28.612	28.605	34.122	4.23	0.06
50	27.249	27.237	34.346	3.97	0.42
75	24.663	24.647	34.380	2.92	0.14
100	19.932	19.913	34.388	2.09	0.06
125	16.931	16.911	34.447	1.97	0.03
150	15.682	15.659	34.477	1.96	0.03
175	14.841	14.814	34.474	1.90	0.03
200	14.204	14.175	34.480	1.87	0.03
250	13.252	13.218	34.473	1.80	0.03
251	13.247	13.212	34.472	1.78	0.03

KH-02-4 St.06-1 | Date: 22 Nov. 2002 (GMT) | Time: 06:12 – 08:24 | Lat. 6 54.13 N | Long. 119 11.05 E | Depth 2975 m | B-P 15 m

CTD DATA (BTL)

Bottle No.		Depth m	Pres. db	Temp. °C	Sal. (psu)	DO ml·l⁻¹	Sal. (psu)	DO ml·l⁻¹	SiO_2 μM	PO_4 μM	NO_2 μM	NO_2+NO_3 μM	Chl-a μg·l⁻¹
Sur.	R	0		29.7	****	****	32.873	4.50	0.57	0.04	N.D.	0.07	0.00
34		5	5	29.724	32.866	4.05							
33		5	5	29.665	32.865	4.06							
36		10	10	29.531	32.862	4.09							
35		10	10	29.524	32.864	4.08							
32		10	10	29.522	32.865	4.08							
31	R	10	10	29.521	32.870	4.06	32.918	4.50	0.52	N.D.	N.D.	N.D.	0.13
30		20	20	29.177	33.332	4.14							
29	R	20	20	29.153	33.439	4.15	33.473	4.43	0.81	0.01	N.D.	N.D.	0.18
28		30	30	28.235	33.542	4.07							
27	R	30	30	28.157	33.639	4.07	33.650	4.42	1.04	0.02	N.D.	N.D.	0.33
26		50	50	27.037	34.224	3.47							
25	R	50	50	26.902	34.232	3.33	33.988	3.74	4.06	0.27	0.23	3.56	0.58
24		74	75	23.765	34.285	2.62							
23	R	74	75	23.498	34.291	2.54	34.278	2.67	11.96	0.72	0.04	11.38	0.09
22		99	100	20.711	34.371	2.25							
21	R	99	100	20.708	34.367	2.23	34.394	2.30	17.43	1.01	0.03	15.67	0.03
20		124	125	17.447	34.480	2.14							
19	R	124	125	17.202	34.489	2.16	34.490	2.22	21.75	1.25	0.01	18.58	0.01
18		149	150	16.383	34.528	2.29							
17	R	149	150	16.292	34.530	2.29	34.528	2.35	22.47	1.26	0.01	19.10	0.01
16	R	174	175	15.737	34.528	2.26	34.528	2.31	24.36	1.33	N.D.	19.82	0.01
15		199	200	14.884	34.524	2.20							
14	R	199	200	14.876	34.522	2.17	34.517	2.27	28.60	1.46	N.D.	21.51	0.01
13	R	249	250	13.647	34.500	1.89	34.494	1.88	37.44	1.67		24.52	
12	R	298	300	12.581	34.478	1.70	34.468	1.74	45.74	1.84		26.81	
11	R	497	501	10.906	34.460	1.68	34.456	1.73	53.71	1.99		28.77	
10	R	745	750	10.212	34.455	1.64	34.450	1.68	61.61	2.10		29.77	
9	R	992	1000	10.111	34.456	1.50	34.452	1.59	67.22	2.16		30.27	
8	R	1239	1250	10.111	34.456	1.43	34.452	1.50	69.48	2.18		30.37	
7	R	1486	1500	10.116	34.458	1.34	34.453	1.41	74.50	2.21		30.60	
6	R	1979	2000	10.153	34.463	1.21	34.455	1.30	80.46	2.24		30.87	
5	R	2471	2500	10.213	34.470	1.09	34.466	1.18	88.61	2.28		30.87	
4	R	2962	3000	10.290	34.473	1.01	34.467	1.13	92.62	2.29		31.06	
3	R	3026	3065	10.299	34.474	1.02	34.465	1.12					
2	R	3026	3065	10.299	34.474	1.02	34.466	1.11					
1	R	3026	3065	10.299	34.474	1.02	34.468	1.12	92.90	2.28		30.87	

CTD DATA (DOWN CAST LAY)

Pres. db	Temp. °C	P.Temp. °C	Sal. (psu)	DO ml·l⁻¹	FIS
1	29.652	29.651	32.865	4.18	0.04
10	29.555	29.552	32.863	4.19	0.04
20	29.452	29.448	33.039	4.18	0.05
30	28.956	28.948	33.565	4.27	0.08
50	27.153	27.142	34.208	3.52	0.48
75	24.009	23.993	34.249	2.77	0.12
100	22.025	22.005	34.310	2.53	0.07
125	19.136	19.114	34.445	2.28	0.04
150	16.997	16.973	34.507	2.31	0.03
175	15.911	15.884	34.542	2.42	0.03
200	15.060	15.030	34.536	2.42	0.02
250	13.957	13.921	34.519	2.27	0.03
300	13.032	12.991	34.487	1.88	0.03
400	11.656	11.605	34.468	1.84	0.03
500	11.004	10.942	34.465	1.83	0.03
600	10.559	10.486	34.460	1.94	0.03
700	10.275	10.191	34.456	1.85	0.03
800	10.179	10.083	34.456	1.73	0.03
1000	10.117	9.996	34.456	1.59	0.03
1250	10.118	9.965	34.457	1.51	0.03
1500	10.118	9.932	34.458	1.40	0.03
1750	10.133	9.914	34.461	1.31	0.03
2000	10.154	9.900	34.463	1.24	0.03
2500	10.213	9.889	34.470	1.10	0.03
3000	10.290	9.891	34.473	1.01	0.03
3053	10.298	9.891	34.474	1.02	0.03

KH-02-4 St.07-1			Date: 23 Nov. 2002 (GMT)				Time: 06:20 - 06:57			Lat. 8 5.88 N / Long. 118 21.87 E				Depth 524 m			B-P 30 m		
			CTD DATA (BTL)											CTD DATA (DOWN CAST LAY)					
Bottle No.		Depth m	Pres. db	Temp. °C	Sal. (psu)	DO $ml \cdot l^{-1}$	Sal. (psu)	DO $ml \cdot l^{-1}$	SiO_2 μM	PO_4 μM	NO_2 μM	NO_2+NO_3 μM	Chl-a $\mu g \cdot l^{-1}$	Pres. db	Temp. °C	P.Temp. °C	Sal. (psu)	DO $ml \cdot l^{-1}$	FIS
Sur.	R	0		29.4	****	****		4.51	0.77	0.03	N.D.	0.05	0.12	1	29.210	29.210	33.363	4.22	0.04
36		6	6	29.090	33.383	4.11								10	29.000	28.997	33.381	4.23	0.06
35		21	21	28.793	33.460	4.07								20	28.814	28.810	33.465	4.23	0.13
34		21	21	28.793	33.460	4.07								30	28.966	28.959	33.860	4.24	0.14
33		21	21	28.793	33.460	4.06								50	28.068	28.057	34.265	4.07	0.26
32		21	21	28.793	33.460	4.06								75	25.552	25.536	34.275	3.18	0.16
31		21	21	28.794	33.461	4.07								100	22.573	22.553	34.326	2.44	0.07
30		21	21	28.793	33.460	4.08								125	20.738	20.714	34.371	2.19	0.04
29		20	21	28.795	33.464	4.06								150	19.115	19.088	34.444	2.18	0.03
28		21	21	28.792	33.460	4.08								175	16.652	16.623	34.521	2.30	0.03
27		20	21	28.793	33.459	4.07								200	15.131	15.100	34.541	2.28	0.02
26		21	21	28.793	33.461	4.08								250	14.111	14.074	34.529	2.40	0.03
25		20	21	28.794	33.462	4.07								300	13.099	13.058	34.498	2.04	0.03
24		20	21	28.794	33.462	4.07								400	11.971	11.919	34.478	1.96	0.03
23		20	21	28.795	33.463	4.08								500	10.905	10.843	34.466	2.09	0.03
22		20	21	28.798	33.467	4.06								502	10.904	10.842	34.465	2.06	0.03
21		20	21	28.799	33.470	4.07													
20		20	21	28.795	33.463	4.07													
19		20	21	28.797	33.465	4.07													
18		20	21	28.796	33.464	4.08													
17		20	21	28.798	33.468	4.07													
16		20	21	28.796	33.465	4.08													
15		20	20	28.814	33.501	4.08													
14		20	20	28.798	33.470	4.09													
13	R	20	20	28.806	33.484	4.08		4.42	1.08	0.04	0.02	0.10	0.42						
12		50	51	26.294	34.267	3.33													
11	R	50	51	26.324	34.263	3.39		3.25	7.74	0.50	0.21	7.53	0.27						
10		100	100	20.456	34.366	2.11													
9	R	100	100	20.470	34.368	2.11		2.20	18.07	1.06	0.01	16.22	0.03						
8		200	201	14.889	34.529	2.27													
7	R	200	201	14.895	34.527	2.27		2.27	27.78	1.41	0.01	21.11	0.00						
6		299	301	13.010	34.488	1.82													
5	R	299	301	12.992	34.486	1.79		1.77	42.27	1.77		25.80							
4		398	400	11.946	34.473	1.79													
3	R	398	400	11.947	34.472	1.78		1.80	46.32	1.88		27.19							
2		498	501	10.901	34.464	2.00													
1	R	497	501	10.901	34.463	1.99		1.91	50.93	1.96		28.16							

KH-02-4 St.09-1			Date: 24 Nov. 2002 (GMT)				Time: 02:36 - 04:18			Lat. 8 21.99 N / Long. 119 4.37 E				Depth 2031 m			B-P 9 m		
			CTD DATA (BTL)											CTD DATA (DOWN CAST LAY)					
Bottle No.		Depth m	Pres. db	Temp. °C	Sal. (psu)	DO $ml \cdot l^{-1}$	Sal. (psu)	DO $ml \cdot l^{-1}$	SiO_2 μM	PO_4 μM	NO_2 μM	NO_2+NO_3 μM	Chl-a $\mu g \cdot l^{-1}$	Pres. db	Temp. °C	P.Temp. °C	Sal. (psu)	DO $ml \cdot l^{-1}$	FIS
Sur.	R	0		29.7	****	****	33.737	4.52	1.86	0.01	N.D.	N.D.	0.19	1	29.601	29.601	33.728	4.18	0.03
36		10	10	29.582	33.750	4.09								10	29.561	29.558	33.756	4.19	0.06
35		10	10	29.582	33.751	4.08								20	29.389	29.384	33.807	4.18	0.06
34		10	10	29.582	33.751	4.08								30	29.022	29.014	34.040	4.21	0.09
33		10	10	29.582	33.751	4.09								50	26.774	26.762	34.349	3.56	0.28
32		10	10	29.582	33.751	4.08								75	24.466	24.450	34.301	2.85	0.13
31		10	10	29.582	33.751	4.08								100	20.791	20.772	34.371	2.18	0.06
30		10	10	29.582	33.750	4.08								125	18.267	18.246	34.479	2.25	0.03
29		10	10	29.582	33.750	4.07								150	15.891	15.867	34.536	2.36	0.03
28		10	10	29.572	33.752	4.09								175	14.404	14.379	34.524	2.21	0.03
27		10	10	29.546	33.761	4.09								200	13.708	13.679	34.509	2.09	0.02
26		10	10	29.571	33.752	4.08								250	13.122	13.088	34.496	2.02	0.03
25	R	10	10	29.555	33.757	4.06	33.807	4.51	1.79	0.01	0.01	N.D.	0.17	300	12.550	12.509	34.485	1.89	0.03
24		20	20	29.361	33.872	4.11								400	11.584	11.533	34.477	2.10	0.03
23	R	20	20	29.359	33.869	4.10	34.027	4.40	2.28	0.04	0.06	0.45	0.31	500	10.810	10.749	34.464	2.04	0.03
22		50	50	26.856	34.327	3.51								600	10.468	10.396	34.459	1.88	0.02
21	R	50	50	26.816	34.319	3.38	34.336	3.57	6.72	0.35	0.50	5.31	0.46	700	10.341	10.256	34.457	1.78	0.03
20		99	100	21.342	34.343	2.11								800	10.214	10.118	34.455	1.76	0.02
19	R	99	100	21.349	34.342	2.09	34.354	2.19	18.82	1.05	0.04	16.31	0.07	1000	10.126	10.005	34.455	1.67	0.03
18		150	151	16.860	34.486	2.12								1250	10.098	9.946	34.456	1.55	0.03
17	R	149	150	16.730	34.493	2.13	34.509	2.23	26.13	1.32	0.01	20.33	0.00	1500	10.108	9.922	34.458	1.40	0.03
16		199	200	13.806	34.500	1.90								1750	10.125	9.906	34.461	1.30	0.03
15	R	198	200	13.766	34.501	1.87	34.496	1.95	36.71	1.62	0.01	24.23	0.00	2000	10.150	9.897	34.464	1.24	0.03
14		299	300	12.497	34.480	1.71								2029	10.153	9.896	34.464	1.23	0.03
13	R	298	300	12.494	34.480	1.71	34.475	1.83	43.85	1.79		26.47							
12		497	500	10.755	34.460	1.88													
11	R	497	500	10.747	34.460	1.88	34.456	1.89	52.83	1.96		28.43							
10		742	748	10.247	34.455	1.69													
9	R	742	748	10.246	34.454	1.67	34.450	1.70	59.28	2.07		29.60							
8		992	1000	10.124	34.454	1.61													
7	R	992	1000	10.119	34.454	1.60	34.450	1.66	64.21	2.10		30.06							
6		1486	1500	10.108	34.458	1.35													
5	R	1486	1500	10.108	34.458	1.35	34.454	1.43	73.58	2.16		30.56							
4		1981	2001	10.150	34.464	1.23													
3	R	1980	2000	10.150	34.464	1.23	34.460	1.25	80.93	2.18		30.71							
2		2037	2059	10.157	34.465	1.21													
1	R	2035	2057	10.157	34.465	1.21	34.460	1.29	81.67	2.19		30.79							

KH-02-4		Date: 24 Nov. 2002 (GMT)					Time: 18:25 - 20:44			Lat. 8 20.35 N				Depth 3205 m			B-P 17 m		
St.C		CTD DATA (BTL)								Long. 119 59.70 E				CTD DATA (DOWN CAST LAY)					
Bottle		Depth	Pres.	Temp.	Sal.	DO	Sal.	DO	SiO_2	PO_4	NO_2	NO_2+NO_3	Chl-a	Pres.	Temp.	P.Temp.	Sal.	DO	FIS
No.		m	db	°C	(psu)	$ml \cdot l^{-1}$	(psu)	$ml \cdot l^{-1}$	µM	µM	µM	µM	$\mu g \cdot l^{-1}$	db	°C	°C	(psu)	$ml \cdot l^{-1}$	
Sur.	R	0		29.7	****	****	32.938	4.54	0.83	0.04	N.D.	0.03	0.09	2	29.599	29.598	32.928	4.18	0.04
36		10	10	29.608	32.927	4.05								10	29.602	29.600	32.928	4.18	0.04
35		10	10	29.604	32.927	4.03								20	29.602	29.597	32.928	4.17	0.04
34		10	10	29.604	32.927	4.04								30	28.665	28.658	33.538	4.28	0.06
33		10	10	29.597	32.927	4.06								50	26.709	26.698	34.106	3.85	0.41
32		10	10	29.611	32.926	4.04								75	23.742	23.727	34.301	2.79	0.17
31		10	10	29.608	32.927	4.06								100	20.227	20.209	34.372	2.08	0.07
30		10	10	29.572	32.928	4.05								125	17.929	17.908	34.445	1.95	0.04
29	R	10	10	29.636	32.927	4.05	32.928	4.40	0.73	N.D.	N.D.	N.D.	0.10	150	15.666	15.643	34.509	2.02	0.03
28		19	19	29.332	33.129	4.09								175	14.705	14.679	34.507	2.03	0.03
27	R	19	19	29.502	32.959	4.10	33.467	4.49	0.79	N.D.	N.D.	N.D.	0.15	200	13.601	13.572	34.481	1.93	0.03
26		50	50	25.967	34.219	3.17								250	12.836	12.802	34.473	1.86	0.03
25	R	50	50	26.092	34.214	3.14	34.226	3.27	7.14	0.46	0.18	6.98	0.40	300	12.504	12.464	34.468	1.85	0.03
24		99	100	18.869	34.397	1.86								400	11.766	11.714	34.468	1.84	0.03
23	R	99	100	18.759	34.420	1.86	34.402	1.95	21.74	1.20	0.01	18.78	0.04	500	11.029	10.967	34.465	1.82	0.03
22		149	150	15.436	34.498	1.88								600	10.556	10.484	34.460	1.74	0.03
21	R	149	150	15.434	34.497	1.88	34.498	1.89	29.27	1.47	N.D.	22.23	0.00	700	10.310	10.225	34.457	1.77	0.03
20		199	200	13.526	34.472	1.76								800	10.208	10.112	34.456	1.72	0.03
19	R	199	200	13.523	34.471	1.76	34.467	1.82	41.17	1.74	N.D.	25.27	0.00	1000	10.113	9.993	34.454	1.75	0.03
18		298	300	12.480	34.463	1.66								1250	10.094	9.942	34.456	1.51	0.03
17	R	298	300	12.480	34.463	1.65	34.460	1.70	46.80	1.87		26.95		1500	10.109	9.924	34.458	1.41	0.03
16		497	500	11.029	34.461	1.66								1750	10.126	9.907	34.460	1.33	0.04
15	R	497	500	11.023	34.461	1.66	34.457	1.76	53.08	2.02		29.02		2000	10.150	9.896	34.463	1.28	0.03
14		745	750	10.259	34.455	1.67								2500	10.213	9.888	34.469	1.14	0.03
13	R	744	750	10.259	34.455	1.67	34.451	1.71	59.39	2.12		29.86		3000	10.289	9.890	34.474	1.04	0.03
12		992	1000	10.117	34.453	1.68								3281	10.332	9.890	34.474	1.04	0.02
11	R	992	1000	10.117	34.453	1.68	34.449	1.73	61.59	2.12		29.75							
10		1488	1502	10.111	34.458	1.35													
9	R	1488	1501	10.111	34.458	1.35	34.453	1.44	72.09	2.22		30.60							
8		1980	2001	10.150	34.463	1.24													
7	R	1980	2000	10.150	34.463	1.24	34.459	1.33	79.24	2.20		30.93							
6		2472	2501	10.212	34.469	1.10													
5	R	2471	2500	10.212	34.469	1.10	34.465	1.20	86.38	2.27		30.87							
4		2963	3001	10.288	34.474	1.01													
3	R	2962	3000	10.288	34.474	1.01	34.468	1.11	92.42	2.27		31.00							
2		3248	3292	10.334	34.474	1.03													
1	R	3248	3292	10.334	34.474	1.03	34.469	1.12	92.25	2.30		30.77							

KH-02-4		Date: 02 Dec. 2002 (GMT)					Time: 17:34 - 20:51			Lat. 8 50.00 N				Depth 4807 m			B-P 8 m		
St.10-1		CTD DATA (BTL)								Long. 121 47.68 E				CTD DATA (DOWN CAST LAY)					
Bottle		Depth	Pres.	Temp.	Sal.	DO	Sal.	DO	SiO_2	PO_4	NO_2	NO_2+NO_3	Chl-a	Pres.	Temp.	P.Temp.	Sal.	DO	FIS
No.		m	db	°C	(psu)	$ml \cdot l^{-1}$	(psu)	$ml \cdot l^{-1}$	µM	µM	µM	µM	$\mu g \cdot l^{-1}$	db	°C	°C	(psu)	$ml \cdot l^{-1}$	
Sur.		0		28.9	****	****								1	28.873	28.872	34.085	4.14	0.05
36		398	400	11.515	34.469	1.74								10	28.775	28.773	34.111	4.15	0.05
35		398	400	11.515	34.468	1.74								20	28.372	28.367	34.248	4.10	0.06
34	R	397	400	11.512	34.469	1.75	34.469	1.81	48.77	1.93		28.09		30	28.363	28.356	34.257	4.09	0.08
33		497	500	10.948	34.462	1.75								40	28.010	28.001	34.335	4.01	0.30
32		497	500	10.947	34.462	1.76								50	27.890	27.879	34.319	3.93	0.30
31	R	497	500	10.940	34.462	1.76	34.461	1.80	52.12	1.99		28.93		75	27.757	27.740	34.380	3.93	0.23
30	R	596	600	10.611	34.458	1.70	34.457	1.78	56.05	2.05		29.59		100	22.126	22.106	34.359	2.30	0.08
29	R	695	700	10.346	34.455	1.75	34.454	1.83	57.36	2.06		29.68		125	17.985	17.963	34.453	1.94	0.04
28		745	750	10.262	34.454	1.73								150	16.077	16.054	34.500	1.99	0.02
27	R	745	750	10.259	34.454	1.73	34.448	1.81	58.62	2.06		29.89		175	14.795	14.769	34.507	1.87	0.03
26	R	793	799	10.214	34.455	1.57	34.453	1.69	61.81	2.11		30.35		200	14.245	14.216	34.510	1.96	0.03
25		992	1000	10.113	34.454	1.56								250	13.087	13.053	34.477	1.55	0.04
24		992	1000	10.113	34.454	1.56								300	12.360	12.320	34.478	1.69	0.03
23	R	992	1000	10.113	34.454	1.56	34.531	1.66	64.36	2.14		30.71		400	11.485	11.434	34.473	1.97	0.03
22		1240	1250	10.098	34.456	1.42								500	10.930	10.869	34.465	1.91	0.03
21	R	1239	1250	10.098	34.456	1.42	34.449	1.50	70.54	2.18		31.10		600	10.581	10.508	34.460	1.80	0.03
20		1486	1500	10.106	34.457	1.35								700	10.330	10.246	34.456	1.87	0.03
19	R	1486	1500	10.105	34.457	1.35	34.455	1.50	73.19	2.19		30.99		750	10.245	10.155	34.455	1.81	0.02
18		1979	2000	10.149	34.463	1.21								800	10.197	10.100	34.455	1.74	0.03
17		1979	2000	10.148	34.463	1.21								1000	10.110	9.990	34.455	1.66	0.03
16	R	1979	1999	10.148	34.463	1.21	34.464	1.33	81.19	2.24		31.50		1250	10.104	9.951	34.457	1.45	0.03
15		2471	2500	10.211	34.469	1.09								1500	10.101	9.916	34.456	1.52	0.03
14	R	2471	2500	10.211	34.469	1.09	34.469	1.23	87.02	2.20		31.45		1750	10.118	9.899	34.458	1.47	0.03
13		2963	3001	10.285	34.473	1.01								2000	10.148	9.895	34.463	1.31	0.03
12		2962	3000	10.285	34.473	1.01								2500	10.211	9.887	34.469	1.15	0.03
11	R	2962	3000	10.285	34.473	1.01	34.474	1.17	91.89	2.21		31.26		3000	10.285	9.886	34.473	1.09	0.04
10		3453	3501	10.364	34.475	0.99								3500	10.364	9.888	34.475	1.02	0.03
9	R	3453	3501	10.364	34.475	0.99	34.509	1.14	93.63	2.26		31.17		4000	10.445	9.888	34.475	1.01	0.03
8		3940	4000	10.444	34.475	0.98								4500	10.528	9.889	34.476	1.01	0.03
7	R	3940	4000	10.444	34.475	0.98	34.475	1.14	94.27	2.24		31.13		5000	10.614	9.889	34.476	1.01	0.03
6		4427	4499	10.527	34.476	0.96								5026	10.618	9.889	34.476	1.01	0.03
5		4427	4499	10.527	34.476	0.96													
4	R	4427	4499	10.527	34.476	0.96	34.475	1.14	94.33	2.23		30.99							
3	R	4845	4928	10.601	34.476	1.00	34.474	1.13	94.29	2.24		31.03							
2		4942	5028	10.618	34.476	1.01													
1	R	4941	5028	10.618	34.476	1.01	34.474	1.13	94.05	2.22		31.01							

KH-02-4 St.10-2		Date: 03 Dec. 2002 (GMT)					Time: 02:13 - 02:48			Lat. 8 50.01 N Long. 121 48.00 E				Depth 4810 m					
		CTD DATA (BTL)												CTD DATA (DOWN CAST LAY)					
Bottle No.		Depth m	Pres. db	Temp. °C	Sal. (psu)	DO ml·l^{-1}	Sal. (psu)	DO ml·l^{-1}	SiO_2 µM	PO_4 µM	NO_2 µM	NO_2+NO_3 µM	Chl-a µg·l^{-1}	Pres. db	Temp. °C	P.Temp. °C	Sal. (psu)	DO ml·l^{-1}	FIS
Sur.	R	0		28.9	****	****	34.169	4.56	1.27	0.05	N.D.	0.63	0.13	1	28.756	28.755	34.158	4.20	0.04
31		5	5	28.776	34.165	4.15								10	28.776	28.773	34.160	4.20	0.04
30		5	5	28.776	34.166	4.15								20	28.663	28.658	34.166	4.20	0.19
36		10	10	28.704	34.165	4.15								30	28.480	28.472	34.223	4.19	0.07
35		10	10	28.704	34.165	4.15								40	28.336	28.326	34.268	4.16	0.09
34		10	10	28.704	34.164	4.16								50	27.978	27.966	34.339	4.05	0.30
33		10	10	28.701	34.166	4.15								75	27.739	27.721	34.313	3.89	0.24
32		10	10	28.701	34.166	4.16								100	23.674	23.653	34.452	2.79	0.06
29		10	10	28.704	34.165	4.13								125	19.123	19.101	34.421	1.96	0.03
28		10	10	28.700	34.165	4.15								150	16.002	15.979	34.507	1.95	0.03
27		10	10	28.698	34.166	4.14								175	14.387	14.362	34.512	1.87	0.03
26	R	10	10	28.702	34.165	4.14	34.169	4.50	1.21	0.05	0.02	0.77	0.16	200	14.067	14.038	34.507	1.93	0.03
25		20	20	28.621	34.182	4.13								250	13.041	13.006	34.475	1.54	0.03
24	R	20	20	28.624	34.181	4.13	34.201	4.62	1.24	0.04	N.D.	0.47	0.20	300	12.457	12.416	34.478	1.74	0.03
23		30	31	28.383	34.250	4.07								301	12.452	12.411	34.478	1.72	0.03
22	R	30	31	28.383	34.250	4.06	34.266	4.45	1.38	0.07	N.D.	0.39	0.22						
21		50	50	27.948	34.319	3.91													
20		50	50	27.944	34.318	3.91													
19	R	50	50	27.940	34.316	3.91	34.319	4.29	2.01	0.11	0.23	1.03	0.64						
18		75	76	27.711	34.309	3.79													
17	R	75	76	27.701	34.312	3.81	34.345	4.18	2.75	0.15	0.38	2.00	0.45						
16		100	100	23.292	34.419	2.64													
15		100	101	23.383	34.421	2.65													
14	R	100	100	23.326	34.411	2.44	34.391	2.41	18.28	0.96	0.03	14.99	0.05						
13		125	125	18.965	34.398	1.89													
12	R	125	125	18.815	34.409	1.86	34.434	1.94	24.09	1.28	0.01	20.04	0.01						
11		149	150	15.924	34.488	1.91													
10	R	150	150	15.983	34.484	1.89	34.497	1.89	29.98	1.47	N.D.	22.70	0.01						
9		175	176	14.391	34.501	1.82													
8	R	175	176	14.386	34.500	1.82	34.501	1.85	34.48	1.58	N.D.	24.25	0.00						
7		199	200	14.075	34.500	1.83													
6		199	200	14.085	34.500	1.84													
5	R	199	200	14.081	34.499	1.83	34.498	1.73	36.84	1.64	N.D.	24.91	0.01						
4		249	251	13.025	34.469	1.44													
3	R	249	251	13.036	34.468	1.44	34.469	1.46	47.89	1.86		27.66							
2		299	301	12.455	34.477	1.69													
1	R	299	301	12.459	34.477	1.70	34.469	1.63	47.22	1.92		27.64							

KH-02-4 St.11-1		Date: 04 Dec. 2002 (GMT)					Time: 02:57 - 05:34			Lat. 8 50.37 N Long. 121 5.34 E				Depth 3668 m			B-P 21 m		
		CTD DATA (BTL)												CTD DATA (DOWN CAST LAY)					
Bottle No.		Depth m	Pres. db	Temp. °C	Sal. (psu)	DO ml·l^{-1}	Sal. (psu)	DO ml·l^{-1}	SiO_2 µM	PO_4 µM	NO_2 µM	NO_2+NO_3 µM	Chl-a µg·l^{-1}	Pres. db	Temp. °C	P.Temp. °C	Sal. (psu)	DO ml·l^{-1}	FIS
Sur.	R	0		28.9	****	****	34.305	4.57	1.05	0.03	N.D.	0.10	0.25	1	28.571	28.571	34.298	4.29	0.05
34		5	5	28.828	34.313	4.19								10	28.569	28.566	34.299	4.31	0.06
33		5	5	28.823	34.312	4.18								20	28.434	28.430	34.294	4.31	0.09
36		10	10	28.619	34.308	4.19								30	28.145	28.137	34.283	4.18	0.15
35		10	10	28.618	34.307	4.18								40	28.097	28.088	34.301	4.20	0.22
32	R	10	10	28.594	34.307	4.18	34.311	4.61	1.06	0.02	N.D.	0.08	0.25	50	27.999	27.987	34.324	4.12	0.23
31	R	20	20	28.549	34.303	4.17	34.306	4.58	1.03	0.02	N.D.	0.05	0.25	75	27.048	27.030	34.390	3.73	0.15
30	R	30	30	28.458	34.293	4.14	34.294	4.57	1.07	0.03	N.D.	0.05	0.31	100	22.774	22.754	34.360	2.43	0.09
29	R	50	50	28.072	34.282	4.00	34.291	4.38	1.65	0.07	0.01	0.17	0.56	125	20.164	20.141	34.400	2.18	0.06
28	R	75	76	27.051	34.387	3.62	34.392	3.82	4.72	0.27	0.47	3.59	0.27	150	16.999	16.975	34.503	2.16	0.03
27		100	100	21.341	34.356	2.15								175	15.344	15.317	34.512	2.02	0.03
26	R	100	100	21.353	34.354	2.16	34.359	2.25	17.33	1.01	0.03	15.72	0.06	200	14.541	14.511	34.515	2.16	0.03
25	R	124	125	18.119	34.449	2.01	34.340	2.12	22.64	1.24	N.D.	18.99	0.02	250	13.412	13.377	34.499	1.94	0.03
24	R	149	150	16.226	34.500	2.01	34.506	2.12	25.93	1.35	N.D.	20.71	0.01	300	12.726	12.686	34.487	1.86	0.03
23	R	174	175	15.037	34.495	1.83	34.500	1.91	31.78	1.53	N.D.	23.21	0.00	400	11.760	11.709	34.478	1.96	0.03
22		199	200	14.424	34.492	1.77								500	10.934	10.872	34.467	1.89	0.03
21	R	199	200	14.426	34.492	1.77	34.495	1.86	34.76	1.61	0.02	24.17	0.01	600	10.583	10.510	34.460	1.96	0.03
20	R	298	300	12.579	34.478	1.64	34.478	1.72	44.73	1.84		27.19		700	10.350	10.266	34.457	1.87	0.03
19	R	397	400	11.774	34.472	1.79	34.475	1.88	46.37	1.85		27.54		750	10.279	10.188	34.456	1.81	0.03
18		497	500	10.923	34.462	1.72								800	10.217	10.121	34.455	1.80	0.03
17	R	497	500	10.920	34.461	1.77	34.462	1.82	52.16	1.96		28.89		1000	10.099	9.978	34.453	1.73	0.03
16	R	596	600	10.548	34.457	1.82	34.459	1.87	54.31	2.00		28.97		1250	10.094	9.941	34.455	1.57	0.03
15	R	745	750	10.276	34.455	1.71	34.457	1.76	59.20	2.05		29.88		1500	10.108	9.923	34.458	1.38	0.03
14		992	1000	10.102	34.453	1.69								1750	10.121	9.902	34.460	1.37	0.03
13	R	992	1000	10.101	34.453	1.68	34.460	1.71	62.80	2.08		30.26		2000	10.147	9.894	34.463	1.26	0.03
12	R	1240	1250	10.098	34.457	1.38	34.457	1.47	70.62	2.15		30.84		2500	10.212	9.888	34.470	1.10	0.03
11	R	1486	1500	10.104	34.458	1.34	34.460	1.46	72.75	2.16		30.82		3000	10.287	9.888	34.473	1.02	0.03
10		1980	2001	10.147	34.464	1.22								3500	10.365	9.889	34.474	1.00	0.03
9	R	1980	2001	10.147	34.464	1.22	34.466		80.71	2.20		31.19		3783	10.410	9.889	34.475	1.01	0.03
8	R	2472	2501	10.212	34.470	1.07	34.472	1.20	88.26	2.23		31.22							
7		2962	3000	10.286	34.473	1.01													
6	R	2962	3000	10.286	34.473	1.01	34.477	1.15	91.84	2.26		31.07							
5		3449	3497	10.364	34.474	1.00													
4	R	3449	3497	10.364	34.474	1.00	34.475	1.13	93.92	2.25		31.24							
3	R	3730	3784	10.410	34.475	1.01	34.474	1.12	94.35	2.26		30.95							
2		3730	3784	10.410	34.475	1.00													
1	R	3730	3784	10.410	34.475	1.00	34.476	1.14	93.98	2.27		30.97							

KH-02-4		Date:	05-06 Dec. 2002 (GMT)				Time: 22:06 - 00:13			Lat. 8 46.82 N				Depth 2904 m			B-P 8 m		
St.12-1			CTD DATA (BTL)							Long. 120 42.19 E				CTD DATA (DOWN CAST LAY)					
Bottle		Depth	Pres.	Temp.	Sal.	DO	Sal.	DO	SiO_2	PO_4	NO_2	NO_2+NO_3	Chl-a	Pres.	Temp.	P.Temp.	Sal.	DO	FIS
No.		m	db	°C	(psu)	ml·l^{-1}	(psu)	ml·l^{-1}	μM	μM	μM	μM	μg·l^{-1}	db	°C	°C	(psu)	ml·l^{-1}	
Sur.	R	0		28.7	****	****	34.211	4.54	1.61	0.04	N.D.	0.02	0.16	1	28.544	28.544	34.155	4.28	0.05
36		9	9	28.538	34.204	4.09								10	28.547	28.544	34.157	4.28	0.06
35		9	9	28.538	34.204	4.09								20	28.372	28.367	34.259	4.27	0.06
34		9	9	28.538	34.204	4.07								30	28.257	28.250	34.282	4.26	0.07
33		9	9	28.538	34.205	4.08								40	28.026	28.017	34.286	4.29	0.11
32		9	9	28.538	34.205	4.08								50	27.160	27.148	34.346	3.81	0.29
31		9	9	28.537	34.205	4.09								75	24.734	24.718	34.386	2.93	0.09
30		8	8	28.536	34.205	4.09								100	19.291	19.274	34.455	2.17	0.04
29	R	9	9	28.538	34.205	4.08	34.211	4.52	1.62	0.04	0.01	N.D.	0.14	125	16.934	16.913	34.484	1.99	0.03
28	R	20	20	28.426	34.242	4.10	34.254	4.54	1.62	0.04	N.D.	N.D.	0.20	150	15.654	15.631	34.497	1.95	0.03
26		49	49	28.047	34.282	4.14								175	14.758	14.732	34.503	2.02	0.03
25	R	49	49	28.049	34.281	4.15	34.293	4.43	1.43	0.08	0.06	0.15	0.36	200	14.087	14.058	34.496	1.98	0.03
24		99	100	21.584	34.348	2.21								250	13.080	13.046	34.490	1.88	0.03
23	R	99	100	21.333	34.351	2.16	34.494	2.23	18.24	1.04	0.03	15.90	0.06	300	12.357	12.317	34.470	1.79	0.03
22		149	150	15.975	34.490	1.86								400	11.588	11.537	34.471	1.89	0.03
21	R	149	150	15.973	34.489	1.85	34.458	1.93	28.79	1.46	0.01	21.83	0.01	500	10.909	10.848	34.464	1.89	0.03
20		199	200	14.270	34.492	1.81								600	10.529	10.456	34.459	1.87	0.03
19	R	199	200	14.255	34.492	1.82	34.492	1.89	35.63	1.63	N.D.	24.10	0.01	700	10.314	10.229	34.456	1.84	0.03
18		298	300	12.327	34.468	1.67								750	10.241	10.151	34.456	1.75	0.02
17	R	298	300	12.327	34.467	1.67	34.469	1.75	46.80	1.86		27.30		800	10.204	10.108	34.456	1.70	0.03
16		496	500	10.854	34.461	1.77								1000	10.126	10.005	34.456	1.54	0.03
15	R	496	500	10.837	34.461	1.77	34.455	1.82	52.82	1.95		28.84		1250	10.101	9.949	34.457	1.47	0.03
14		744	750	10.213	34.455	1.61								1500	10.109	9.924	34.458	1.39	0.03
13	R	744	749	10.212	34.455	1.61	34.455	1.67	61.32	2.11		30.32		1750	10.126	9.907	34.460	1.35	0.03
12		992	1000	10.121	34.456	1.48								2000	10.150	9.896	34.463	1.29	0.03
11	R	992	1000	10.120	34.455	1.48	34.239	1.55	66.45	2.17		30.92		2500	10.212	9.888	34.469	1.14	0.04
10		1486	1500	10.109	34.458	1.34								2982	10.285	9.889	34.473	1.05	0.03
9	R	1486	1500	10.109	34.458	1.34	34.457	1.43	74.17	2.20		31.07							
8		1978	1999	10.150	34.463	1.24													
7	R	1978	1999	10.150	34.463	1.24	34.462	1.38	79.76	2.18		31.13							
6		2471	2500	10.212	34.470	1.10													
5	R	2471	2500	10.212	34.470	1.10	34.468	1.23	87.46	2.25		31.26							
4		2952	2989	10.287	34.473	1.01													
3	R	2951	2989	10.287	34.473	1.02	34.468	1.15	92.57	2.26		31.36							
2		2951	2989	10.287	34.473	1.02													
1	R	2952	2990	10.287	34.473	1.02	34.472	1.16	92.75	2.25		31.28							
27		Did not fire																	

KH-02-4		Date:	06 Dec. 2002 (GMT)				Time: 19:38 - 21:20			Lat. 8 57.15 N				Depth 1843 m			B-P 10 m		
St.13-1			CTD DATA (BTL)							Long. 120 10.93 E				CTD DATA (DOWN CAST LAY)					
Bottle		Depth	Pres.	Temp.	Sal.	DO	Sal.	DO	SiO_2	PO_4	NO_2	NO_2+NO_3	Chl-a	Pres.	Temp.	P.Temp.	Sal.	DO	FIS
No.		m	db	°C	(psu)	ml·l^{-1}	(psu)	ml·l^{-1}	μM	μM	μM	μM	μg·l^{-1}	db	°C	C	(psu)	ml·l^{-1}	
Sur.	R	0		29.2	****	****	33.771	4.54	1.37	0.04	N.D.	N.D.	0.19	1	28.994	28.994	33.752	4.22	0.07
36		10	10	28.956	33.770	4.11								10	29.000	28.997	33.753	4.22	0.07
35		10	11	28.956	33.769	4.10								20	29.006	29.001	33.754	4.22	0.06
34		10	11	28.957	33.774	4.11								30	28.989	28.982	33.820	4.23	0.09
33		10	11	28.957	33.774	4.11								40	28.902	28.892	34.138	4.20	0.21
32		10	11	28.958	33.775	4.10								50	28.585	28.573	34.150	4.10	0.25
31		10	11	28.957	33.774	4.09								75	25.703	25.687	34.321	3.31	0.14
30		11	11	28.955	33.769	4.11								100	22.106	22.086	34.370	2.58	0.07
29		10	11	28.954	33.765	4.10								125	18.531	18.509	34.504	2.46	0.04
28		10	10	28.954	33.763	4.10								150	15.643	15.620	34.534	2.32	0.03
27		10	11	28.955	33.763	4.10								175	14.515	14.489	34.534	2.39	0.02
26		10	11	28.955	33.763	4.09								200	14.206	14.177	34.528	2.43	0.03
25		10	11	28.954	33.765	4.09								250	13.068	13.033	34.496	1.98	0.03
24		10	11	28.954	33.765	4.10								300	12.416	12.376	34.489	2.09	0.03
23		10	10	28.954	33.768	4.08								400	11.642	11.591	34.475	2.02	0.03
22		10	11	28.956	33.774	4.11								500	11.023	10.960	34.466	2.00	0.03
21	R	10	10	28.958	33.788	4.07	33.949	4.49	1.42	0.01	0.03	N.D.	0.32	600	10.626	10.552	34.460	1.90	0.03
20	R	30	30	28.741	34.123	4.04	34.110	4.41	1.37	0.02	0.11	N.D.	0.40	700	10.357	10.272	34.457	1.82	0.03
19	R	50	50	27.798	34.128	3.76	34.177	4.09	2.38	0.14	0.48	1.30	0.34	750	10.298	10.207	34.456	1.80	0.03
18	R	75	75	25.068	34.338	2.95	34.346	3.19	9.27	0.54	0.38	8.09	0.16	800	10.228	10.132	34.455	1.75	0.03
17	R	100	101	22.131	34.357	2.48	34.363	2.60	14.00	0.84	0.06	12.80	0.07	1000	10.115	9.994	34.455	1.61	0.03
16	R	125	125	18.712	34.484	2.35	34.503	2.39	18.60	1.12	0.05	16.96	0.02	1250	10.095	9.942	34.456	1.51	0.04
15	R	149	150	16.019	34.509	2.15	34.524	2.24	26.08	1.39	0.03	20.82	0.01	1500	10.108	9.922	34.457	1.44	0.03
14	R	199	200	14.085	34.517	2.11	34.514	2.13	32.79	1.53	0.04	23.06	0.00	1750	10.130	9.911	34.460	1.37	0.04
13	R	248	250	12.946	34.490	1.79	34.491	1.87	40.76	1.72		25.57		1871	10.139	9.904	34.461	1.29	0.03
12	R	298	300	12.308	34.474	1.69	34.471	1.71	45.64	1.86		27.23							
11	R	397	400	11.564	34.471	1.91	34.469	1.96	46.51	1.86		27.20							
10	R	496	500	10.943	34.463	1.87	34.463	1.90	51.80	1.93		28.31							
9	R	596	600	10.544	34.458	1.73	34.458	1.80	55.45	2.00		29.31							
8	R	695	700	10.328	34.455	1.72	34.456	1.74	58.56	2.03		29.62							
7	R	793	799	10.226	34.455	1.66	34.455	1.71	61.31	2.09		29.93							
6	R	992	1000	10.124	34.455	1.56	34.454	1.61	65.26	2.11		30.22							
5	R	1241	1251	10.095	34.456	1.47	34.453	1.47	69.35	2.17		30.62							
4	R	1484	1498	10.108	34.457	1.41	34.458	1.46	73.13	2.17		30.54							
3	R	1485	1498	10.108	34.457	1.41	34.457	1.47	73.49	2.20		30.88							
2	R	1846	1864	10.139	34.461	1.28	34.459	1.36	78.92	2.21		30.82							
1	R	1860	1879	10.141	34.461	1.28	34.461	1.34	79.38	2.22		30.95							

KH-02-4 St.14-1	Date: 07 Dec. 2002 (GMT)	Time: 15:58 - 17:22	Lat. 9 59.16 N	Long. 120 54.56 E	Depth 1494 m	B-P 20 m

CTD DATA (BTL)

Bottle No.		Depth m	Pres. db	Temp. °C	Sal. (psu)	DO ml·l^{-1}	Sal. (psu)	DO ml·l^{-1}	SiO_2 μM	PO_4 μM	NO_2 μM	NO_2+NO_3 μM	Chl-a μg·l^{-1}
Sur.	R	0		29.1	****	****	33.710	4.50	1.28	0.09	0.01	N.D.	0.29
36	R	10	10	29.069	33.697	4.11	33.704	4.52	1.23	0.05	0.01	N.D.	0.29
35		20	20	29.075	33.696	4.12							
34		20	20	29.077	33.696	4.11							
33	R	20	20	29.075	33.696	4.12	33.702	4.49	1.31	0.06	0.01	N.D.	0.28
32	R	30	30	29.060	33.694	4.13	33.702	4.51	1.25	0.04	0.02	N.D.	0.30
31		50	50	27.687	34.023	4.05							
30		50	50	27.686	34.023	4.05							
29	R	50	50	27.686	34.022	4.05	34.070	4.32	0.58	0.11	0.08	0.15	0.63
28	R	75	75	24.685	34.168	3.13	34.195	3.19	6.78	0.51	0.17	6.78	0.27
27		100	100	20.818	34.379	2.53							
26		100	100	20.750	34.380	2.49							
25	R	100	100	20.610	34.390	2.49	34.417	2.47	12.71	0.93	0.03	13.79	0.08
24	R	124	125	18.424	34.493	2.33	34.492	2.38	15.30	1.07	0.02	16.07	0.04
23	R	149	150	17.392	34.522	2.34	34.522	2.42	18.03	1.18	0.02	17.19	0.03
22	R	174	175	15.688	34.547	2.39	34.547	2.45	21.81	1.29	N.D.	18.91	0.01
21		199	200	14.755	34.538	2.36							
20		199	200	14.769	34.536	2.37							
19	R	199	200	14.700	34.539	2.38	34.538	2.41	25.39	1.36	N.D.	20.13	0.00
18	R	249	250	14.006	34.510	1.93	34.500	1.93	36.20	1.63		23.76	
17		299	301	13.083	34.500	2.09							
16		298	300	13.084	34.500	2.10							
15	R	298	300	13.084	34.500	2.10	34.498	2.08	37.06	1.66		24.05	
14	R	397	400	11.821	34.471	1.78	34.469	1.76	47.09	1.88		27.32	
13		497	500	11.094	34.465	1.84							
12		497	500	11.089	34.465	1.84							
11	R	497	500	11.096	34.465	1.84	34.464	1.86	50.69	1.93		28.00	
10	R	596	600	10.590	34.458	1.89	34.457	1.92	52.99	1.98		28.37	
9	R	745	750	10.301	34.453	1.96	34.453	1.98	54.79	1.99		28.64	
8		992	1000	10.129	34.452	1.87							
7		992	1000	10.129	34.452	1.87							
6	R	993	1001	10.128	34.452	1.87	34.451	1.90	58.28	2.05		29.02	
5	R	1240	1251	10.098	34.453	1.71	34.453	1.73	64.66	2.11		29.69	
4		1486	1500	10.113	34.458	1.21							
3		1486	1500	10.113	34.458	1.21							
2	R	1486	1500	10.113	34.458	1.21	34.418	1.27	85.76	2.24		30.34	
1	R	1486	1500	10.113	34.458	1.21	34.457	1.27	85.51	2.23		30.30	

CTD DATA (DOWN CAST LAY)

Pres. db	Temp. °C	P.Temp. °C	Sal. (psu)	DO ml·l^{-1}	FIS
2	29.095	29.095	33.697	4.27	0.07
10	29.096	29.094	33.697	4.27	0.07
20	29.091	29.086	33.697	4.27	0.06
30	28.809	28.801	33.714	4.28	0.10
40	27.815	27.805	33.956	4.10	0.39
50	27.689	27.678	34.026	4.14	0.31
75	23.065	23.049	34.280	2.82	0.13
100	19.801	19.783	34.434	2.48	0.07
125	18.406	18.384	34.502	2.46	0.06
150	17.207	17.182	34.538	2.51	0.04
175	15.828	15.801	34.558	2.58	0.03
200	14.731	14.702	34.548	2.54	0.03
250	13.918	13.882	34.518	2.38	0.03
300	13.154	13.112	34.505	2.27	0.03
400	11.749	11.697	34.476	1.94	0.04
500	11.041	10.978	34.467	1.98	0.03
600	10.560	10.487	34.460	1.91	0.03
700	10.334	10.249	34.455	2.08	0.03
750	10.254	10.164	34.454	2.02	0.03
800	10.213	10.117	34.454	1.93	0.03
1000	10.125	10.005	34.452	1.94	0.03
1250	10.099	9.946	34.453	1.74	0.03
1497	10.113	9.928	34.458	1.21	0.04

KH-02-4 St.15-1	Date: 08 Dec. 2002 (GMT)	Time: 04:05 - 05:06	Lat. 10 10.98 N	Long. 121 27.35 E	Depth 1062 m	B-P 9 m

CTD DATA (BTL)

Bottle No.		Depth m	Pres. db	Temp. °C	Sal. (psu)	DO ml·l^{-1}	Sal. (psu)	DO ml·l^{-1}	SiO_2 μM	PO_4 μM	NO_2 μM	NO_2+NO_3 μM	Chl-a μg·l^{-1}
Sur.	R	0		29.0	****	****	33.971	4.58	0.40	0.08	N.D.	N.D.	0.23
36		10	10	28.620	33.993	4.18							
35		10	10	28.612	33.995	4.19							
34		10	10	28.633	33.988	4.20							
33		10	10	28.638	33.986	4.18							
32		10	10	28.605	33.996	4.17							
31		10	10	28.634	33.987	4.17							
30		10	10	28.625	33.990	4.19							
29		10	10	28.624	33.990	4.19							
28		10	10	28.582	34.000	4.18							
27		10	10	28.565	34.004	4.18							
26		10	10	28.531	34.010	4.18							
25		10	10	28.478	34.020	4.19							
24		10	10	28.391	34.049	4.21							
23	R	10	10	28.371	34.052	4.20	34.121	4.73	N.D.	0.05	0.01	N.D.	0.18
22		20	20	27.501	34.296	4.17							
21	R	20	20	27.519	34.292	4.17	34.335	4.52	N.D.	0.12	0.07	0.29	0.48
20		30	30	26.921	34.319	3.92							
19	R	30	30	26.951	34.314	3.94	34.336	3.72	2.51	0.36	0.41	3.92	0.83
18		50	50	25.647	34.349	2.75							
17	R	50	50	25.605	34.350	2.74	34.357	2.97	9.00	0.58	0.39	8.46	0.67
16		100	100	21.339	34.363	2.11							
15	R	100	100	21.199	34.365	2.08	34.377	2.19	17.36	1.05	0.04	15.70	0.03
14		149	150	16.730	34.489	2.06							
13	R	149	150	16.689	34.490	2.02	34.511	2.27	25.10	1.32	0.02	19.72	0.01
12		199	200	13.801	34.515	2.19							
11	R	199	200	13.782	34.515	2.20	34.517	2.28	31.90	1.55	0.02	22.38	0.01
10		298	300	12.469	34.492	2.30							
9	R	298	300	12.450	34.494	2.30	34.497	2.33	37.17	1.63		23.93	
8		497	500	10.716	34.460	2.13							
7	R	497	500	10.707	34.460	2.13	34.457	2.15	49.66	1.92		27.58	
6		744	750	10.200	34.452	2.05							
5	R	744	750	10.200	34.452	2.06	34.454	2.08	54.45	2.02		28.73	
4		991	999	10.069	34.450	2.10							
3	R	991	999	10.069	34.450	2.10	34.451	2.12	54.80	2.03		28.64	
2		1054	1063	10.058	34.450	2.11							
1	R	1054	1063	10.058	34.450	2.11	34.450	2.10	55.01	2.04		28.61	

CTD DATA (DOWN CAST LAY)

Pres. db	Temp. °C	P.Temp. °C	Sal. (psu)	DO ml·l^{-1}	FIS
1	28.697	28.696	33.987	4.31	0.06
10	27.907	27.905	34.235	4.40	0.08
20	27.518	27.513	34.321	4.33	0.29
30	26.689	26.682	34.339	4.02	0.56
40	25.869	25.860	34.351	2.96	0.59
50	25.513	25.502	34.357	2.84	0.37
75	23.232	23.217	34.401	2.68	0.08
100	20.586	20.567	34.391	2.17	0.04
125	18.416	18.394	34.475	2.27	0.04
150	17.131	17.106	34.514	2.37	0.03
175	15.400	15.373	34.547	2.47	0.03
200	14.235	14.206	34.539	2.50	0.03
250	13.388	13.353	34.519	2.49	0.03
300	12.752	12.711	34.508	2.55	0.03
400	11.436	11.385	34.477	2.38	0.03
500	10.952	10.890	34.467	2.36	0.03
600	10.358	10.286	34.456	2.19	0.02
700	10.262	10.178	34.453	2.17	0.03
750	10.199	10.109	34.453	2.15	0.03
800	10.182	10.086	34.452	2.13	0.03
1000	10.067	9.946	34.450	2.14	0.03
1051	10.057	9.930	34.450	2.12	0.03

KH-02-4		Date: 09 Dec. 2002 (GMT)					Time: 19:15 - 20:22			Lat. 11 27.60 N				Depth 1046 m			B-P 10 m		
St.S2			CTD DATA (BTL)							Long. 121 49.16 E				CTD DATA (DOWN CAST LAY)					
Bottle		Depth	Pres.	Temp.	Sal.	DO	Sal.	DO	SiO2	PO4	NO2	NO2+NO3	Chl-a	Pres.	Temp.	P.Temp.	Sal.	DO	FIS
No.		m	db	°C	(psu)	ml·l⁻¹	(psu)	ml·l⁻¹	μM	μM	μM	μM	μg·l⁻¹	db	°C	°C	(psu)	ml·l⁻¹	
Sur.	R	0		28.6	****	****	33.603	4.52	0.69	0.02	0.05	0.07	0.19	1	28.704	28.704	33.792	4.20	0.06
36		10	10	28.637	33.804	4.12								10	28.718	28.716	33.792	4.22	0.07
20	R	10	10	28.680	33.789	4.11	33.968	4.34	1.20	0.08	0.12	0.31	0.26	20	28.116	28.111	33.962	4.18	0.14
19	R	30	30	27.221	34.175	3.70	34.193	4.03	1.96	0.18	0.38	1.50	0.51	30	27.353	27.346	34.146	3.87	0.32
35		50	50	26.941	34.237	3.49								40	27.204	27.195	34.191	3.80	0.34
18	R	50	50	26.877	34.248	3.49	34.295		4.88	0.34	0.42	4.49	0.44	50	26.434	26.423	34.325	3.31	0.24
17	R	75	75	23.655	34.400	2.70	34.409	2.79	14.67	0.77	0.06	10.79	0.05	75	23.692	23.676	34.391	2.84	0.06
34		100	101	20.155	34.435	2.52								100	20.416	20.398	34.435	2.63	0.05
16	R	100	101	20.146	34.435	2.52	34.446	2.63	14.09	0.92	0.04	13.75	0.04	125	19.199	19.176	34.486	2.64	0.05
15	R	125	126	17.073	34.541	2.44	34.553	2.45	18.79	1.20	0.02	17.76		150	16.188	16.164	34.564	2.42	0.03
33		150	151	16.089	34.554	2.29								175	15.378	15.351	34.562	2.49	0.03
14	R	150	151	16.030	34.554	2.30	34.558	2.37	21.29	1.26	N.D.	19.08	0.01	200	14.663	14.633	34.559	2.58	0.03
13	R	175	176	15.337	34.553	2.34	34.559	2.41	22.98	1.32	N.D.	19.70	0.00	250	13.085	13.050	34.525	2.63	0.03
32		200	201	14.676	34.549	2.40								300	12.236	12.197	34.495	2.54	0.02
12	R	200	201	14.668	34.547	2.41	34.546	2.46	24.90	1.36	0.01	20.19	0.00	400	10.619	10.571	34.459	2.33	0.03
31		249	251	13.358	34.520	2.40								500	10.075	10.016	34.449	2.20	0.03
11	R	249	251	13.350	34.518	2.42	34.516	2.46	30.91	1.51		22.21		600	9.518	9.450	34.443	2.09	0.03
30		299	301	12.134	34.488	2.30								700	9.303	9.224	34.442	2.03	0.03
10	R	299	301	12.135	34.487	2.30	34.486	2.32	38.56	1.68		24.50		750	9.236	9.151	34.441	2.01	0.03
29		348	351	11.518	34.473	2.24								800	9.233	9.142	34.441	2.01	0.03
9	R	348	350	11.517	34.473	2.25	34.472	2.26	41.96	1.77		25.57		1000	9.251	9.136	34.441	1.98	0.03
28		398	401	10.597	34.456	2.15								1040	9.250	9.131	34.440	1.98	0.03
8	R	398	400	10.593	34.455	2.15	34.456	2.15	49.04	1.91		27.62							
27		447	450	10.246	34.450	2.10													
7	R	447	450	10.249	34.450	2.10	34.451	2.12	51.96	1.96		28.32							
26		497	500	10.035	34.447	2.06													
6	R	497	500	10.033	34.447	2.05	34.444	2.08	54.20	2.01		28.89							
25		596	600	9.462	34.442	1.98													
5	R	596	600	9.458	34.441	1.98	34.439	2.00	60.41	2.11		30.09							
24		695	700	9.236	34.441	1.94													
4	R	695	700	9.236	34.441	1.94	34.440	1.97	61.74	2.16		30.52							
23		794	800	9.233	34.441	1.95													
3	R	793	800	9.233	34.440	1.95	34.439	1.97	62.17	2.15		30.65							
22		993	1001	9.249	34.440	1.96													
2	R	992	1000	9.249	34.440	1.96	34.438	1.97	62.39	2.18		30.57							
21		1042	1051	9.251	34.440	1.96													
1	R	1040	1049	9.250	34.441	1.96	34.440	1.97	61.97	2.16		30.62							

KH-02-4		Date: 09 Dec. 2002 (GMT)					Time: 18:48 - 22:09			Lat. 13 30.25 N				Depth 5004 m			B-P 6 m		
St.16-1			CTD DATA (BTL)							Long. 119 29.75 E				CTD DATA (DOWN CAST LAY)					
Bottle		Depth	Pres.	Temp.	Sal.	DO	Sal.	DO	SiO2	PO4	NO2	NO2+NO3	Chl-a	Pres.	Temp.	P.Temp.	Sal.	DO	FIS
No.		m	db	°C	(psu)	ml·l⁻¹	(psu)	ml·l⁻¹	μM	μM	μM	μM	μg·l⁻¹	db	°C	°C	(psu)	ml·l⁻¹	
Sur.		0		28.7	****	****								1	28.721	28.721	33.208	4.23	0.04
36		397	400	9.498	34.428	2.07								10	28.724	28.721	33.208	4.23	0.04
35		397	400	9.503	34.428	2.07								20	28.674	28.669	33.242	4.24	0.05
34		397	400	9.499	34.427	2.07								30	28.643	28.636	33.250	4.24	0.05
33		397	400	9.461	34.427	2.06								40	28.062	28.052	33.574	4.29	0.08
32		397	400	9.445	34.427	2.06								50	27.275	27.263	33.665	4.17	0.11
31	R	397	400	9.434	34.428	2.07	34.430	2.13	56.96	2.07		29.36		75	24.297	24.282	34.236	3.17	0.20
30		496	500	8.426	34.431	1.76								100	20.259	20.240	34.403	2.57	0.09
29	R	497	500	8.417	34.431	1.76	34.435	1.86	69.69	2.32		32.37		125	18.150	18.128	34.546	2.51	0.04
28	R	595	600	7.354	34.449	1.60		1.72	83.51	2.50		34.65		150	17.310	17.285	34.574	2.65	0.03
27	R	695	700	6.559	34.461	1.65	34.465	1.78	93.85	2.61		35.60		175	15.679	15.651	34.589	2.79	0.02
26		744	750	6.096	34.474	1.66								200	14.485	14.455	34.566	2.83	0.03
25	R	745	750	6.096	34.474	1.66	34.477	1.78	100.25	2.64		36.32		250	12.665	12.632	34.509	2.79	0.02
24	R	794	800	5.680	34.486	1.68	34.490	1.83	106.12	2.69		36.99		300	11.385	11.347	34.469	2.67	0.03
23		992	1000	4.220	34.539	1.80								400	9.505	9.460	34.434	2.32	0.03
22	R	992	1000	4.221	34.539	1.80	34.541	1.95	129.40	2.81		38.54		500	8.294	8.242	34.437	2.03	0.03
21		1240	1251	3.372	34.574	1.89								600	7.326	7.267	34.452	1.81	0.03
20	R	1239	1250	3.375	34.574	1.89	34.574	2.06	142.07	2.88		39.33		700	6.527	6.462	34.465	1.84	0.03
19		1487	1501	2.881	34.595	1.97								750	6.098	6.030	34.477	1.84	0.03
18	R	1487	1501	2.883	34.595	1.98	34.596	2.13	150.63	2.90		39.85		800	5.682	5.612	34.489	1.85	0.03
17		1979	2000	2.469	34.613	2.18								1000	4.218	4.140	34.540	1.97	0.03
16	R	1980	2001	2.469	34.613	2.18	34.622	2.32	153.73	2.87		39.68		1250	3.382	3.291	34.574	2.02	0.03
15		2470	2499	2.365	34.619	2.27								1500	2.875	2.769	34.596	2.10	0.03
14	R	2470	2499	2.365	34.619	2.27	34.628	2.39	153.03	2.78		39.19		1750	2.637	2.513	34.606	2.18	0.03
13		2961	2999	2.369	34.621	2.30								2000	2.485	2.341	34.613	2.24	0.03
12	R	2961	2999	2.369	34.621	2.30	34.630	2.49	151.55	2.77		39.22		2500	2.362	2.175	34.619	2.37	0.03
11		3449	3498	2.406	34.621	2.33								3000	2.369	2.133	34.621	2.39	0.03
10	R	3449	3498	2.406	34.621	2.33	34.628	2.46	152.23	2.80		39.32		3500	2.407	2.118	34.621	2.41	0.04
9		3938	3998	2.445	34.621	2.37								4000	2.447	2.102	34.621	2.44	0.03
8	R	3937	3998	2.445	34.621	2.37	34.629	2.53	150.50	2.79		39.27		4500	2.491	2.086	34.621	2.48	0.03
7		4428	4501	2.491	34.621	2.43								5000	2.553	2.084	34.621	2.48	0.02
6	R	4428	4501	2.491	34.621	2.43	34.626	2.55	147.82	2.79		39.10		5112	2.568	2.084	34.621	2.48	0.03
5		4914	5000	2.553	34.621	2.46													
4	R	4914	5000	2.553	34.621	2.46	34.627	2.57	149.69	2.75		38.85							
3	R	4975	5064	2.561	34.621	2.47	34.627	2.57	148.32	2.78		38.96							
2		5030	5120	2.569	34.621	2.46													
1	R	5030	5120	2.569	34.621	2.45	34.619	2.57	148.90	2.80		38.96							

KH-02-4			Date: 10 Dec. 2002 (GMT)			Time: 08:56 - 09:33			Lat. 13 30.10 N				Depth 5002 m					
St.16-2			CTD DATA (BTL)						Long. 119 29.90 E				CTD DATA (DOWN CAST LAY)						
Bottle		Depth	Pres.	Temp.	Sal.	DO	Sal.	DO	SiO2	PO4	NO2	NO2+NO3	Chl-a	Pres.	Temp.	P.Temp.	Sal.	DO	FIS
No.		m	db	°C	(psu)	$ml \cdot l^{-1}$	(psu)	$ml \cdot l^{-1}$	μM	μM	μM	μM	$\mu g \cdot l^{-1}$	db	°C	°C	(psu)	$ml \cdot l^{-1}$	
Sur.	R	0		28.7	****	****	33.236	4.50	0.64	0.01	N.D.	0.05	0.14	1	28.661	28.661	33.223	4.25	0.06
25		6	6	28.646	33.227	4.18								10	28.670	28.667	33.223	4.27	0.05
35		11	11	28.641	33.228	4.18								20	28.665	28.660	33.225	4.27	0.06
34		11	11	28.643	33.227	4.17								30	28.601	28.594	33.246	4.28	0.06
33		11	11	28.649	33.225	4.19								40	28.435	28.426	33.368	4.28	0.08
32		11	11	28.650	33.225	4.17								50	27.329	27.318	33.719	4.34	0.12
31		10	10	28.646	33.226	4.18								75	24.568	24.552	34.179	3.25	0.22
30		9	10	28.644	33.226	4.18								100	20.796	20.777	34.370	2.67	0.09
29		10	10	28.644	33.225	4.18								125	17.791	17.769	34.560	2.54	0.04
28		11	11	28.644	33.225	4.17								150	16.308	16.284	34.588	2.72	0.02
27		10	11	28.644	33.225	4.17								175	15.246	15.219	34.581	2.82	0.02
26		10	11	28.644	33.225	4.16								200	14.506	14.476	34.563	2.82	0.02
24		11	11	28.644	33.225	4.15								250	13.140	13.105	34.526	2.85	0.02
23	R	11	11	28.643	33.225	4.17	33.231	4.51	0.63	N.D.	N.D.	N.D.	0.13	300	11.793	11.754	34.479	2.69	0.03
36		20	20	28.646	33.227	4.14								302	11.744	11.705	34.480	2.69	0.02
22		21	21	28.647	33.227	4.14													
21	R	20	20	28.648	33.226	4.13	33.233	4.51	0.59	N.D.	N.D.	N.D.	0.13						
20		30	30	28.580	33.258	4.17													
19	R	30	30	28.577	33.259	4.18	33.291	4.53	0.65	N.D.	N.D.	N.D.	0.16						
18		49	50	27.406	33.733	4.16													
17	R	49	49	27.339	33.741	4.15	33.811	4.30	1.45	N.D.	N.D.	0.06	0.31						
16		75	75	24.383	34.181	3.14													
15	R	74	74	24.329	34.192	3.10	34.230	3.14	6.40	0.43	0.11	6.14	0.28						
14		99	100	20.561	34.368	2.51													
13	R	99	99	20.631	34.362	2.52	34.385	2.53	10.50	0.85	0.02	13.46	0.05						
12		125	125	17.342	34.567	2.55													
11	R	124	125	17.261	34.568	2.55	34.573	2.56	15.40	1.08	N.D.	16.36	0.00						
10		149	150	16.261	34.579	2.64													
9	R	148	149	16.194	34.580	2.65	34.583	2.62	17.71	1.15	0.01	17.29	0.00						
8		174	175	15.250	34.571	2.71													
7	R	173	174	15.216	34.570	2.70	34.573	2.64	20.86	1.26	0.01	18.59	0.00						
6		197	199	14.462	34.555	2.71													
5	R	197	199	14.515	34.554	2.72	34.559	2.63	23.07	1.32	N.D.	19.28	0.00						
4		249	251	13.024	34.512	2.75													
3	R	249	250	12.964	34.511	2.74	34.514	2.61	29.71	1.50		21.60							
2		298	300	11.714	34.474	2.63													
1	R	296	298	11.722	34.474	2.63	34.475	2.46	37.54	1.66		24.12							

KH-02-4			Date: 10-11 Dec. 2002 (GMT)			Time: 22:19 - 00:52			Lat. 14 30.18 N				Depth 3754 m			B-P 13 m			
St.17-1			CTD DATA (BTL)						Long. 118 0.08 E				CTD DATA (DOWN CAST LAY)						
Bottle		Depth	Pres.	Temp.	Sal.	DO	Sal.	DO	SiO2	PO4	NO2	NO2+NO3	Chl-a	Pres.	Temp.	P.Temp.	Sal.	DO	FIS
No.		m	db	°C	(psu)	$ml \cdot l^{-1}$	(psu)	$ml \cdot l^{-1}$	μM	μM	μM	μM	$\mu g \cdot l^{-1}$	db	°C	°C	(psu)	$ml \cdot l^{-1}$	
Sur.		0		28.7	****	****								1	28.562	28.562	32.914	4.26	0.06
36		398	401	9.575	34.429	2.10								10	28.574	28.572	32.919	4.27	0.06
35		398	401	9.574	34.429	2.10								20	28.580	28.575	32.921	4.27	0.06
34		398	401	9.578	34.429	2.10								30	28.581	28.574	32.921	4.27	0.06
33		397	400	9.582	34.429	2.10								40	28.583	28.573	32.922	4.24	0.06
32	R	397	400	9.573	34.428	2.09	34.448	2.14	56.18	2.06		29.39		50	28.592	28.581	32.933	4.27	0.07
31		497	500	8.248	34.429	1.86								75	25.056	25.040	34.047	3.64	0.20
30		497	500	8.252	34.429	1.85								100	20.038	20.020	34.446	2.75	0.09
29	R	496	500	8.242	34.429	1.85	34.448	1.92	70.86	2.30		32.54		125	18.181	18.159	34.561	2.69	0.04
28	R	596	600	7.275	34.444	1.72	34.467	1.77	83.27	2.43		34.51		150	17.074	17.050	34.586	2.83	0.03
27	R	695	700	6.432	34.466	1.64	34.486	1.73	96.31	2.61		36.21		175	16.192	16.164	34.596	2.97	0.02
26		745	750	6.011	34.478	1.65								200	15.085	15.055	34.581	3.00	0.03
25	R	744	750	6.010	34.478	1.65	34.498	1.75	101.74	2.66		36.94		250	13.163	13.129	34.521	2.96	0.02
24	R	794	800	5.684	34.488	1.65	34.508	1.76	106.46	2.69		37.08		300	11.855	11.816	34.481	2.64	0.03
23		992	1000	4.551	34.526	1.77								400	9.761	9.715	34.435	2.35	0.03
22		992	1000	4.551	34.526	1.77								500	8.474	8.421	34.432	2.07	0.03
21	R	991	1000	4.549	34.525	1.78	34.547	1.89	123.08	2.76		38.11		600	7.423	7.364	34.443	1.92	0.03
20		1239	1250	3.562	34.566	1.87								700	6.585	6.520	34.465	1.78	0.03
19	R	1239	1250	3.563	34.566	1.87	34.587	2.00	139.78	2.82		39.09		750	6.154	6.086	34.477	1.79	0.03
18		1486	1500	2.993	34.590	2.00								800	5.806	5.736	34.486	1.80	0.03
17	R	1486	1500	2.987	34.590	2.00	34.610	2.14	147.93	2.85		39.65		1000	4.563	4.483	34.527	1.91	0.03
16		1978	1999	2.535	34.610	2.22								1250	3.554	3.461	34.568	1.99	0.03
15		1978	1999	2.535	34.609	2.22								1500	3.000	2.892	34.590	2.09	0.03
14	R	1978	1999	2.534	34.610	2.22	34.631	2.35	150.29	2.82		39.57		1750	2.705	2.579	34.603	2.18	0.03
13		2471	2500	2.384	34.618	2.33								2000	2.537	2.392	34.610	2.30	0.03
12	R	2471	2500	2.384	34.617	2.33	34.638	2.45	152.64	2.82		39.42		2500	2.386	2.199	34.617	2.39	0.02
11		2961	3000	2.372	34.620	2.37								3000	2.373	2.137	34.620	2.41	0.02
10		2961	3000	2.372	34.620	2.37								3500	2.405	2.116	34.621	2.43	0.03
9	R	2961	2999	2.372	34.620	2.37	34.637	2.49	152.49	2.82		39.36		3754	2.425	2.108	34.621	2.45	0.02
8		3451	3500	2.405	34.621	2.41													
7	R	3451	3500	2.405	34.621	2.41	34.644	2.50	150.73	2.75		39.32							
6		3451	3500	2.404	34.621	2.41													
5	R	3451	3500	2.404	34.621	2.41	34.643	2.53	152.49	2.77		38.90							
4	R	3609	3662	2.418	34.621	2.43	34.643	2.52	151.40	2.76		39.41							
3		3707	3762	2.426	34.621	2.44													
2		3707	3762	2.426	34.621	2.44													
1	R	3707	3762	2.426	34.621	2.44	34.644	2.55	150.29	2.76		39.20							

KH-02-4			Date: 11 Dec. 2002 (GMT)				Time: 07:31 - 08:08			Lat. 14 30.07 N				Depth 3687 m					
St.17-2			CTD DATA (BTL)							Long. 118 0.03 E				CTD DATA (DOWN CAST LAY)					
Bottle No.		Depth m	Pres. db	Temp. °C	Sal. (psu)	DO ml·l^{-1}	Sal. (psu)	DO ml·l^{-1}	SiO_2 μM	PO_4 μM	NO_2 μM	NO_2+NO_3 μM	Chl-a μg·l^{-1}	Pres. db	Temp. °C	P.Temp. °C	Sal. (psu)	DO ml·l^{-1}	FIS
Sur.	R	0		28.9	****	****	32.976	4.59	0.94	0.11	0.08	0.01	0.16	4	28.690	28.689	32.953	4.31	0.05
30		6	6	28.672	32.950	4.20								10	28.672	28.670	32.951	4.32	0.06
29		5	6	28.673	32.950	4.20								20	28.663	28.658	32.950	4.32	0.07
28		5	5	28.672	32.949	4.19								30	28.646	28.639	32.949	4.31	0.07
36		9	9	28.669	32.949	4.19								40	28.636	28.626	32.949	4.29	0.07
35		9	9	28.676	32.950	4.20								50	28.528	28.516	33.064	4.28	0.11
34		9	9	28.682	32.951	4.17								75	23.544	23.528	34.203	3.74	0.22
33		9	9	28.673	32.950	4.19								100	19.718	19.700	34.434	2.60	0.08
32		9	9	28.679	32.950	4.19								125	18.250	18.228	34.553	2.67	0.04
31		9	10	28.674	32.950	4.19								150	17.366	17.341	34.586	2.87	0.03
27		9	9	28.676	32.950	4.17								175	16.231	16.203	34.599	2.99	0.03
26	R	9	9	28.678	32.950	4.18	32.959	4.63	0.89	0.06	0.08	N.D.	0.19	200	15.243	15.213	34.583	3.02	0.02
25		19	19	28.666	32.948	4.17								250	13.440	13.405	34.533	2.96	0.02
24	R	19	19	28.650	32.947	4.18	32.955	4.57	0.96	0.04	0.05	N.D.	0.18	300	11.991	11.952	34.485	2.64	0.02
23		31	31	28.641	32.946	4.18								305	11.934	11.894	34.481	2.65	0.03
22	R	30	30	28.640	32.947	4.19	32.964	4.51	0.87	0.03	0.05	N.D.	0.20						
21		51	51	27.622	33.422	4.10													
20		50	51	27.831	33.329	4.12													
19	R	51	51	27.652	33.410	4.12	33.521	4.32	1.06	0.02	0.02	N.D.	0.39						
18		75	76	22.991	34.254	3.97													
17	R	76	76	22.991	34.254	3.96	34.277	4.02	3.52	0.27	0.66	2.70	0.22						
16		99	100	19.309	34.452	2.47													
15		100	101	19.276	34.455	2.46													
14	R	99	100	19.278	34.454	2.46	34.479	2.56	12.37	0.91	0.04	14.58	0.06						
13		124	125	17.955	34.561	2.66													
12	R	124	125	17.948	34.561	2.66	34.583	2.72	13.58	0.98	0.03	15.01	0.02						
11		150	150	17.157	34.580	2.72													
10	R	150	150	17.116	34.580	2.72	34.599	2.77	15.23	1.03	0.03	15.54	0.01						
9		174	175	16.084	34.584	2.85													
8	R	174	175	16.046	34.587	2.86	34.605	2.80	17.25	1.11	N.D.	16.35	0.00						
7		199	201	15.152	34.573	2.87													
6		199	200	15.150	34.573	2.88													
5	R	200	201	15.134	34.573	2.88	34.592	2.85	20.24	1.20	N.D.	17.41	0.00						
4		247	249	13.355	34.523	2.85													
3	R	248	249	13.405	34.524	2.86	34.544		27.13	1.40		19.94							
2		298	300	11.989	34.482	2.58													
1	R	298	300	11.973	34.481	2.58	34.499	2.46	36.51	1.58		23.78							

6-6-2. CTD casts without routine seawater analyses

KH-02-4	Date: 11 Nov. 2002 (GMT)				Time: 01:19 – 02:18				Depth 5494m		
St.TEST	Lat. 13 4.46 N				Long. 131 57.44 E						
	CTD DATA (BTL)				CTD DATA (DOWN CAST LAY)						
Bottle No.	Depth m	Pres. db	Temp. °C	Sal. (psu)	DO ml·l^{-1}	Pres. db	Temp. °C	P.Temp. °C	Sal. (psu)	DO ml·l^{-1}	FIS
Sur.	0		29.8	****	****	6	29.594	29.593	34.547	3.94	0.02
36	102	102	25.217	35.100	3.80	10	29.597	29.594	34.547	3.94	0.02
35	100	100	25.174	35.106	3.78	20	29.591	29.586	34.549	3.94	0.02
34	201	202	15.728	34.632	3.76	30	29.592	29.585	34.550	3.96	0.02
33	201	202	15.662	34.630	3.72	40	29.569	29.559	34.567	3.97	0.03
32	200	202	15.754	34.635	3.72	50	29.196	29.183	34.721	4.08	0.04
31	200	201	15.754	34.635	3.66	75	27.146	27.129	35.027	4.15	0.08
30	201	202	15.752	34.634	3.71	100	25.440	25.418	35.118	3.99	0.18
29	199	200	15.776	34.634	3.68	125	23.258	23.233	35.143	3.84	0.09
28	398	401	8.127	34.330	1.77	150	20.547	20.519	35.008	3.82	0.04
27	399	401	8.133	34.330	1.77	175	17.895	17.865	34.823	3.82	0.02
26	398	401	8.130	34.330	1.77	200	15.991	15.960	34.668	3.85	0.02
25	398	401	8.136	34.329	1.77	250	12.809	12.776	34.448	4.25	0.01
24	398	401	8.133	34.330	1.77	300	10.685	10.649	34.355	3.13	0.02
23	397	400	8.135	34.329	1.77	400	8.167	8.126	34.348	1.98	0.03
22	599	604	6.087	34.448	1.62	500	6.739	6.692	34.357	1.64	0.02
21	598	602	6.088	34.448	1.61	600	6.122	6.069	34.448	1.64	0.02
20	599	603	6.090	34.448	1.61	700	5.565	5.505	34.482	1.79	0.02
19	597	601	6.094	34.448	1.61	750	5.327	5.264	34.505	1.89	0.03
18	598	602	6.092	34.447	1.60	800	5.010	4.945	34.508	1.86	0.03
17	596	600	6.098	34.448	1.60	1000	4.235	4.158	34.540	1.95	0.02
16	797	804	5.018	34.513	1.80	1007	4.209	4.131	34.541	1.96	0.02
15	797	803	5.020	34.513	1.80						
14	797	803	5.019	34.513	1.80						
13	796	802	5.020	34.513	1.80						
12	796	802	5.017	34.512	1.80						
11	795	801	5.016	34.512	1.80						
10	994	1003	4.205	34.542	1.92						
9	994	1002	4.210	34.541	1.92						
8	993	1002	4.212	34.541	1.92						
7	994	1002	4.207	34.542	1.92						
6	993	1001	4.211	34.541	1.91						
5	993	1001	4.214	34.540	1.91						
4	993	1001	4.216	34.540	1.91						
3	992	1001	4.217	34.540	1.91						
2	992	1000	4.228	34.539	1.93						
1	992	1000	4.226	34.539	1.93						

KH-02-4	Date: 13 Nov. 2002 (GMT)				Time: 14:06 – 17:25				Depth 5484m		
St.01-3	Lat. 7 0.18 N				Long. 129 59.78 E				B-P 600m		
	CTD DATA (BTL)				CTD DATA (DOWN CAST LAY)						
Bottle No.	Depth m	Pres. db	Temp. °C	Sal. (psu)	DO ml·l^{-1}	Pres. db	Temp. °C	P.Temp. °C	Sal. (psu)	DO ml·l^{-1}	FIS
Sur.	0		30.2	****	****	2	30.197	30.196	34.146	4.11	0.03
36	21	21	28.851	34.645	4.21	10	30.018	30.016	34.154	4.11	0.03
35	21	21	28.846	34.646	4.21	20	29.616	29.611	34.159	4.23	0.03
34	20	21	28.857	34.644	4.21	30	28.596	28.589	34.484	4.35	0.04
33	20	21	28.839	34.648	4.21	40	28.057	28.048	34.839	4.43	0.05
32	21	21	28.853	34.645	4.20	50	25.909	25.898	35.015	4.29	0.06
31	21	21	28.849	34.645	4.21	75	23.292	23.277	35.060	4.22	0.11
30	21	21	28.816	34.651	4.21	100	19.660	19.642	34.913	3.84	0.35
29	20	20	28.750	34.665	4.23	125	17.011	16.991	34.746	3.72	0.16
28	51	52	25.849	35.004	4.15	150	13.363	13.342	34.545	3.16	0.06
27	51	51	25.830	35.005	4.16	175	11.080	11.059	34.498	2.49	0.03
26	100	101	19.601	34.896	3.66	200	10.159	10.136	34.496	2.33	0.02
25	101	102	19.596	34.895	3.66	250	9.250	9.222	34.528	2.04	0.03
24	200	201	9.819	34.488	2.04	300	8.639	8.607	34.552	2.11	0.03
23	199	200	9.809	34.488	2.05	400	7.782	7.742	34.547	2.27	0.03
22	298	300	8.564	34.547	1.87	500	7.302	7.254	34.535	2.25	0.02
21	298	300	8.567	34.547	1.87	600	6.552	6.497	34.524	2.33	0.02
20	497	500	7.230	34.534	2.11	700	6.050	5.987	34.520	2.22	0.03
19	497	501	7.224	34.534	2.11	750	5.684	5.619	34.531	2.30	0.02
18	993	1001	4.737	34.547	1.93	800	5.449	5.381	34.533	2.23	0.03
17	993	1001	4.736	34.547	1.93	1000	4.744	4.662	34.548	2.09	0.03
16	1487	1501	2.961	34.597	2.22	1250	3.792	3.697	34.572	2.21	0.03
15	1487	1500	2.959	34.597	2.22	1500	2.999	2.891	34.596	2.34	0.02
14	1980	2001	2.185	34.634	2.53	1750	2.507	2.384	34.615	2.45	0.02
13	1980	2001	2.183	34.634	2.53	2000	2.183	2.044	34.634	2.60	0.02
12	2472	2501	1.848	34.653	2.79	2500	1.834	1.657	34.654	2.91	0.02
11	2472	2501	1.848	34.653	2.79	3000	1.637	1.418	34.666	3.17	0.02
10	2963	3001	1.646	34.666	3.04	3500	1.555	1.287	34.675	3.36	0.02
9	2964	3002	1.646	34.666	3.04	4000	1.568	1.248	34.678	3.42	0.02
8	3452	3500	1.563	34.674	3.25	4500	1.622	1.243	34.679	3.43	0.02
7	3452	3500	1.563	34.674	3.25	5000	1.681	1.241	34.678	3.44	0.01
6	3942	4001	1.568	34.678	3.34	5004	1.682	1.241	34.678	3.44	0.02
5	3941	4001	1.568	34.678	3.34						
4	4429	4501	1.621	34.679	3.38						
3	4428	4500	1.621	34.679	3.38						
2	4916	5001	1.681	34.679	3.43						
1	4915	5001	1.681	34.679	3.43						

KH-02-4	Date: 18 Nov. 2002 (GMT)				Time: 08:34 – 09:05				Depth 3471m		
St.U-1	Lat. 5 6.27 N				Long. 120 53.22 E						
	CTD DATA (BTL)				CTD DATA (DOWN CAST LAY)						
Bottle No.	Depth m	Pres. db	Temp. °C	Sal. (psu)	DO ml·l^{-1}	Pres. db	Temp. °C	P.Temp. °C	Sal. (psu)	DO ml·l^{-1}	FIS
Sur.	0		29.2	****	****	1	29.514	29.514	33.948	4.36	0.18
26	5	5	29.268	33.980	4.34	10	28.691	28.689	33.982	4.40	0.12
25	5	5	29.252	33.979	4.34	20	28.451	28.447	33.987	4.43	0.14
36	10	10	28.667	33.979	4.36	30	27.723	27.716	34.012	4.13	0.35
35	10	10	28.667	33.980	4.35	40	26.935	26.926	34.068	3.99	0.24
34	10	10	28.673	33.980	4.34	50	26.109	26.098	34.131	3.85	0.15
33	10	10	28.672	33.979	4.35	75	24.756	24.740	34.540	3.79	0.10
32	10	10	28.671	33.979	4.34	100	20.022	20.004	34.532	3.03	0.05
31	10	10	28.662	33.979	4.35	125	18.300	18.278	34.663	3.53	0.03
30	10	10	28.665	33.976	4.35	150	17.062	17.037	34.664	3.44	0.03
29	10	10	28.668	33.977	4.35	175	16.419	16.391	34.668	3.80	0.03
28	10	10	28.617	33.978	4.35	200	15.637	15.606	34.635	3.96	0.03
24	10	10	28.605	33.974	4.36	250	13.594	13.559	34.530	3.57	0.02
23	10	10	28.609	33.974	4.34	300	11.442	11.404	34.442	3.25	0.02
22	20	20	27.936	33.992	4.19	305	11.210	11.172	34.421	3.26	0.02
21	20	20	27.965	33.989	4.16						
27	30	30	27.446	34.013	3.97						
20	30	30	27.295	34.024	3.94						
19	30	30	27.250	34.033	3.95						
18	30	30	27.219	34.038	3.95						
17	50	50	26.455	34.044	3.82						
16	50	50	26.462	34.040	3.81						
15	50	50	26.441	34.042	3.81						
14	75	75	24.829	34.482	3.75						
13	75	75	24.841	34.486	3.75						
12	99	100	20.222	34.438	2.94						
11	99	100	19.944	34.520	3.18						
10	124	125	18.439	34.676	3.42						
9	124	125	18.440	34.672	3.32						
8	149	150	17.025	34.662	3.56						
7	149	150	16.997	34.669	3.59						
6	199	201	15.781	34.632	3.79						
5	199	200	15.791	34.631	3.79						
4	249	250	13.680	34.529	3.44						
3	249	250	13.677	34.526	3.50						
2	298	300	11.589	34.443	3.18						
1	298	300	11.584	34.443	3.20						

KH-02-4	Date: 20 Nov. 2002 (GMT)				Time: 16:05 – 19:03				Depth 4459m		
St.04-3	Lat. 7 25.40 N				Long. 121 12.34 E				B-P 170m		
	CTD DATA (BTL)				CTD DATA (DOWN CAST LAY)						
Bottle No.	Depth m	Pres. db	Temp. °C	Sal. (psu)	DO ml·l^{-1}	Pres. db	Temp. °C	P.Temp. °C	Sal. (psu)	DO ml·l^{-1}	FIS
Sur.	0		29.7	****	****	2	29.613	29.612	33.485	4.19	0.05
36	20	20	29.294	33.516	4.01	10	29.398	29.395	33.509	4.21	0.03
35	20	20	29.286	33.536	4.01	20	29.270	29.266	33.628	4.21	0.04
34	20	20	29.290	33.539	4.01	30	28.898	28.891	34.078	4.37	0.05
33	20	20	29.289	33.536	4.02	40	28.559	28.549	34.237	4.28	0.05
32	20	20	29.290	33.532	4.03	50	27.730	27.718	34.356	4.15	0.09
31	20	20	29.287	33.537	4.02	75	24.842	24.826	34.406	2.99	0.16
30	20	20	29.289	33.523	4.01	100	21.485	21.466	34.371	2.23	0.08
29	20	20	29.295	33.514	4.02	125	17.512	17.491	34.432	2.06	0.04
28	20	20	29.296	33.514	4.00	150	15.683	15.660	34.483	1.97	0.03
27	20	20	29.293	33.534	4.03	175	14.694	14.668	34.476	1.90	0.03
26	49	49	27.517	34.349	3.90	200	13.862	13.833	34.487	1.88	0.03
25	49	49	27.517	34.350	3.94	250	13.131	13.097	34.474	1.82	0.03
24	99	100	22.918	34.341	2.33	300	12.621	12.581	34.473	1.73	0.03
23	99	100	22.644	34.349	2.28	400	11.763	11.711	34.472	1.83	0.03
22	199	201	13.986	34.472	1.69	500	10.989	10.927	34.465	1.90	0.02
21	199	201	13.937	34.474	1.70	600	10.576	10.503	34.460	1.70	0.03
20	300	302	12.635	34.467	1.50	700	10.346	10.261	34.458	1.63	0.03
19	300	301	12.625	34.467	1.49	750	10.284	10.194	34.458	1.62	0.03
18	497	501	10.867	34.460	1.62	800	10.272	10.175	34.457	1.61	0.03
17	497	501	10.867	34.460	1.62	1000	10.141	10.020	34.456	1.57	0.03
16	992	1000	10.134	34.456	1.50	1250	10.106	9.954	34.456	1.51	0.03
15	992	1000	10.134	34.455	1.50	1500	10.116	9.931	34.458	1.39	0.03
14	1487	1500	10.116	34.458	1.34	1750	10.130	9.911	34.461	1.30	0.03
13	1487	1500	10.116	34.458	1.34	2000	10.155	9.902	34.463	1.24	0.03
12	1980	2000	10.155	34.463	1.19	2500	10.212	9.888	34.468	1.17	0.03
11	1980	2000	10.155	34.463	1.19	3000	10.285	9.887	34.473	1.07	0.03
10	2471	2500	10.213	34.468	1.10	3500	10.365	9.889	34.475	1.00	0.03
9	2471	2500	10.213	34.468	1.10	4000	10.445	9.889	34.475	1.00	0.03
8	2962	3000	10.285	34.473	1.01	4500	10.528	9.889	34.476	1.02	0.03
7	2962	3000	10.285	34.473	1.01	4502	10.528	9.889	34.476	1.02	0.03
6	3452	3500	10.364	34.475	1.00						
5	3452	3500	10.364	34.475	1.00						
4	3940	4000	10.445	34.475	0.98						
3	3940	4000	10.445	34.476	0.98						
2	4428	4500	10.528	34.476	1.01						
1	4428	4500	10.528	34.476	1.01						

KH-02-4		Date: 18 Nov. 2002 (GMT)				Time: 06:05 - 06:38				Depth 1458m	
St.U-3		Lat. 5 17.08 N				Long. 120 42.33 E					
		CTD DATA (BTL)				CTD DATA (DOWN CAST LAY)					
Bottle	Depth	Pres.	Temp.	Sal.	DO	Pres.	Temp.	P.Temp.	Sal.	DO	FIS
No.	m	db	°C	(psu)	ml·l⁻¹	db	°C	°C	(psu)	ml·l⁻¹	
Sur.	0		29.6	****	****	2	28.914	28.914	33.817	4.39	0.53
26	5	5	28.670	33.861	4.41	10	28.359	28.356	33.856	4.37	0.87
25	5	5	28.553	33.857	4.41	20	27.728	27.723	33.897	4.35	0.97
36	10	10	27.914	33.874	4.36	30	27.440	27.433	33.897	4.15	0.69
35	10	10	27.935	33.873	4.37	40	27.299	27.290	33.913	4.14	0.53
34	10	10	27.929	33.873	4.37	50	26.835	26.824	33.977	4.06	0.47
33	10	10	27.930	33.871	4.36	75	25.996	25.979	34.043	3.98	0.40
32	10	10	27.905	33.874	4.37	100	24.082	24.061	34.180	3.83	0.28
31	10	10	27.868	33.875	4.34	125	22.498	22.473	34.354	3.59	0.09
30	10	10	27.877	33.875	4.36	150	19.509	19.482	34.491	3.38	0.04
29	10	10	27.816	33.878	4.36	175	18.706	18.676	34.501	3.39	0.04
28	10	10	27.812	33.878	4.33	200	14.223	14.194	34.581	3.47	0.03
24	10	10	27.798	33.878	4.34	250	12.194	12.161	34.481	3.21	0.03
23	10	10	27.781	33.878	4.36	300	10.855	10.819	34.441	3.36	0.03
27	20	20	27.480	33.893	4.22	307	10.530	10.493	34.442	3.29	0.03
22	20	20	27.487	33.894	4.22						
21	20	20	27.464	33.892	4.22						
20	30	30	27.327	33.897	4.10						
19	30	30	27.323	33.896	4.12						
18	30	30	27.291	33.901	4.10						
17	50	50	27.056	33.946	4.00						
16	50	50	27.052	33.947	4.02						
15	50	50	27.059	33.948	4.01						
14	74	75	25.588	34.089	3.84						
13	74	75	25.480	34.095	3.81						
12	100	101	23.766	34.195	3.71						
11	99	100	23.802	34.189	3.68						
10	124	125	22.504	34.349	3.51						
9	124	125	22.494	34.353	3.52						
8	149	150	19.714	34.460	3.35						
7	149	150	19.625	34.460	3.36						
6	199	200	14.619	34.555	3.38						
5	199	200	14.398	34.540	3.28						
4	248	249	12.215	34.478	3.17						
3	248	250	12.219	34.477	3.18						
2	299	301	10.786	34.435	3.00						
1	298	300	10.797	34.433	3.01						

KH-02-4		Date: 18 Nov. 2002 (GMT)				Time: 07:09 - 07:45				Depth 2614m	
St.U-2		Lat. 5 13.34 N				Long. 120 46.28 E					
		CTD DATA (BTL)				CTD DATA (DOWN CAST LAY)					
Bottle	Depth	Pres.	Temp.	Sal.	DO	Pres.	Temp.	P.Temp.	Sal.	DO	FIS
No.	m	db	°C	(psu)	ml·l⁻¹	db	°C	°C	(psu)	ml·l⁻¹	
Sur.	0		28.4	****	****	1	28.350	28.350	33.809	4.48	0.64
26	5	5	27.859	33.836	4.33	10	27.616	27.614	33.891	4.30	1.07
25	5	5	27.926	33.831	4.32	20	27.509	27.505	33.999	4.28	0.66
36	10	10	27.515	33.861	4.21	30	26.851	26.844	34.002	4.11	0.42
35	10	10	27.519	33.861	4.22	40	26.200	26.191	34.212	3.93	0.11
34	10	10	27.521	33.861	4.22	50	25.876	25.865	34.165	3.87	0.11
33	10	10	27.523	33.861	4.23	75	24.882	24.866	34.338	3.76	0.07
32	10	10	27.519	33.861	4.23	100	22.418	22.398	34.454	3.53	0.05
31	10	10	27.517	33.861	4.21	125	20.928	20.904	34.542	3.47	0.04
29	10	10	27.510	33.861	4.22	150	18.949	18.923	34.510	3.42	0.04
30	10	10	27.506	33.861	4.20	175	17.194	17.165	34.550	3.40	0.03
28	10	10	27.506	33.861	4.21	200	15.604	15.573	34.588	3.50	0.02
24	10	10	27.501	33.862	4.22	250	13.702	13.666	34.539	3.38	0.02
23	10	10	27.490	33.862	4.20	300	11.402	11.364	34.454	3.10	0.02
27	20	20	27.467	33.911	4.18	303	11.081	11.044	34.444	3.03	0.03
22	20	20	27.465	33.911	4.16						
21	20	20	27.461	33.902	4.17						
20	29	29	27.134	33.974	4.07						
19	29	29	27.120	33.976	4.07						
18	29	29	27.128	33.976	4.05						
17	50	50	26.241	34.202	3.84						
16	50	50	26.242	34.199	3.87						
15	49	50	26.234	34.195	3.87						
14	75	75	24.962	34.335	3.67						
13	75	75	24.982	34.329	3.67						
12	99	100	23.331	34.385	3.50						
11	99	100	23.174	34.393	3.49						
10	124	125	20.789	34.525	3.41						
9	124	125	20.820	34.522	3.40						
8	149	150	18.933	34.499	3.32						
7	149	150	18.938	34.498	3.33						
6	198	199	15.524	34.576	3.39						
5	198	199	15.537	34.576	3.40						
4	249	250	12.400	34.481	3.16						
3	248	250	12.532	34.485	3.18						
2	297	299	11.201	34.443	3.03						
1	297	299	11.190	34.442	3.03						

KH-02-4		Date: 15 Nov. 2002 (GMT)				Time: 16:45 - 17:11				Depth 5091m	
St.02NG		Lat. 5 10.93 N				Long. 124 4.83 E					
		CTD DATA (BTL)				CTD DATA (DOWN CAST LAY)					
Bottle	Depth	Pres.	Temp.	Sal.	DO	Pres.	Temp.	P.Temp.	Sal.	DO	FIS
No.	m	db	°C	(psu)	ml·l⁻¹	db	°C	°C	(psu)	ml·l⁻¹	
Sur.	0		29.3	****	****	2	29.793	29.793	34.279	4.17	0.04
30	20	20	29.802	34.336	4.00	10	29.799	29.797	34.282	4.18	0.04
29	20	20	29.801	34.336	4.00	20	29.753	29.748	34.389	4.19	0.05
28	20	20	29.798	34.339	3.99	30	29.664	29.657	34.405	4.20	0.04
21	51	51	29.655	34.417	4.09	40	29.650	29.640	34.419	4.21	0.05
20	51	51	29.649	34.420	4.10	50	29.579	29.567	34.448	4.23	0.05
19	50	50	29.638	34.421	4.10	75	26.747	26.729	34.022	3.98	0.35
12	148	149	15.206	34.606	3.89	100	24.829	24.808	34.895	4.11	0.23
11	148	149	15.197	34.605	3.90	125	20.973	20.949	34.895	4.09	0.09
10	149	150	15.175	34.603	3.91	150	15.971	15.947	34.652	3.66	0.02
3	298	300	10.783	34.422	3.05	175	14.824	14.798	34.597	4.04	0.02
2	298	300	10.873	34.419	3.06	200	12.957	12.930	34.490	3.92	0.02
1	297	299	10.842	34.417	3.00	250	12.195	12.162	34.443	3.91	0.01
36	0					300	11.018	10.982	34.419	3.25	0.02
35	0					302	11.004	10.967	34.418	3.24	0.02
34	0										
33	0										
32	0										
31	0										
27	0										
26	0										
25	0										
24	0										
23	0										
22	0										
18	0										
17	0										
16	0										
15	0										
14	0										
13	0										
9	0										
8	0										
7	0										
6	0										
5	0										
4	0										

KH-02-4		Date: 18 Nov. 2002 (GMT)				Time: 04:55 - 05:38				Depth 510m	
St.U-4		Lat. 5 19.13 N				Long. 120 40.33 E					
		CTD DATA (BTL)				CTD DATA (DOWN CAST LAY)					
Bottle	Depth	Pres.	Temp.	Sal.	DO	Pres.	Temp.	P.Temp.	Sal.	DO	FIS
No.	m	db	°C	(psu)	ml·l⁻¹	db	°C	°C	(psu)	ml·l⁻¹	
Sur.	0		27.0	****	****	2	26.780	26.779	33.930	4.18	0.45
26	5	5	26.815	33.919	4.11	10	26.856	26.853	33.928	4.18	0.49
25	5	5	26.813	33.919	4.10	20	26.920	26.915	33.927	4.20	0.59
36	10	10	26.870	33.918	4.10	30	26.707	26.700	33.938	4.16	0.55
35	10	10	26.907	33.916	4.09	40	26.683	26.674	33.937	4.16	0.51
34	10	10	27.009	33.914	4.15	50	26.566	26.555	33.947	4.15	0.53
33	10	10	27.279	33.915	4.21	75	26.280	26.264	33.973	4.13	0.53
32	10	10	27.420	33.892	4.14	100	24.987	24.965	34.083	3.98	0.35
31	10	10	27.494	33.890	4.19	125	22.455	22.430	34.333	3.64	0.12
30	10	10	27.568	33.887	4.21	150	21.442	21.412	34.414	3.55	0.05
29	10	10	27.369	33.896	4.16	175	20.332	20.299	34.437	3.53	0.06
28	10	10	27.321	33.894	4.16	200	17.891	17.857	34.540	3.41	0.04
24	10	10	27.094	33.907	4.12	250	14.099	14.063	34.554	3.45	0.02
23	10	10	27.144	33.912	4.21	300	11.367	11.329	34.459	0.37	0.03
22	20	20	27.071	33.905	4.13	302	11.373	11.335	34.459	0.17	0.02
21	20	20	26.983	33.906	4.11						
20	30	30	27.162	33.902	4.13						
19	30	30	27.234	33.901	4.15						
27	35	35	27.091	33.909	4.13						
18	39	40	27.128	33.907	4.13						
17	39	40	27.117	33.908	4.10						
16	50	50	26.971	33.914	4.10						
15	49	50	26.993	33.914	4.09						
14	74	74	26.428	33.962	4.01						
13	74	74	26.418	33.963	4.00						
12	100	100	25.529	34.104	3.88						
11	99	100	25.503	34.108	3.86						
10	125	126	22.487	34.291	3.62						
9	124	125	22.510	34.286	3.61						
8	149	150	21.425	34.415	3.43						
7	149	150	21.381	34.414	3.45						
6	198	200	17.413	34.549	3.32						
5	199	200	17.484	34.547	3.35						
4	249	251	13.634	34.523	3.36						
3	248	250	13.677	34.522	3.37						
2	298	300	11.379	34.457	3.29						
1	298	300	11.382	34.458	3.42						

KH-02-4 St.05-1		Date: 21 Nov. 2002 (GMT)	Lat. 7 33.47 N			Time: 17:12 - 19:49	Long. 120 19.28 E			Depth 3955m	B-P 28m
		CTD DATA (BTL)				CTD DATA (DOWN CAST LAY)					
Bottle No.	Depth m	Pres. db	Temp. °C	Sal. (psu)	DO $ml \cdot l^{-1}$	Pres. db	Temp. °C	P.Temp. °C	Sal. (psu)	DO $ml \cdot l^{-1}$	FIS
Sur.	0		29.6	****	****	3	29.542	29.541	32.863	4.20	0.04
36	0					10	29.557	29.554	32.859	4.17	0.04
35	0					20	29.561	29.556	32.866	4.17	0.04
34	0					30	29.272	29.265	33.097	4.23	0.05
33	0					40	28.662	28.652	33.484	4.21	0.08
32	0					50	27.814	27.802	33.743	4.04	0.25
31	0					75	24.688	24.672	34.278	2.90	0.17
30	0					100	20.427	20.409	34.391	2.30	0.07
29	0					125	17.900	17.879	34.450	1.96	0.03
28	0					150	16.220	16.196	34.492	2.02	0.03
27	0					175	15.004	14.978	34.502	2.01	0.03
26	0					200	14.191	14.162	34.498	1.88	0.02
25	0					250	13.078	13.044	34.481	1.79	0.02
24	0					300	12.465	12.425	34.471	1.93	0.03
23	0					400	11.701	11.650	34.468	1.87	0.03
22	0					500	11.161	11.098	34.464	1.81	0.03
21	0					600	10.634	10.561	34.461	1.73	0.03
20	0					700	10.392	10.307	34.459	1.69	0.03
19	0					750	10.286	10.196	34.457	1.68	0.03
18	0					800	10.221	10.125	34.457	1.64	0.03
17	0					1000	10.119	9.999	34.456	1.62	0.03
16	0					1250	10.104	9.951	34.457	1.47	0.03
15	0					1500	10.109	9.924	34.459	1.37	0.03
14	0					1750	10.126	9.907	34.459	1.38	0.03
13	0					2000	10.151	9.898	34.463	1.27	0.03
12	0					2500	10.212	9.888	34.469	1.14	0.03
11	0					3000	10.285	9.887	34.473	1.06	0.03
10	0					3500	10.365	9.889	34.475	1.00	0.03
9	0					4000	10.446	9.889	34.475	1.02	0.03
8	0					4085	10.459	9.889	34.475	0.99	0.03
7	0										
6	0										
5	0										
4	0										
3	0										
2	0										
1	0										

KH-02-4 St.08-1		Date: 23 Nov. 2002 (GMT)	Lat. 8 7.82 N			Time: 17:52 - 18:38	Long. 118 35.00 E			Depth 1040m	B-P 38m
		CTD DATA (BTL)				CTD DATA (DOWN CAST LAY)					
Bottle No.	Depth m	Pres. db	Temp. °C	Sal. (psu)	DO $ml \cdot l^{-1}$	Pres. db	Temp. °C	P.Temp. °C	Sal. (psu)	DO $ml \cdot l^{-1}$	FIS
Sur.	0		29.4	****	****	1	29.345	29.345	33.149	4.17	0.04
36	0					10	29.357	29.355	33.156	4.19	0.04
35	0					20	28.699	28.695	33.478	4.19	0.10
34	0					30	28.388	28.380	33.499	4.16	0.29
33	0					40	28.720	28.711	34.268	4.23	0.17
32	0					50	28.388	28.377	34.314	4.16	0.21
31	0					75	24.006	23.990	34.309	2.75	0.13
30	0					100	20.827	20.808	34.374	2.12	0.06
29	0					125	19.115	19.093	34.405	2.01	0.03
28	0					150	17.055	17.030	34.492	2.18	0.02
27	0					175	14.827	14.801	34.535	2.37	0.02
26	0					200	14.181	14.152	34.524	2.31	0.03
25	0					250	13.425	13.390	34.505	2.10	0.02
24	0					300	12.647	12.606	34.489	1.97	0.03
23	0					400	11.161	11.111	34.470	2.08	0.02
22	0					500	10.719	10.657	34.462	2.01	0.02
21	0					600	10.476	10.403	34.458	1.99	0.03
20	0					700	10.280	10.196	34.455	1.94	0.02
19	0					750	10.221	10.131	34.454	1.91	0.03
18	0					800	10.184	10.088	34.454	1.85	0.03
17	0					1000	10.117	9.997	34.454	1.75	0.03
16	0					1003	10.118	9.997	34.454	1.74	0.03
15	0										
14	0										
13	0										
12	0										
11	0										
10	0										
9	0										
8	0										
7	0										
6	0										
5	0										
4	0										
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2	0										
1	0										

KH-02-4 St.10-3		Date: 03 Dec. 2002 (GMT)	Lat. 8 50.21 N			Time: 14:44 - 17:52	Long. 121 48.04 E			Depth 4809m	B-P 18m
		CTD DATA (BTL)				CTD DATA (DOWN CAST LAY)					
Bottle No.	Depth m	Pres. db	Temp. °C	Sal. (psu)	DO $ml \cdot l^{-1}$	Pres. db	Temp. °C	P.Temp. °C	Sal. (psu)	DO $ml \cdot l^{-1}$	FIS
Sur.	0		28.9	****	****	1	28.759	28.759	34.176	4.27	0.04
36	994	1002	10.111	34.454	1.56	10	28.760	28.758	34.176	4.25	0.05
35	994	1002	10.111	34.454	1.56	20	28.744	28.739	34.175	4.25	0.06
34	994	1002	10.111	34.454	1.56	30	28.727	28.720	34.177	4.26	0.06
33	993	1001	10.111	34.454	1.56	40	28.504	28.495	34.235	4.25	0.08
32	993	1001	10.111	34.454	1.56	50	28.080	28.069	34.340	4.18	0.29
31	993	1001	10.111	34.454	1.56	75	27.862	27.844	34.318	3.96	0.28
30	1487	1501	10.110	34.458	1.35	100	23.202	23.181	34.378	2.66	0.07
29	1487	1501	10.110	34.458	1.35	125	19.127	19.105	34.412	1.97	0.03
28	1980	2001	10.147	34.462	1.24	150	16.470	16.446	34.501	2.01	0.03
27	1980	2001	10.147	34.462	1.24	175	15.109	15.083	34.513	1.95	0.03
26	1980	2001	10.147	34.462	1.24	200	14.013	13.984	34.509	1.94	0.03
25	1980	2001	10.147	34.462	1.24	250	12.879	12.845	34.476	1.55	0.03
24	1980	2001	10.147	34.462	1.24	300	12.393	12.353	34.477	1.73	0.03
23	1980	2001	10.147	34.462	1.24	400	11.482	11.432	34.473	1.96	0.03
22	2471	2500	10.211	34.469	1.09	500	10.834	10.773	34.464	1.93	0.03
21	2471	2500	10.211	34.469	1.09	600	10.463	10.390	34.459	1.81	0.03
20	2961	2999	10.284	34.473	1.01	700	10.293	10.209	34.456	1.85	0.02
19	2961	2999	10.284	34.473	1.01	750	10.246	10.155	34.455	1.84	0.03
18	2961	2999	10.284	34.473	1.01	800	10.201	10.105	34.455	1.76	0.03
17	2961	2999	10.284	34.473	1.01	1000	10.111	9.990	34.456	1.58	0.03
16	2961	2999	10.284	34.473	1.01	1250	10.100	9.947	34.457	1.42	0.03
15	2961	2999	10.284	34.473	1.01	1500	10.103	9.918	34.457	1.48	0.03
14	3451	3499	10.364	34.475	0.98	1750	10.119	9.900	34.458	1.48	0.03
13	3451	3499	10.364	34.475	0.98	2000	10.147	9.894	34.463	1.30	0.03
12	3939	3998	10.444	34.475	0.98	2500	10.211	9.887	34.469	1.13	0.03
11	3939	3998	10.444	34.475	0.98	3000	10.285	9.886	34.473	1.08	0.03
10	3939	3998	10.444	34.475	0.98	3500	10.364	9.888	34.475	1.00	0.03
9	3939	3998	10.444	34.475	0.98	4000	10.445	9.888	34.475	0.98	0.03
8	3939	3998	10.444	34.475	0.98	4500	10.528	9.889	34.476	1.00	0.03
7	3939	3998	10.444	34.475	0.98	5000	10.614	9.889	34.476	1.00	0.03
6	4427	4499	10.527	34.476	0.95	5013	10.616	9.889	34.476	1.00	0.03
5	4427	4499	10.527	34.476	0.94						
4	4933	5019	10.617	34.476	1.01						
3	4933	5019	10.617	34.476	0.99						
2	4932	5019	10.617	34.476	0.99						
1	4932	5018	10.617	34.476	0.99						

KH-02-4 St.10-4		Date: 03 Dec. 2002 (GMT)	Lat. 8 49.92 N			Time: 20:51 - 21:42	Long. 121 48.08 E			Depth 4809m	
		CTD DATA (BTL)				CTD DATA (DOWN CAST LAY)					
Bottle No.	Depth m	Pres. db	Temp. °C	Sal. (psu)	DO $ml \cdot l^{-1}$	Pres. db	Temp. °C	P.Temp. °C	Sal. (psu)	DO $ml \cdot l^{-1}$	FIS
Sur.	0		28.7	****	****	1	28.720	28.720	34.179	4.22	0.06
36	49	50	28.426	34.254	4.08	10	28.710	28.708	34.179	4.22	0.05
35	49	50	28.259	34.294	4.05	20	28.720	28.716	34.182	4.22	0.06
34	49	50	28.260	34.296	4.09	30	28.691	28.684	34.193	4.22	0.06
33	49	50	28.293	34.289	4.09	40	28.665	28.655	34.203	4.21	0.07
32	99	100	22.602	34.373	2.37	50	28.481	28.469	34.251	4.19	0.09
31	99	100	22.423	34.369	2.36	75	27.582	27.564	34.335	3.81	0.18
30	99	100	22.527	34.370	2.36	100	22.132	22.112	34.362	2.25	0.06
29	99	100	22.534	34.364	2.34	125	18.248	18.226	34.441	1.95	0.03
28	198	200	13.972	34.498	1.76	150	15.871	15.848	34.505	1.99	0.03
27	198	200	13.971	34.498	1.75	175	14.645	14.619	34.512	1.97	0.03
26	198	200	13.963	34.497	1.74	200	13.978	13.949	34.506	1.91	0.03
25	198	200	13.886	34.497	1.74	250	13.113	13.079	34.476	1.58	0.03
24	298	299	12.452	34.472	1.53	300	12.452	12.412	34.477	1.65	0.04
23	298	299	12.451	34.472	1.53	400	11.558	11.507	34.474	1.91	0.03
22	298	299	12.450	34.472	1.53	500	10.906	10.844	34.464	1.88	0.03
21	298	299	12.433	34.472	1.53	600	10.565	10.492	34.460	1.78	0.03
20	397	400	11.548	34.470	1.80	700	10.382	10.297	34.456	1.87	0.03
19	397	400	11.543	34.470	1.80	750	10.294	10.203	34.456	1.80	0.03
18	397	400	11.530	34.469	1.78	800	10.218	10.122	34.455	1.76	0.03
17	397	399	11.508	34.469	1.78	804	10.218	10.121	34.455	1.77	0.03
16	496	499	10.932	34.462	1.82						
15	496	499	10.933	34.462	1.83						
14	496	499	10.933	34.462	1.85						
13	496	499	10.918	34.462	1.87						
12	595	600	10.576	34.459	9.30						
11	595	599	10.575	34.458	0.19						
10	595	599	10.574	34.458	-0.04						
9	595	600	10.577	34.458	-1.26						
8	695	700	10.387	34.455	1.82						
7	695	700	10.387	34.455	1.82						
6	695	700	10.386	34.455	1.82						
5	695	700	10.386	34.455	1.82						
4	795	801	10.225	34.454	1.77						
3	794	801	10.225	34.454	1.77						
2	794	800	10.226	34.454	1.77						
1	794	800	10.227	34.454	1.77						

KH-02-4	Date: 03 Dec. 2002 (GMT)					Time: 22:35 - 23:09				Depth 4809m	
St.10-5	Lat. 8 50.02 N					Long. 121 48.27 E					
	CTD DATA (BTL)					CTD DATA (DOWN CAST LAY)					
Bottle No.	Depth m	Pres. db	Temp. ℃	Sal. (psu)	DO ml·l⁻¹	Pres. db	Temp. ℃	P.Temp. ℃	Sal. (psu)	DO ml·l⁻¹	FIS
Sur.	0		28.7	****	****	1	28.684	28.684	34.188	4.15	0.07
36	565	569	10.668	34.459	1.89	10	28.685	28.682	34.189	4.20	0.07
35	572	576	10.654	34.459	1.75	20	28.687	28.682	34.189	4.20	0.06
34	578	582	10.642	34.459	1.74	30	28.682	28.675	34.194	4.22	0.06
33	582	586	10.633	34.458	1.73	40	28.664	28.655	34.206	4.20	0.07
32	586	590	10.624	34.458	1.74	50	28.614	28.602	34.218	4.19	0.09
31	590	594	10.615	34.458	1.73	75	27.869	27.851	34.317	3.92	0.23
30	593	597	10.601	34.458	1.72	100	23.061	23.041	34.402	2.51	0.06
29	598	602	10.587	34.458	1.72	125	18.515	18.493	34.449	1.92	0.03
28	602	606	10.578	34.458	1.73	150	16.263	16.239	34.498	1.95	0.03
27	606	610	10.562	34.458	1.74	175	14.880	14.853	34.512	1.95	0.03
26	610	614	10.549	34.458	1.74	200	14.148	14.119	34.510	1.94	0.03
25	615	619	10.538	34.458	1.74	250	13.221	13.187	34.481	1.63	0.04
24	625	629	10.519	34.458	1.73	300	12.669	12.629	34.472	1.51	0.03
23	632	637	10.492	34.457	1.72	400	11.675	11.624	34.474	1.87	0.03
22	636	641	10.477	34.457	1.72	500	10.972	10.910	34.465	1.88	0.03
21	640	644	10.469	34.457	1.72	600	10.616	10.543	34.460	1.80	0.03
20	643	648	10.465	34.457	1.72	700	10.385	10.300	34.456	1.88	0.03
19	647	652	10.459	34.457	1.72	702	10.383	10.298	34.456	1.88	0.03
18	651	656	10.451	34.457	1.74						
17	655	660	10.446	34.457	1.74						
16	659	664	10.440	34.457	1.76						
15	664	669	10.429	34.456	1.78						
14	669	674	10.415	34.456	1.81						
13	675	680	10.401	34.456	1.84						
12	680	685	10.397	34.456	1.87						
11	684	689	10.390	34.456	1.85						
10	687	692	10.388	34.456	1.85						
9	690	695	10.387	34.456	1.85						
8	695	700	10.383	34.456	1.85						
7	695	700	10.383	34.456	1.85						
6	695	700	10.383	34.456	1.86						
5	695	700	10.382	34.456	1.86						
4	694	700	10.383	34.456	1.86						
3	694	699	10.383	34.456	1.86						
2	694	700	10.383	34.456	1.86						
1	694	700	10.383	34.456	1.86						

KH-02-4	Date: 04 Dec. 2002 (GMT)					Time: 19:03 - 21:28				Depth 3668m	
St.11-2	Lat. 8 50.33 N					Long. 121 5.12 E					
	CTD DATA (BTL)					CTD DATA (DOWN CAST LAY)					
Bottle No.	Depth m	Pres. db	Temp. ℃	Sal. (psu)	DO ml·l⁻¹	Pres. db	Temp. ℃	P.Temp. ℃	Sal. (psu)	DO ml·l⁻¹	FIS
Sur.	0		28.6	****	****	1	28.465	28.465	34.274	4.30	0.06
36	20	20	28.397	34.271	4.12	10	28.436	28.434	34.269	4.29	0.08
35	20	20	28.397	34.271	4.11	20	28.302	28.298	34.253	4.29	0.10
34	20	20	28.398	34.271	4.13	30	28.275	28.268	34.259	4.29	0.10
33	20	20	28.393	34.270	4.11	40	28.299	28.290	34.303	4.29	0.14
32	20	20	28.394	34.270	4.12	50	28.205	28.193	34.308	4.20	0.21
31	20	20	28.383	34.269	4.11	75	27.184	27.167	34.369	3.87	0.17
30	20	20	28.384	34.269	4.11	100	21.325	21.306	34.376	2.28	0.07
29	20	20	28.376	34.268	4.12	125	16.965	16.944	34.490	2.11	0.03
28	20	20	28.379	34.269	4.11	150	15.991	15.968	34.517	2.22	0.03
27	20	20	28.380	34.268	4.11	175	14.946	14.919	34.504	2.00	0.03
26	50	50	28.195	34.282	4.01	200	14.124	14.095	34.501	1.94	0.03
25	50	50	28.192	34.283	4.03	250	13.096	13.062	34.493	1.89	0.03
24	100	100	21.245	34.360	2.15	300	12.614	12.573	34.482	1.82	0.03
23	99	100	21.256	34.348	2.09	400	11.600	11.549	34.475	2.01	0.03
22	198	199	13.673	34.500	1.82	500	11.000	10.937	34.465	1.97	0.03
21	198	199	13.704	34.498	1.80	600	10.561	10.488	34.460	1.95	0.03
20	299	301	12.433	34.476	1.61	700	10.329	10.245	34.456	1.86	0.03
19	298	300	12.437	34.475	1.63	750	10.248	10.158	34.455	1.80	0.03
18	497	500	10.877	34.462	1.78	800	10.192	10.096	34.455	1.78	0.03
17	497	500	10.877	34.461	1.77	1000	10.111	9.990	34.454	1.76	0.03
16	992	1000	10.109	34.452	1.74	1250	10.090	9.937	34.455	1.58	0.03
15	992	1000	10.109	34.452	1.74	1500	10.105	9.920	34.457	1.46	0.03
14	1486	1499	10.107	34.458	1.35	1750	10.127	9.908	34.460	1.35	0.03
13	1486	1499	10.107	34.458	1.35	2000	10.148	9.895	34.463	1.29	0.03
12	1978	1999	10.148	34.463	1.24	2500	10.212	9.888	34.470	1.11	0.03
11	1978	1999	10.148	34.463	1.24	3000	10.286	9.888	34.473	1.05	0.04
10	2471	2499	10.212	34.470	1.09	3500	10.365	9.889	34.474	1.00	0.03
9	2471	2499	10.212	34.470	1.09	3505	10.365	9.889	34.474	1.00	0.02
8	2962	3000	10.286	34.473	1.01						
7	2962	3000	10.286	34.473	1.01						
6	3455	3503	10.365	34.474	1.00						
5	3454	3503	10.365	34.474	1.00						
4	3454	3502	10.365	34.474	1.00						
3	3453	3502	10.365	34.474	1.00						
2	3453	3501	10.365	34.474	1.00						
1	3452	3500	10.365	34.474	1.00						

KH-02-4	Date: 08 Dec. 2002 (GMT)					Time: 15:21 - 16:17				Depth 1184m	
St.Ex1	Lat. 11 0.55 N					Long. 121 54.84 E				B-P 8m	
	CTD DATA (BTL)					CTD DATA (DOWN CAST LAY)					
Bottle No.	Depth m	Pres. db	Temp. ℃	Sal. (psu)	DO ml·l⁻¹	Pres. db	Temp. ℃	P.Temp. ℃	Sal. (psu)	DO ml·l⁻¹	FIS
Sur.	0		29.1	****	****	7	29.039	29.037	33.744	4.23	0.06
36	0					10	29.016	29.014	33.744	4.25	0.07
35	0					20	28.891	28.886	33.753	4.24	0.08
34	0					30	28.458	28.451	33.869	4.24	0.12
33	0					40	27.252	27.242	33.978	3.84	0.48
32	0					50	26.265	26.254	34.298	3.19	0.41
31	0					75	24.460	24.444	34.364	2.70	0.12
30	0					100	19.545	19.527	34.481	2.53	0.05
29	0					125	17.959	17.938	34.529	2.48	0.05
28	0					150	16.826	16.801	34.553	2.46	0.03
27	0					175	16.301	16.273	34.566	2.52	0.03
26	0					200	15.097	15.067	34.567	2.63	0.03
25	0					250	13.689	13.654	34.533	2.60	0.03
24	0					300	12.901	12.860	34.514	2.56	0.03
23	0					400	11.853	11.801	34.487	2.48	0.03
22	0					500	11.081	11.018	34.469	2.38	0.03
21	0					600	10.703	10.630	34.461	2.31	0.03
20	0					700	10.430	10.345	34.456	2.24	0.03
19	0					750	10.370	10.279	34.454	2.21	0.03
18	0					800	10.214	10.117	34.452	2.18	0.03
17	0					1000	10.092	9.971	34.450	2.13	0.03
16	0					1190	10.034	9.890	34.448	2.09	0.03
15	0										
14	0										
13	0										
12	0										
11	0										
10	0										
9	0										
8	0										
7	0										
6	0										
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4	0										
3	0										
2	0										
1	0										

KH-02-4	Date: 08-9 Dec. 2002 (GMT)					Time: 23:18 - 00:02				Depth 623m	
St.Ex2	Lat. 11 45.60 N					Long. 121 5.29 E				B-P 19m	
	CTD DATA (BTL)					CTD DATA (DOWN CAST LAY)					
Bottle No.	Depth m	Pres. db	Temp. ℃	Sal. (psu)	DO ml·l⁻¹	Pres. db	Temp. ℃	P.Temp. ℃	Sal. (psu)	DO ml·l⁻¹	FIS
Sur.	0		28.8	****	****	1	28.580	28.580	33.410	4.21	0.09
36	0					10	28.277	28.275	33.657	4.25	0.15
35	0					20	27.982	27.978	33.885	4.26	0.26
34	0					30	27.859	27.852	33.964	4.25	0.34
33	0					40	27.774	27.765	34.028	4.24	0.35
32	0					50	27.759	27.747	34.073	4.23	0.28
31	0					75	23.757	23.741	34.191	3.13	0.13
30	0					100	20.327	20.308	34.400	2.53	0.07
29	0					125	19.160	19.138	34.467	2.44	0.06
28	0					150	17.541	17.516	34.540	2.40	0.04
27	0					175	15.890	15.863	34.563	2.41	0.04
26	0					200	14.717	14.687	34.554	2.53	0.03
25	0					250	12.809	12.775	34.518	2.61	0.03
24	0					300	12.048	12.009	34.489	2.48	0.03
23	0					400	11.286	11.235	34.469	2.39	0.02
22	0					500	9.495	9.438	34.446	2.13	0.03
21	0					600	9.085	9.018	34.440	2.00	0.03
20	0					605	9.102	9.035	34.440	2.00	0.03
19	0										
18	0										
17	0										
16	0										
15	0										
14	0										
13	0										
12	0										
11	0										
10	0										
9	0										
8	0										
7	0										
6	0										
5	0										
4	0										
3	0										
2	0										
1	0										

KH-02-4		Date: 09 Dec. 2002 (GMT)				Time: 03:49 - 04:25				Depth	823m
St.Ex3		Lat. 12 33.62 N				Long. 120 46.07 E				B-P	34m
		CTD DATA (BTL)				CTD DATA (DOWN CAST LAY)					
Bottle	Depth	Pres.	Temp.	Sal.	DO	Pres.	Temp.	P.Temp.	Sal.	DO	FIS
No.	m	db	°C	(psu)	ml·l⁻¹	db	°C	°C	(psu)	ml·l⁻¹	
Sur.	0		29.6	****	****	1	29.443	29.443	33.158	4.16	0.02
36	0					10	29.205	29.203	33.151	4.20	0.03
35	0					20	29.187	29.182	33.151	4.20	0.04
34	0					30	29.166	29.159	33.159	4.22	0.05
33	0					40	28.293	28.284	33.359	4.15	0.10
32	0					50	27.048	27.037	33.601	4.03	0.39
31	0					75	24.113	24.098	34.126	3.21	0.17
30	0					100	20.995	20.976	34.374	2.58	0.08
29	0					125	18.760	18.738	34.505	2.42	0.05
28	0					150	17.348	17.323	34.568	2.45	0.04
27	0					175	15.546	15.519	34.578	2.44	0.03
26	0					200	14.617	14.587	34.565	2.48	0.03
25	0					250	13.389	13.354	34.533	2.45	0.03
24	0					300	12.100	12.061	34.494	2.40	0.03
23	0					400	9.843	9.797	34.445	2.38	0.03
22	0					500	8.370	8.318	34.442	1.96	0.03
21	0					600	7.479	7.419	34.453	1.88	0.03
20	0					700	6.704	6.638	34.469	1.84	0.03
19	0					750	6.304	6.235	34.479	1.84	0.03
18	0					800	5.561	5.492	34.498	1.86	0.03
17	0					800	5.575	5.506	34.497	1.85	0.03
16	0					801	5.557	5.488	34.498	1.86	0.04
15	0										
14	0										
13	0										
12	0										
11	0										
10	0										
9	0										
8	0										
7	0										
6	0										
5	0										
4	0										
3	0										
2	0										
1	0										

KH-02-4		Date: 11 Dec. 2002 (GMT)				Time: 18:20 - 19:13				Depth	3681m
St.17-3		Lat. 14 29.91 N				Long. 118 0.01 E					
		CTD DATA (BTL)				CTD DATA (DOWN CAST LAY)					
Bottle	Depth	Pres.	Temp.	Sal.	DO	Pres.	Temp.	P.Temp.	Sal.	DO	FIS
No.	m	db	°C	(psu)	ml·l⁻¹	db	°C	°C	(psu)	ml·l⁻¹	
Sur.	0		28.5	****	****	3	28.578	28.577	32.942	4.30	0.05
34	20	20	28.575	32.936	4.15	10	28.579	28.577	32.942	4.28	0.06
33	21	21	28.575	32.936	4.13	20	28.579	28.575	32.942	4.28	0.06
32	21	21	28.576	32.936	4.15	30	28.584	28.577	32.943	4.24	0.07
31	20	20	28.573	32.937	4.14	40	28.588	28.579	32.944	4.29	0.06
20	20	20	28.573	32.937	4.13	50	28.585	28.573	32.951	4.28	0.06
19	20	21	28.573	32.937	4.13	75	25.733	25.717	33.840	4.12	0.30
18	20	20	28.574	32.937	4.14	100	21.051	21.032	34.350	2.94	0.12
17	21	21	28.575	32.936	4.12	125	18.644	18.622	34.512	2.56	0.06
16	21	21	28.576	32.936	4.13	150	17.377	17.352	34.588	2.83	0.03
15	21	21	28.575	32.937	4.13	175	15.963	15.936	34.600	2.97	0.02
14	20	20	28.575	32.936	4.11	200	14.662	14.632	34.571	3.01	0.02
13	21	21	28.575	32.936	4.14	250	13.128	13.093	34.523	2.95	0.02
12	51	51	28.582	32.938	4.14	300	11.978	11.939	34.488	2.73	0.03
11	51	51	28.578	32.941	4.16	400	9.870	9.824	34.438	7.08	0.03
30	65	66	26.785	33.605	3.93	500	8.476	8.424	34.432	2.12	0.03
29	65	65	26.820	33.595	3.92	600	7.394	7.335	34.445	1.94	0.03
28	65	66	26.715	33.624	3.95	700	6.518	6.454	34.467	1.80	0.03
27	65	65	26.862	33.584	3.96	750	6.105	6.037	34.477	1.80	0.03
26	65	65	26.842	33.587	3.93	800	5.750	5.680	34.487	1.82	0.03
25	65	65	26.780	33.603	3.94	1000	4.510	4.431	34.529	1.90	0.03
24	65	65	26.824	33.590	3.95	1000	4.512	4.433	34.528	1.90	0.03
23	65	65	26.780	33.601	3.95	1001	4.507	4.427	34.529	1.91	0.03
22	64	65	26.733	33.609	3.98						
21	65	65	26.797	33.593	3.95						
10	100	101	20.408	34.386	2.66						
9	100	100	20.407	34.385	2.66						
8	200	201	14.591	34.558	2.77						
7	199	200	14.605	34.557	2.77						
6	298	300	11.981	34.479	2.43						
5	298	299	11.951	34.478	2.43						
4	498	501	8.495	34.427	1.92						
3	498	502	8.499	34.427	1.91						
36	993	1001	4.512	34.528	1.88						
35	993	1001	4.506	34.528	1.89						
2	992	1001	4.513	34.528	1.89						
1	993	1001	4.509	34.528	1.89						

7. Chemical oceanography (general/trace elements, isotopes)

7-1. Hydrography of the Sulu Sea deduced from its chemical characteristics and their long term variation

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It is known that the Sulu Sea water, even at the bottom layer with a depth of >5,000 m, contains dissolved oxygen of ~50 μmol kg^{-1}, proving the existence of oxygenated water ventilation to the Sulu Sea bottom water. There is a connection between the Sulu Sea and the South China Sea through a narrow passage (Mindoro Strait), whose sill depth is ~420 m. Other passages between the Sulu Sea and its surrounding seas have much shallower sill depths. It has been believed, therefore, that the Sulu Sea deep water is strongly affected by the inflow of the intermediate water of the South China Sea through the Mindoro strait. Few studies have been available, however, on the mechanism of deep water supply and the convection mechanism in the Sulu Sea.

Sulu Sea was surveyed in December 1996 during the KH-96-5 Cruise (Piscis Austrinus Expedition) of the R/V Hakuho Maru of the Ocean Research Insitute, the University of Tokyo. We conducted a CTD observation from surface to bottom at the deepest area of the northern Sulu Sea using a highly precise CTD (Seabird 911-plus) for the first time in this area. Niskin hydrocasts were performed at the same time for the measurements of chemical tracers, such as dissolved oxygen, nutrients and tritium. A CTD observation and chemical measurements were also conducted in the South China Sea during the same expedition for comparison. A part of the results has already been published (Nozaki et al., 1999).

This time we the geochemical group revisited the Sulu Sea after an interval of six years. We expect that the water inflow through the Mindoro Strait should be intermittent and chemical characteristics of the inflow water be variable with time. If so, vertical profiles of chemical components in the Sulu Sea might reflect such temporal variation. A purpose of this study is to detect such features by comparing the results of this cruise with those obtained six years ago. Moreover, Sulu Sea has been investigated several times since 1972 by the Japanese, German, and U.S. scientific cruises, so we could trace the previous data back to 1972. In addition, R/V Hakuho Maru visited the Sulu Sea in 2000 during the KH-00-1 cruise for biological investigations. By properly compiling and connecting these previous data with the present data, dynamic hydrography of the Sulu Sea will be revealed.

7-2. Behavior of dissolved methane and its carbon isotope characteristics in the Sulu Sea and the South China Sea

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Methane (CH_4) is an important component of the global carbon cycle and a powerful greenhouse gas. The formation of CH_4 by methanogenic bacteria and inorganic processes, however, is restricted in anaerobic or high temperature environments and does not occur in aerobic circumstances. Therefore, the concentration of dissolved CH_4 in oxygenated ocean water is generally very low, almost equal to, or less than the air saturated value of about a few nmol per kg. Local bottom waters close to submarine hydrothermal vents or cold seepages show high CH_4 concentration due to the CH_4 supply from anoxic environments below seafloor.

Although CH_4 cannot be formed in oxygenated seawater, it has been known as “oceanic methane paradox” that CH_4 is commonly observed as supersaturated levels in subsurface seawater. This can be attributed to CH_4 formation in anaerobic micro-environments such as the interior of falling marine snow, but its detailed mechanism is still unknown. In order to elucidate biogeochemical cycles of CH_4 in marine environments, distributions and behaviors of CH_4 have to be surveyed in a global scale.

This study is the first one aiming at elucidating CH_4 cycles in the two typical marginal seas: Sulu Sea and South China Sea. We will especially pay our attention to the carbon isotopic ratio ($^{13}C/^{12}C$) of CH_4 (expressed as $\delta^{13}C_{CH4}$), because it provides valuable information on the origin of CH_4. We employ an isotope-ratio-monitoring gas chromatography/mass spectrometry (irm-GC/MS) system, which separates and measure CH_4 by gas chromatography, quantitatively converts it to CO_2, and introduces the CO_2 continuously to an isotope ratio mass spectrometer.

Seawater samples were taken in 120 mL brown colored glass vials with no air contamination. At least 120 mL of seawater was overflowed for this purpose. 0.5 mL of saturated $HgCl_2$ solution was added in order to cease any biological activities. The $HgCl_2$ solution had been degassed prior to use. Then each vial was sealed with a butyl rubber stopper and stored in refrigerator at ~5°C. After the cruise, the concentration of CH_4 and its $\delta^{13}C$ will be measured using the method mentioned above. We also expect that CH_4 may be a good tracer to study water movement from the South China Sea to the Sulu Sea.

7-3. Helium isotope ratio ($^3He/^4He$) in the Sulu Sea and the South China Sea

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Helium (He) has two stable isotopes, ^3He and ^4He. Helium in the atmosphere has the $^3He/^4He$ isotope ratio of $1.4x10^{-6}$, and the atmospheric helium dissolves in seawater at the air-sea interface. On the other hand, mantle-derived helium, locally supplied and dispersed from the seafloor such as mid-oceanic ridges where submarine volcanic activity occurs, has an order of magnitude higher $^3He/^4He$ ratio than the atmospheric helium. These two types of helium in seawater play an important role in tracing water mass advection and mixing processes, because helium is a rare gas whose distribution is never affected by biological activity.

The helium isotope data in the ocean is still insufficient to be restricted in the open seas, and no data is available in the Sulu Sea and the South China Sea so far. This study aims at obtaining the first helium isotope data in these tropical marginal seas, in order 1) to know whether the mid-depth $^3He/^4He$ maximum originated from the East Pacific Rise can be recognized in these marginal seas, and 2) to utilize the helium isotope data as a useful water mass tracer in the westernmost Pacific.

Sampling was performed at Station 10 (Sulu Sea) and Station 17 (South China Sea). Seawater samples of ~30 mL were carefully taken in ~1 m copper tubing (3/8 inch o.d., 1/4 inch i.d.) with no air contamination. Both ends of each tube were completely sealed using special pinching tools made of iron and stainless steel. Dissolved helium gas will be extracted in a shorebased laboratory to measure the helium isotope ratio by mass spectrometry.

7-4. Investigation of man-made perfluorinated compounds in the ocean

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[2]National Institute of Advanced Industrial Science and Technology

Perfluorooctane sulfonate (PFOS) and related perfluorinated compounds (e.g. PFHS, PFBS, PFOA) have received worldwide attention during the last three years. These chemicals are referred to as "PCBs of the 21-st century". The products containing PFOS and related compounds have been used in a wide variety of applications such as coatings for textiles, papers, packaging, fire-fighting foams, herbicides and pesticides. PFOS is an end product of the biological metabolism of various sulfonated fluorochemicals.

PFOS has been identified in human sera and in wildlife. These chemicals are considered as emerging persistent organic pollutants, but compared with chlorinated and brominated organic compounds, the environmental distribution of perfluorinated compounds (PFCs) is poorly understood. There has been no oceanic data, so this study is the first attempt to elucidate the behavior of PFCs in the ocean.

Seawater samples (~800 mL) were taken in plastic bottles at Stations 10, 13, S2, 16 and 17 at ~10 different depths from the surface to the bottom. 250~500 μL of a 250 mg/mL sodium thiosulfate solution was added to each sample for reducing residual chlorine. The samples were kept in a freezer at –30°C.

In a shorebased laboratory, each sample is passed through C18 SPE cartridge to concentrate the PFCs, and HPLC-MS/MS measurement will be performed using an Agilent HP1100 liquid chromatograph equipped with Quattro Ultima Pt (micromass). MS/MS parameter were optimized to transmit the [M-K]- (m/z : 499) ion for PFOS using atmospheric pressure ionization operated in the electrospray negative ion mode.

7-5. Rare earth elements in the Sulu, Celebes, South China and Philippine Seas

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[2] *Ocean Research Institute, University of Tokyo*

Purpose: The recent progress in marine geochemistry of rare earth elements (REEs) has shown that the REEs are strong tools for understanding the chemical systematics in the ocean. Nozaki et al. (1999), and Alibo and Nozaki (2000) showed the REE patterns provide useful means of characterizing the water masses in the Sulu Sea and the South China Sea. However, the geochemical cycles of REEs in these areas are not clear yet. During this cruise, the samples were collected in the Sulu Sea, Celebes Sea, South China Sea and Philippine Sea. The REEs will be determined in the Ocean Research Institute, University of Tokyo.

Methods: Samples were filtered with 0.2 μm polycarbonate membrane filters (Steradisk, Toyobo) in the clean laboratory (No. 4) built in the R.V. Hakuho-Maru immediately after sampling. The determinations will be made by inductively coupled plasma mass spectrometry (ICPMS) on the samples preconcentrated from 1-L aliquot of seawater using a solvent extraction technique (Shabani et al., 1991, Alibo and Nozaki, 1999).

Samples: 5L of seawater samples were collected at St. 1 (the Philippine Sea), 2 (the Celbes Sea), 4 and 10 (the Sulu Sea), S2 (the Mindoro Strait) and 16 (the South China Sea).

Reference

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7-6. Distributions and speciation of manganese in the Sulu, Celebes and Philippine Seas

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Introduction: Manganese, a redox-sensitive element in the natural waters, is a good tracer for the redox conditions. Manganese oxide is also an important scavenger for other metals. However, the speciation of manganese is not clear yet in the ocean. In order to clarify the speciation of manganese in the ocean, we applied a newly-developed analytical method using a chelating resin to the seawater. We also studied the distributions of manganese in the Sulu, Celebes and Philippine Seas, where only few data had been reported before.

Method: Manganese was determined with a new shipboard analytical method using the chelating preconcentration and chemiluminescence detection. We compared this method with the previous method using the electrolytic column preconcnetration. Filtered and unfiltered samples collected in the Stns 1, 2, 3, area-U, 4, 10, and 17 were determined with these methods.

Results: The vertical profiles of manganese are shown.

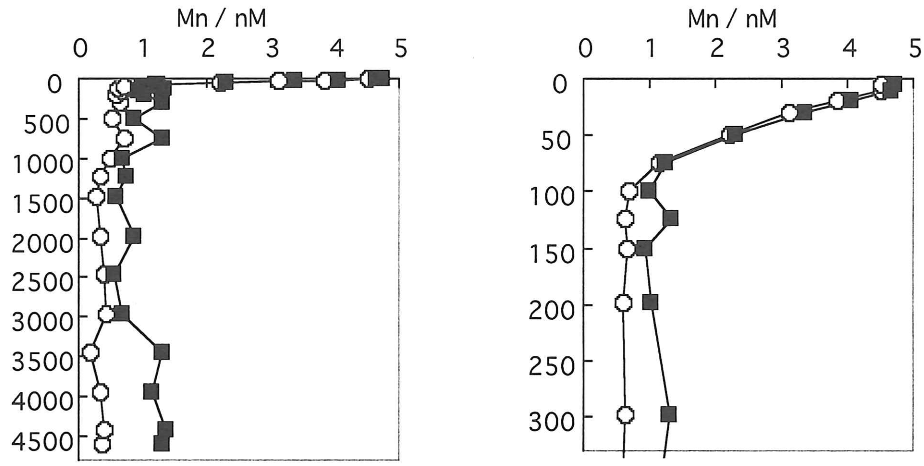

Figure. The vertical profiles of manganese in sulu sea (St.4). ○, filtered sample; ■, unfiltered sample.

7-7. Trace metals in the Sulu, Celebes, South China and Philippine Seas

Hajime Obata[1], Takashi Doi[2] and Masahiro Maruo[2]

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[2]*University of Shiga Prefecture*

Purpose: Some trace metals, such as iron, zinc and cobalt, are essential for the phytoplankton growth in the ocean. Their concentrations and speciations may have some influence on the oceanic productivity. However, only few data for the trace metals were reported in the Sulu and Celebes, South China and Philippine Sea. To reveal the distributions and speciations of the trace metals, samples were collected in these areas during the cruise. The samples will be brought back and analyzed in the Ocean Research Institute, University of Tokyo.

Methods: Iron: Iron in seawater will be determined automatically in a closed folw system using chelating resin concentration and chemiluminescence detection (Obata et al., 1993). Iron will also be determined with cathodic stripping voltammetry (CSV) using dihydoxynaphthalene (DHN) and bromate (Obata and van den Berg, 2001). 125 ml of filtered/unfiltered samples were frozen and stored for Fe analysis.

Cobalt: Cobalt in seawater will be determined with CSV using nioxime and nitrite. 100 ml of filtered samples were frozen and stored for Co analysis.

Samples: 250 ml of seawater samples were collected at Stns 1 (the Philippine Sea), 2 (the Celbes Sea), 4 and 10 (the Sulu Sea) and 17 (the South China Sea).

Reference

Obata, H. et al. (1993): Anal. Chem., 65, 1524-1528.

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7-8. Distribution of trace metals in the Sulu Sea

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The distribution of trace metals in seawater is controlled by various physical, chemical and biological processes. In order to reveal the behavior of trace metals and to elucidate the processes occurring in the ocean, we have developed multi-elemental determination of trace metals in seawater based on column concentration and measurements with inductively coupled plasma mass spectrometry (ICP-MS)[1]. Based on the technique, we have revealed the distribution of Nb and Ta in the ocean for the first time[2]. The purpose of this study is to reveal the distribution of trace metals in the Sulu Sea and its adjacent regions. On the present cruise, we are studying trace bioelements (Fe, Co, Cu, Ni, Zn, Cd) and elements of group 4, 5 and 6 (Zr, Nb, Hf, Ta, W).

Sampling and pretreatment on board: Sampling stations of our study are Stn. 1, Stn. 2, Stn. 4, Stn. 10, Stn. 14, Stn. 16 and Stn. 17. Seawater samples were collected with 12-L X-Niskin bottles. Five hundred milliliters of seawater was carefully sampled using an acid-cleaned bell and silicon-tube to avoid contamination, and stored in acid-cleaned polyethylene bottles (500 mL LDPE; Nalge). Within 16 hours after sampling, 250 mL of seawater was filtered with 0.2-µm Nuclepore PC membrane filters in a closed filtration system in a clean room (No.4 Laboratory), and acidified to p*H* 2 with acid solutions for the preservation. For samples of Fe, Co, Cu, Ni, Zn, Cd, we used 6 *M* hydrochloric acid (TAMAPURE AA-10; Tamakagaku), and for Zr, Nb, Hf, Ta, W, we used mixed acid solution of 5 *M* hydrochloric acid- 1 *M* hydrofluoric acid (TAMAPURE AA-100). Also some un-filtered samples were acidified with these acid solutions.

Future works in our laboratory: The water samples will be brought to our laboratory and analyzed. The both filtered and un-filtered samples will be adjusted to p*H* = 4.1 with ammonium acetate buffer and pass through a column of 8-quinolinol immobilized fluoride containing metal alkoxide glass (MAF-8HQ) in order to extract trace metals from seawater samples. The trace metals on MAF-8HQ will be eluted with 25 mL of 0.5 *M* nitric acid for the analysis of Fe, Co, Cu, Ni, Zn, Cd, and eluted with 25 mL of 0.5 *M* nitric acid containing 1 m*M* oxalic acid for Zr, Nb, Hf, Ta, W. The eluates will be analyzed with a high resolution-inductively coupled plasma-mass spectrometer (JMS-PLASMAX 1; JEOL or ELAN 6100DRC; Perkin-Elmer Japan). We will reveal the distribution of trace metals in the Sulu Sea and the adjacent regions, and discuss on the relation between the profiles and various processes occurring in the basins.

References

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2: Sohrin, Y.; Fujishima, Y.; Ueda, K.; Akiyama, S.; Mori, K.; Hasegawa, H.; Matsui, M.; *Geophys. Res. Lett.* **1998**, *25*, 999.

7-9. The geochemical behavior of trace elements in the Celebes, Sulu and South China Seas considering with seawater exchange and bottom water formation

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Introduction: Selenium is one of major essential elements because the marine phytoplankton needs selenium occasionally in the surface water. The selenium input by the atmospheric depositions and output by the biomethylated volatilization of dimethylselenide (DMSe) and dimethyldiselenide (DMDSe) occurred in the surface seawater. Most of supplied selenium was changed dissolved form in seawater and its chemical forms were selenite (+4) and selenate (+6) as the inorganic species. Especially, selenite was selectively required by phytoplankton in the surface and sub-surface water. Accumulated selenite was changed to organic selenide in that body, and output as particulate selenium such as fecal pellets or shells into seawater. This particulate selenium was immediately decomposed by microorganisms to dissolved form (dissolved organic selenide) again (Cutter and Bruland, 1984).

Many studies of selenium distributions in the Atlantic, the east Pacific Ocean and the coastal area had been reported, but few reports were in the peculiar ocean. However, as mentioned above, it is very important that the research in such regions affected to an open-ocean directly for the flux study of selenium into the deep ocean. In this KH02-4 Cruise, we chose the Celebes, Sulu and South China Sea that were connecting points between Pacific and Indian ocean for studying the vertical and/or horizontal behaviors of trace selenium species.

Sampling and Methodology: Seawater was collected by CTD-CMS system equipped with pre-cleaned 12L-Niskin bottles on board. Collected seawater samples were filtrated with 0.2 μm membrane filter immediately. Those samples were placed in 125 ml Nalgene HDPE bottle and stored in a freezer (–20 °C) before laboratory analysis. Dissolved selenium species (Se(IV), Se(VI) and Org. Se) were determined with DAN-HPLC method (Hattori et al., 2001). For Se(IV), a portion of 20 ~ 30 ml sample was into grass beaker and a 5 ml of 0.1 % 2,3-diaminonaphtalene (DAN) solution was added. That solution was warmed at 50 ~ 60 °C in a water bath for 25 minutes, and formed the complex 4,5-benzopiazselenol. After extraction with 5 ml cyclohexane in a separate funnel, that complex in the cyclohexane was determined by high performance liquid chromatography (HPLC) at excitation wavelength of 375 nm and emission wavelength of 520 nm using silica-gel filled column. Se(VI) was reduced to selenite by HCl and KBr, and determined as total inorganic selenium ([Se(IV) + Se(VI)]). The concentration of Se(VI) was subtracting that of [Se(IV)] from [Se(IV) + Se(VI)]. The Org. Se was digested to inorganic selenium by HNO_3 and $HClO_4$, and determined as total selenium ([Se(IV) + Se(VI) + Org. Se]). The concentration of [Org. Se] was subtracting that of [Se(IV) + Se(VI)] from total selenium amount.

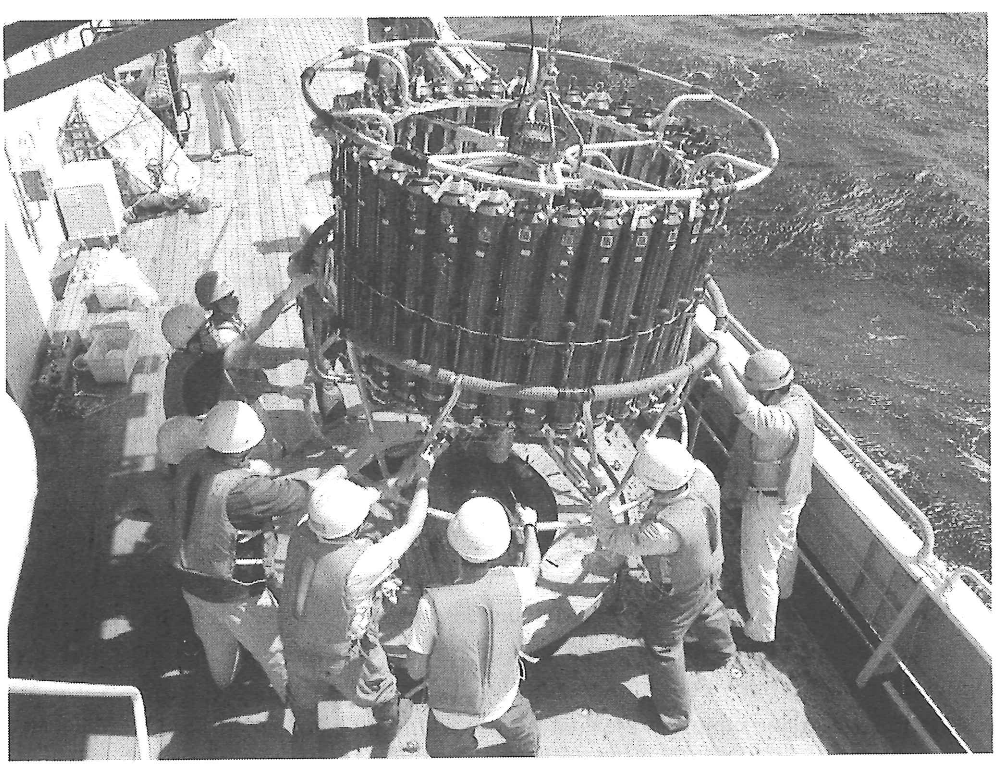

Photo : It's ready for the lowering of the CTD system. (Taken by J. Nishikawa.)

8. DOM/POM studies

8-1. Behavior and distribution of dissolved organic matter in the Sulu Sea

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Introduction: Dissolved organic matter (DOM) in seawater is one of the largest reservoirs of reduced carbon in the ocean carbon cycle. Therefore, DOM in the ocean plays an important role for the carbon cycle on the earth. In addition to the importance in the carbon cycle, DOM in the ocean has a significant role in other material circulation. For example, DOM forms the complex compound with metal ions and it is influenced to the behavior of those (Hirose and Tanoue, 1998). Therefore, the behavior of DOM is related to the cycles and chemical forms of other material in the ocean. However, the source and fate of this large carbon pool are still debated. The major source of it is considered to input from atmosphere and terrestrial DOM pass through a river line into the ocean (Siegenthaler and Sarmiento, 1993; Bauer and Druffel 1998), and degradation of old dying phytoplankton (Sharp, 1977). However, the ultimate source of DOM and exact mechanisms are still unknown. Purpose of this study is to know the concentration of dissolved organic carbon (DOC) and the source of DOM in the Sulu Sea.

Sampling and Methodology: Seawater samples were collected with CTD-CMS system equipped with 12 l Niskin bottles and surface seawater samples were collected with bucket. These samples were transferred directly to a glass bottle (250 ml) to prevent the contamination. About 200 ml of this water was immediately filtered through the Whatman GF/F filter (25 mm ø) with grass syringe. Seawater samples (50ml) were filtered to wash the filter before the sample filtration. About 100 ml of the seawater samples were filtered for analysis of this study. The filtrates were poured into 5-ml grass ampoule. The filtered samples for analysis of DOC were acidified with 50 μl of 6N-HCl. Samples for analysis of three dimensional excitation-emission matrix spectra were also poured into 5-ml grass ampoule and not acidified. These ampoules were sealed with torch and preserved in freezer. The remaining filtrate samples were transferred into 100 ml polyethylene bottles for determination of dissolved organic nitrogen and phosphorus.

Analysis: Concentration of DOC is determined by high temperature catalytic oxidation method with Shimadzu TOC-5000.Three dimensional excitation-emission matrix spectrum is measured with HITACHI model F-4500 fluorescence spectrophotometer equipped with a 150W-xenon lamp. Dissolved organic nitrogen and phosphorus are determined by wet chemical oxidation method.

8-2. POC flux in the Sulu Sea estimated from ^{228}Ra-^{228}Th and ^{238}U-^{230}Th disequilibria

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Outline: The purpose of this study is to estimate the POC flux in the Sulu Sea, based on the vertical profiles of natural radionuclides ^{228}Ra (half-life, 5.7 years), ^{228}Th (half-life, 1.9 years), and ^{230}Th (half-life, 75,200 years). Dissolved thorium, particle reactive element, is easily removed from the water column by adsorption onto the settling particles, while uranium and radium are relatively stable in the water column. This disequilibria between the parent and daughter radionuclides, caused by the differences in their chemical behaviors, is useful for quantifying the removal rate of thorium. Furthermore, the POC flux can also be estimated using by the removal rate of thorium and the Th/POC ratio in the sinking particles.

Sampling and treatment: Each water sample was taken by X-Niskin bottles installed on the CTD-CMS system of the R/V Hakuho-maru and transferred to previously acid-washed cubic containers. For the particulate thorium and POC analysis, 20 L aliquots of seawater samples were immediately filtered after sampling using 0.4 μm-porosity Nuclepore filters and GF/F filters, respectively. For ^{228}Ra and ^{228}Th, 20L of samples were passed through manganese oxide-impregnated fiber (MnO_2 fiber) columns to extract Ra and Th isotopes quantitatively (Reid et al., 1979). The MnO_2 fibers were preserved in a plastic bag, and brought back to the ORI. For total ^{230}Th, 2L of samples were acidified to pH< 1.8 with HCl, and stored in the polyethylene bottles.

Methods: ^{228}Ra and ^{228}Th ; In the laboratory, the radionuclides collected on the MnO_2-fibers will be extracted with 2N HCl + H_2O_2. ^{228}Ra will be co-precipitated with $PbSO_4$ from the extract. ^{228}Th will be purify by anion exchange from the residual solution. Th activity will be measured by α spectrometer. The $Pb(Ra)SO_4$ precipitate will be stored for more than 3 weeks to let the short-lived daughter nuclides of Ra grow. The activity of the Ra isotopes in the $Pb(Ra)SO_4$ precipitate will be measured with γ spectrometer, germanium detectors coupled with a multichannel analyzer.

^{230}Th ; After adding spikes, total ^{230}Th in seawater will be co-precipitated with $Fe(OH)_3$. After purified by anion exchange, the Th fraction will be determined by thermal ionization mass spectrometry (TIMS). The filter samples for particulate ^{230}Th will be decomposed with HF + HNO_3. The following procedure is same as that for total ^{230}Th.

8-3. Chemical composition of suspended particles in the Sulu Sea and Celebes Sea

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Purpose: In the ocean, various kinds of particles exist, for example, mineral particles transported from the atmosphere and rivers, anthropogenic particles and particles produced in seawater through biological activities and chemical reactions. Thus the differences of chemical compositions and size of suspended particles in seawater depend on their origins. By studying the chemical composition of suspended particles in seawater, we can understand the origin and the feature of water masses. Also, suspended particles are thought to play important roles in oceanic biogeochemical cycles.During this cruise, I will study the chemical compositions of suspended particles in the Sulu Sea and Celebes Sea, and clarify the feature and behavior of particles in this oceanic region.

Sampling: Surface waters were collected by using a polyethylene bucket. Vertical samples were obtained using the CTD-CMS at most sampling stations (St-1, 2, 3 and 4).

Methods（Filtration）: Seawater samples (100-5000 ml) were filtered through 25 mm, 0.4 μm porosity Nuclepore filter immediately after sampling.

Analysis : Particles collected on the filters were preserved at 4 °C in a refrigerator. The shape and size of particles will be observed with the Scanning Electron Microscope (SEM) and the chemical composition of particles will be analyzed with Energy Dispersive Spectroscopy (EDS) in the laboratory.

9. Sedimentary geochemistry

9-1. Biogeochemical and paleoceanographic studies on Ba in seawaters and sediment cores from the Sulu Sea and adjacent regions

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Barite ($BaSO_4$) has been found in suspended and settling particles in seawaters, and also in sea-floor sediments under high productivity regions. It is believed that the barite particles are formed during the biological process. Therefore, the distribution of barite or biogenic Ba (as the excess amount relative to the crustal abundance) in the sediment core is useful as a proxy for the change of paleo-productivity, while it is important for us to understand the uptake in the euphotic zone and the regeneration in the deep-water of Ba. And also, we must know about the early diagenesis of sedimentary Ba through its distribution in the pore water and solid phase of sediment core. The purposes of this research are divided into three categories; (1) to clarify the distribution of Ba in seawater, (2) to understand the recycling of Ba including nutrients in the sediment core during early diagenesis, and (3) to evaluate the change of ocean fluxes of biogenic Ba including carbonate and opal during the last glacial age in the Sulu Sea.

Ba in seawater: It is known that the vertical distribution of Ba in seawater is very like that of silicate. However, the correlation between the two is less than that between Ba and the silicate/nitrate ratio. Previously, we found out the linear relationship between Ba and Si/N in the North Pacific cross section study, WOCE P-1 revisit observation along 47 degree N in 1999. There is every possibility of using this relation as a paleoceanographic tool, as well as the case of the linearity of Ba versus alkalinity in the ocean. Our object is to confirm the relation between Ba and Si/N ratio in this unique sea.

We collected seawater samples at all hydrocast stations in the Sulu Sea and adjacent areas. The samples were stored into 100 ml polyethylene bottles.

Early diagenesis of Ba in sediments: The objective of this study is to clear the behavior of Ba in pore water as well as other biophile elements, nitrate, nitrite, phosphate and silicate. The following works were carried out on board.

For pore water chemistry, sediment cores were collected at St-1 (PH-1bMC), St-2 (CE-1aMC and CE-1bMC), St-3 (CE-2MC), St-4 (SU-1MC), St-6 (SU-3MC), St-7 (SU-4MC), St-9 (SU-6MC), St-11 (SU-8MC), St-12 (SU-9MC) and St-13 (SU-10MC), using a multiple corer. Sediment samples were immediately extruded by 1.0 cm sections after collection. Pore waters were squeezed from each extruded sediment sample under the air-tight condition by pressure filtration through a 0.45 micrometer Millipore filter. Sediment extruding and pore water extracting were performed in the walk-in refrigerator Lab. 10. The concentrations of nitrate, nitrite, phosphate and silicate were determined by a Autoanalyzer on board by Dr. Y. Yamaguchi and Y. Arii of Kinki University. The residual portion of pore waters were stored in polyethylene tubes for Ba analysis, and divided to measure Fe (Dr. Obata) and Se (Dr. Yamaguchi).

To investigate the distributions of biogenic Ba, carbonate and opal in sediments, the multiple-cores were also collected at Stns. 14 (SU-11MC) and 15 (SU-12MC) adding to the stations mentioned above.

Paleoceanographic study: As generally known, siliceous phytoplankton, such as diatoms, is an abundant species in eutrophic surface waters, which extend in polar and upwelling regions. Oppositely in oligotorophic waters of sub-tropical to temperate regions, where the vertical mixing of surface waters is limited, calcareous plankton like cocolithophores and foraminifera are predominant. Consequently, the change of the predominant plankton species implies the variation of the trophic level of the surface water, and this suggests whether or not eutrophic waters in the sub-tropical regions were reinforced with the climate change during the last glacial age.

For this study, long sediment cores were obtained at 3 stations (Core # SU-8PC at St-11, SU-9PC at St-12 and SU-10PC at St-13) using a piston corer. The distributions of biogenic Ba, carbonate and opal will be examined, and the concentrations of metals, Fe, Mn, Al, etc., in sediments will be also determined.

9-2. Biogeochemical studies of organic materials in the Sulu Sea

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The Sulu Sea is completely surrounded by a small shelf, most of which is less than 200 m deep. Deepwater exchange is limited by the depth of the deepest sill supplying water to the Sulu Sea from the surrounding basins. At the present deep water from 1000 m to 4800 m is uniformly warm at ca. 10°C with a near uniform salinity. The Sulu Sea has another uniqueness geochemical feature. Sediment rates are 2-4 times higher than the South China Sea as result of higher terrestrial input and better carbonate preservation. The purpose of this study is to understand the biogeochemical processes for organic materials at the uniqueness marine environments. The geochemical behavior of organic materials in the Sulu Sea are studied for water column and sediment by the isotopic, radiochemical and GC-mass spectroscopic analysis.

Geochemical behavior of organic materials in water column: To study geochemical processes for organic materials in the Sulu Sea, we study the spatial and vertical distributions of dissolved and suspended organic materials, and also study the flux and characteristics of organic materials for sinking particles.

20-L of water samples from surface to deep bottom waters were collected by a CTD-CMS system at 7 stations (Stn.1, 2, 4, 7, 11, 14 and 17), and then filtered with pre-combusted Whatman GF/F filters. The surface water samples were also taken from the Sulu Sea (Stn.5, 6, 8, 9, C, 13, and S2), the upwelling area (Stn.U-1, 2, 3, 4) and the South China Sea (Stn.16). The GF/F filter samples were stored in a freezer at –20°C. The $\delta^{13}C$ and $\delta^{15}N$ for particulate organic materials on the filters will be analyzed by an elemental analyzer-mass spectrometer (NA1500-ConFloll-MAT 252 system).

The water samples were collected at 2 stations (Stn. S1 and Stn. 7) for the measurements of DOC concentration and at 8 stations (Stn.1, 2, 4, 6, 7, 10, 14, and 17) for the fluorescence properties of dissolved organic materials. The samples were filtered with Whatman GF/F filters and the filtered water samples were kept in the freezer at –20°C. The DOC concentration will be determined by a TOC analyzer (Shimadzu TOC-5000). The fluorescence properties will be analyzed by excitation-emission matrix spectroscopy and high-performance size exclusion chromatography with fluorescence detection to characterize labile and non-labile dissolved organic materials.

Sediment trap experiments were carried out at 2 stations in the Sulu and the Celebes Sea to collect sinking particles from surface to bottom water. Sediment traps were attached to the free-floating array, which consisted of 3 traps at water depths of 50m, 150m and 300m. The schematic illustration of the free-floating sediment trap array was shown in Figure 1. The free-floating array was deployed for 48hr (2002/11/15 8:40-11/17 8:30) at Stn.2 in the Celebes Sea and 44hr (2002/11/19 18:20-11/21 15:00) at Stn.4 in the Sulu Sea. The sinking particles were preserved in the bottles with formalin in a refrigerator. The stable isotopes ($\delta^{13}C$ and $\delta^{15}N$), biomarker and major chemical components will be analyzed on land. The biological components, including possible 'swimmers' and organisms associated with the sinking particles, will be analyzed for a fraction of the samples by light- and electron microscopy at the Plankton Laboratory, Ocean Research Institute (see "Biological and ecological studies on zooplankton and micronekton in the Sulu Sea and its adjacent seas", this volume). Part of the sediment trap sample will be used by the Laboratory of Aquatic Bioscience, The University of Tokyo, for estimating the concentrations and variations in the downward flux of transparent exopolymer particles (TEP) from the euphotic zone.

Sedimentation processes for organic materials from coastal to deep water environments: The sediment samples were taken from coastal area to deep water basin in the Sulu Sea to understand the sedimentation of terrestrial and marine origin of organic materials. The sediment core samples were collected at 11 stations (Stn.4, 5, 6, 7, 8, 9, 11, 12, 13, 14, and 15) by a multiple corer. The reference sediment samples were also collected at Stn.1 from the Philippine Sea, Stn.2 and 3 from the Celebes Sea, and Stn.17 from the South China Sea. The sediment cores were cut in 1-cm interval on board.

To estimate sedimentation rate, the radioactive contents of Pb-210 and Cs-137 will be measured for the coastal sediments by gamma-spectrometry, and Th isotopes will be measured for the deep water sediments by alpha-spectrometry. The sedimentation for the organic materials will be studied by using stable isotopes ($\delta^{13}C$ and $\delta^{15}N$) and biomarker related to the production of organic materials and the supply of riverine materials. The contents of elements from terrestrial origin such as K, Mg, Ti and the redox-sensitive elements (U, Mo) will be also measured by ICP-MS or ICP-AES after the digestion of the samples.

Paleoceanograhic studies for organic materials: The sea level change between glacial and interglacial periods should be caused significant change in surface water environments such as exchange of surface water, primary production and supply of riverine materials in the Sulu Sea because the open exchange of surface water is limited by two main strait at the water depth of 250m and 420m. Three piston core samples were collected at Stn.11 (water depth of 4000m), Stn.12 (water depth of 3000m) and Stn.13 (water depth of 2000m) from the Sulu Sea during the cruise. The sediment samples will be analyzed for stable isotopes ($\delta^{13}C$ and $\delta^{15}N$), biomarker, radionuclides and chemical components. The color parameter such L*, a* and b* values for dry-powdered sediment samples will be measured to understand geochmical environments for the sediments because the color may be a simple and sensitive indicator of major chemical composition, primary production and redox environments.

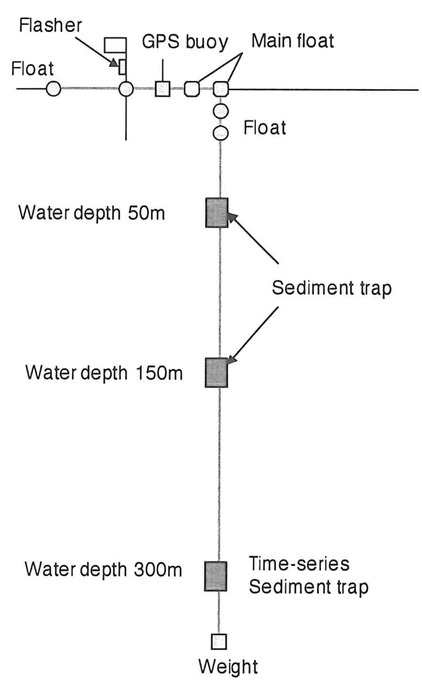

Figure 1 Schematic illustration of free-floating sediment trap array.

9-3. Piston-core works (Group Report)

Yoshihisa Kato, Masafumi Murayama, Seiya Nagao, Motohiro Shimanaga and Hidetaka Nomaki
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The main objective of the piston core group is to resolve the change of ocean flux systems in the Sulu Sea during glacial-interglacial cycles. To meet this objective, we collected long sediment cores at 3 stations in the SE slope of the Cagayan Ridge (Core# SU-8PC at St-11, SU-9PC at St-12 and SU-10PC at St-13) using a piston corer.

The coring sites were decided by surveying the sea floor topography using a 3.5 kHz sub-bottom profiler, where were topographically flat as shown in Fig. 1 to 3. The piston corer used on board is composed of 900 kg weight and 15 m length aluminum pipe.

The sediment cores obtained at each site were presumably carbonaceous, and those lengths were ca. 14.2 m at St-13, 14.7 m at St-12 and 14.5 m at St-13, respectively. On board, we cut sediments in the pipes into 1 m-lenghs and stored in Lab. 10 (about 4 °C). These samples will be transported to Marine Core Research Center, Kochi University.

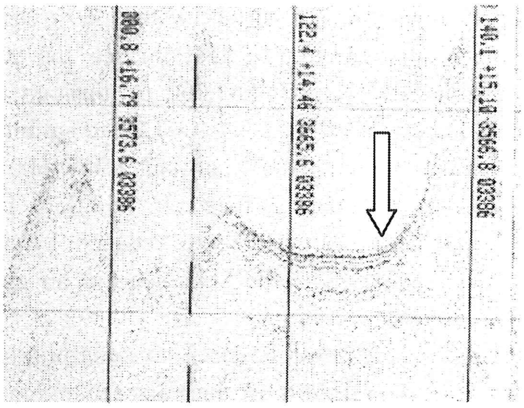

Fig. 1. The topography in St-11. Core #; SU-8PC, Touching Bottom Data, 2002/12/05 10:12; 8-50.00'N, 121-05.61'E; PDR Depth 3668 m; Total Wire-out 3751 m

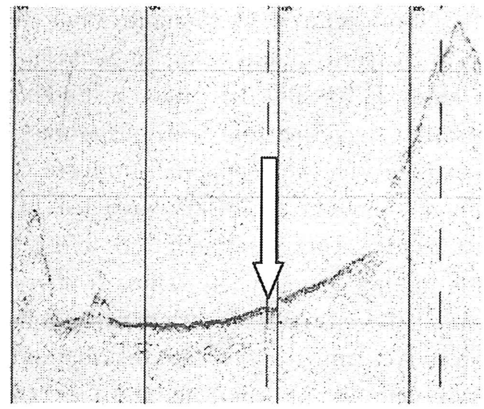

Fig. 2. The topography in St-12., Core #; SU-9PC, Touching Bottom Data, 2002/12/06 09:52; 8-46.88'N, 120-43.00'E;, PDR Depth 2900 m; Total Wire-out 2962 m

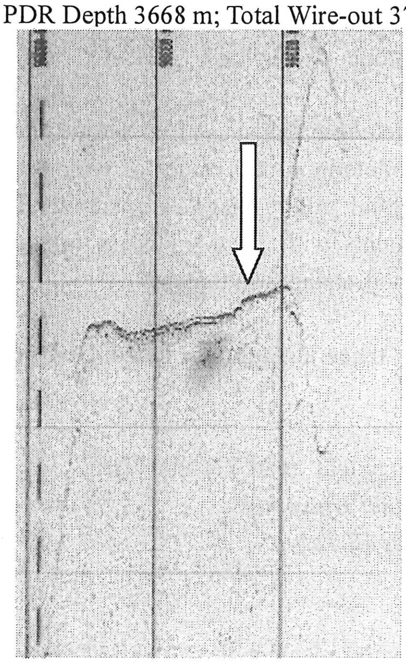

Fig. 3. The topography in St-13. Core #; SU-10PC, Touching Bottom Data 2002/12/07 12:01; 8-57.49'N, 120-11.48'E; PDR Depth 1870 m; Total Wire-out 1862 m

In the shore-based research, we intend to measure useful parameters to clear the paleoceanography of the Sulu Sea, as follows; (1) magnetic susceptibility, digital color, X-ray CT scan and water content to determine physical properties and sedimentary structures, (2) assemblage analysis of calcareous microfossils to estimate the age of the sediment, (3) oxygen isotopes (O-18/O-16 ratio) and radio isotopes (Th-230, Th-232 and C-14) to determine the sedimentation rate, (4) biogenic materials (organic carbon, $CaCO_3$ and SiO_2), lithogenic elements (Al, Ba, Ti, Fe, Mn, U, etc.) and organic compounds (UK-37, stable isotopes of C and N, lipids and pigments) to determine past changes in oceanic mass fluxes.

9-4. Distribution and its characteristics of surface sediment in the Sulu Sea and adjacent area

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Introduction: The Sulu Sea is a deep back arc basin (~ 5,000 m) surrounded by a shelf most of which is less than 100 m deep, except Mindoro Strait silled with a depth of 420 m. The surface water mixes easily with that of the surrounding seaes. In contrast, due to the isolated configuration of the Sulu Sea, the deep water is renewed by episodic surges of South China Sea Intermediate Water (600-1,000 m) through the Mindoro Strait suggested from previous works. As a results, temperatures (almost 9.8-10 °C) and salinities (34.5 ‰) which were well supported from our CTD-data (this report) are remarkably constant below 600 m. Therefore, the bottom sediments have led to well-preserved the carbonate particles. In addition, low dissolved oxygen concentration (<1.6 ml/L) in the deep water also has resulted to reduced benthic organisms mixing of sediments. Thus, to investigate the surface sediments in the Sulu Sea has an good relationship between water characteristics and its fluxes to the sediments.

My objectives are to survey the distribution of sediments varying depth preferences, to determine the components and age of sediments and their stratigrahic histories, as indicators of the paleoceanographic events during the late Quaternary.

Sampling and Methods: 17 surface sediment cores were taken from the 16 stations in the Sulu Sea, Celebes Sea and adjacent area using a multiple corer during this KH02-4 cruise (table list in this report). 2 cores at each site were used. During on-board works, a core was used for visual description, taking close-up photographs and color analyses using a digital color photospectrometer (MINOLTA CM-2022). The other core cut into segments with 1 cm thickness for oxygen isotope chronology, AMS-^{14}C dating and micropaleontological assemblage assessment.

Shore-based operations will include non-destructive physical determinations using a X-ray CT Scanner and a Multi-Sensor Core Logger (MSCL). MSCL will be used to determine the values of various physical properties (gamma density, p-wave, magnetic susceptibility, digital color image, electric conductivity, natural gamma ray). Following this, the sediments cut into segments with 1 cm thickness for grain size analysis to evaluate the source of sediments during the environmental changes in the past.

9-5. The geochemical status and early diagenetic processes for trace elements of bottom sediments in the closed Basins

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Introduction:: Generally, selenium is known as toxic and essential element in the natural environment, and can form four oxidation states as Se(+VI), Se(+IV), Se(0), and Se(-II) in several organic forms. These selenium species exist in the atmospheric environment, natural water and sedimentary ecosystems at the level of ca. 0.05 ~ 5 μg/g. In the natural water ecosystem, especially marine environment, the distributions and behaviors of selenium species depend on biological activity such as phytoplankton uptake and regeneration process from particle matters. Thus, the profiles of selenium species in water column show the nutrients-type, surface depletion – deep water enrichment, and the concentrations are in ca. 1.0 ~ 160 μg/l. However, sedimentary selenium is 107 ~ 1010 times higher than in natural waters, and its behavior is largely dependent on pH and oxic-anoxic conditions in each sediments. The present studies of selenium in the sediment indicated several geochemical processes. Se(+IV) can be strongly adsorbed to Fe and Mn oxide in the oxic condition surface sediments. The microbial (bacterial) reduction of Se(+IV) and Se(+VI) to Se(0) is also mainly mechanism in the soil and marine sediments. Furthermore, the oxidation of organic selenide (Se(-II)) and incorporation of selenium into solid phase such as FeSe, FeSe2 and pyrite were occurred.

The authors selected the open-ocean or closed basin deep sediment samples and presented the selenium speciation in porewater and the fractionated selenium distributions in this paper. Other related distributions of nutrients, iron, manganese and organic content were also determined. The recent geochemical behavior of selenium based on the early diagenetic behavior in the marine sediment is proposed.

Sampling and Methodology: Deep-sea core samples were collected by Multiple Corer. After collection, two cores were immediately transported to ship board laboratory and partitioned by 1 cm section after separated the overlying water.

Nutrients (nitrite, nitrate, silicate and phosphate) concentrations of the porewater samples were measured by BRAN+LUEBBE AACSII auto-analyzer after 3 ~ 5 times dilution with low nutrient seawater. Analytical procedure described in JGOFS protocols. Dissolved selenium species were determined with DAN-HPLC method (Hattori et al., 2001) after dilution with Milli-Q water. Total dissolved manganese and iron in the porewater samples were determined by inductively coupled plasma atomic emission spectrometry (ICP-AES). The sequential extraction method for the fractionated selenium in the sediment samples modified and developed the technique of Tessier et al. (1979), Xu et al. (1997) and Belzile et al. (2000) (detailed in Hattori et al., in preparation).

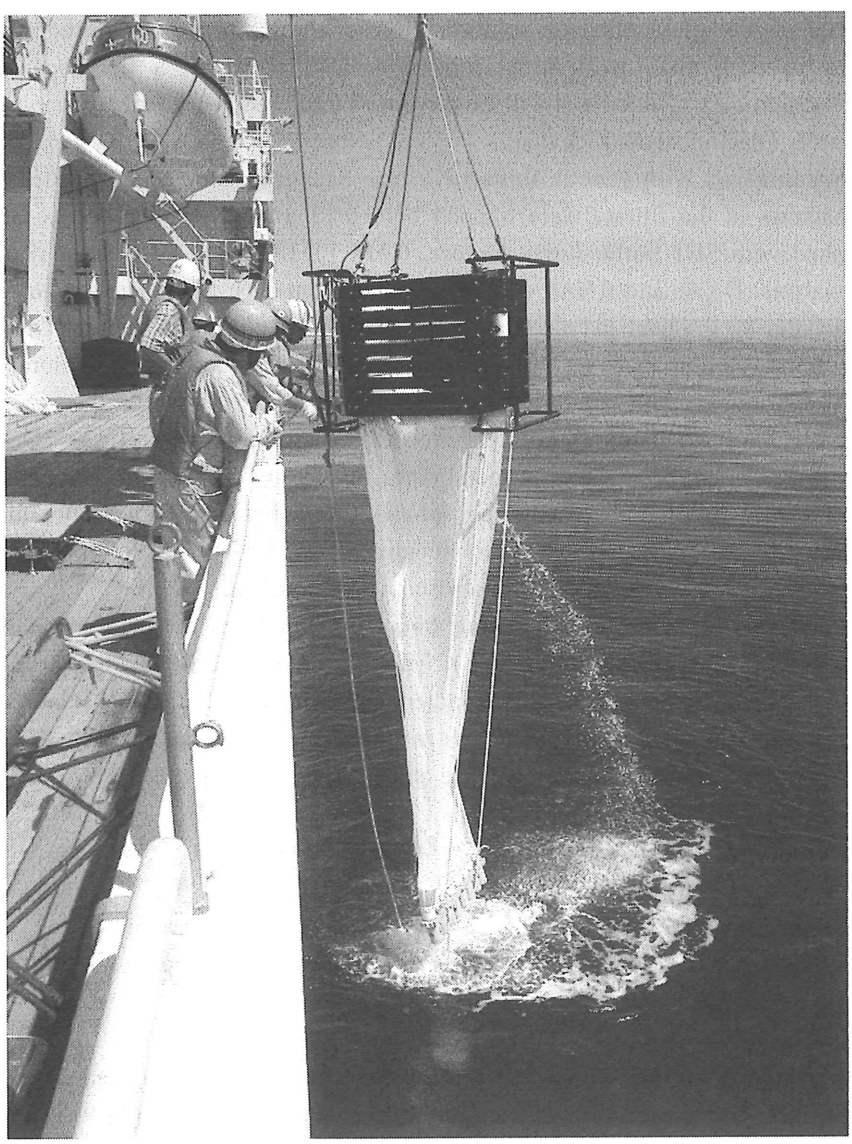

Photo : Retriving the brand-new plankton sampler, the VMPS-6000. (Taken by J. Nishikawa.)

10. Biological oceanography and biodiversity studies

10-1. Ecological studies of marine microbes in the Sulu and Celebes Seas

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It has been about one hundred years since microscopic organisms were shown to be abundant in marine environments. In the late 1970s, the advent of fluorescence microscopy helped us to learn that a huge abundance of microbes existed in the oceans. This has brought into the focus of interest of biological oceanography microbial roles closely related not only to organic disintegration but also to biological production in the oceans. We took seawater samples with 11-litre Niskin samplers empowered by CTD-CMS system at Stns. 1, 2, 4, 9, 11, 14, 17 and the following studies were conducted during the research cruise of KH-02-4. To the best of our knowledge, little is known about vertical distribution of microbes in the Sulu and Celebes Seas. The objectives of our studies are aimed at disclosing carbon biomass of marine microbes; e.g. virus, bacteria, heterotrophic fragellates and ciliates, and community structures of bacteria in these interesting areas.

Distribution of marine microbes; virus, bacteria, heterotrophic fragellates and ciliates: Water samples for protozoan enumeration were fixed with alkaline lugol-formalin solution. Samples for virus and bacteria were fixed with paraformaldehyde -glutaraldehyde solution. Both of the samples were stored at a cold room and the enumerations of each taxon will be performed at ORI by using a fluorescence microscope and flow cytometer. The numbers of microbes will be converted into carbon content by using a fluorescent microscope equipped with image-analysing device.

Microbial community structure analysis with genetic fingerprinting: Seawater samples were filtered by 3 μm nuclepore filters, and bacteria in the filtrate were trapped onto 0.22 μm sterilized Sterivex-GS filter units. Both filters were washed with SET buffer (20% sucrose, 0.1M EDTA and 0.1M Tris, pH7.6) and stored at –20℃ for genetic analysis. DNAs and RNAs will be extracted from each filter. The extracted nucleic acids will be brought to denaturing gradient gel electrophoresis (DGGE) with 16S ribosomal DNA (16SrDNA), one of the genetic fingerprinting analyses, in order to analyse the microbial community structure. We will examine vertical distribution both in microbial composition and microbial activity.

Direct counts of specific marine bacteria using fluorescent in situ hybridization technique: One hundred millilitres of waters were filtered onto polycarbonate membranes in order to collect bacterial cells. Trapped cells were fixed with 4% of paraformaldehyde in phosphate-buffered saline. Oligonucleotide probes complimentary to the unique sequences of some taxonomic groups will be applied to the FISH technique. The numbers of each group will be estimated out of microscopic observation.

Density gradient centrifugal cell sorting (DGCS) of marine bacteria: Ten litres of surface waters were concentrated onto the disposable filter unit (Sterivex-GS). Trapped cells will be detached and removed with ultrasonic waves, and led to percoll density gradient centrifugal cell sorting. Natural assemblages of bacteria can be separated into some banding patterns in a centrifuge tube. Each band will be taken out and applied to further experiments, mainly flow cytometric analyses.

10-2. Phytoplankton population dynamics and primary productivity in the Sulu and Celebes Seas

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Introduction: During the R/V Hakuho-Maru KH-00-1 cruise in Jan-Feb, 2000, we investigated spatial variations in phytoplankton composition and distribution of transparent exopolymer particles (TEP) in the Sulu Sea. TEP are sulfated polysaccharide particles formed from dissolved organic precursors such as extracellular organic compounds released from phytoplankton, and have a role in aggregation of sinking particles. The observed results indicated that phytoplankton assemblage consists of wide-variety of phytoplankton groups from photosynthetic prokaryotes, which typically occur in oligotrophic waters, to diatoms, which are major contributors to production in coastal waters. We also found uniform distributions of TEP concentration in the water column between the bottom of euphotic zone and 4000 m depth. Based on the above preliminary results, investigations into the dynamics of the phytoplankton community and primary productivity during the R/V Hakuho-Maru KH-02-4 cruise focused on three main topics: Why phytoplankton assemblages in the oligotrophic Sulu and Celebes Seas have large spatial variations? Do spatial distributions of micronutrients such as iron play a role in the variability of phytoplankton distribution and their composition?; Is biological and chemical reactivity of TEP slow enough to explain their high concentration and homogenous distribution in the deep water?

Phytoplankton productivity in the upwelling area near the Sulu Islands: According to the ocean color remote-sensing data, chlorophyll *a* concentrations around the center of the basin in the Sulu Sea show some seasonal variations, and its concentration range is intermediate between that of subtropical North Pacific waters and Kuroshio counter current area. From its relatively low phytoplankton standing stocks, the central part of the basin in the Sulu Sea could be regarded as an oligotrophic area. On the other hand, higher concentrations of chlorophyll *a* are usually observed in the waters near the Sulu group of Islands, Visaya Islands and Palawan Island. These high chlorophyll *a* waters are occasionally extending over the central part of the basin. High chlorophyll *a* water near the Sulu Island can be seen throughout the year and have temperature lower than that of surrounding waters, indicating upwelling of subsurface water due to topographical features near the islands. The extension of cool, chlorophyll-rich water to the basin area seems to be one of the factors causing spatio-temporal variability in phytoplankton production in the Sulu Sea. The object of this study was to understand the differences in photosynthetic parameters, primary productivity and phytoplankton community structure between the upwelling area near the Sulu group of Islands and oligotrophic area in the Sulu Sea and adjacent Celebes Sea, in order to asses the effects of high chlorophyll *a* water on plankton productivity in the Sulu Sea. During KH-02-4 Leg.1, Rosette/CTD casts were taken along transect between St. 3 in the Celebes Sea and St. U-4 near the Sulu group of Islands. From these casts, samples were taken in the surface 200 m for chlorophyll *a* (fluorometry), phycoerythrin (in vivo glycerol-uncoupling fluorescence), plant pigments (HPLC) and species composition (microscopic counts), and from all depths for nutrients (nitrate, nitrite, phosphate, and silicate; measured by Y. Yamaguchi and Y. Arii, Kinki Univ.) and total iron. Samples were also taken from 10 m and chlorophyll maximum layer for measurement of P vs E curve by ^{14}C method. Along the transect line, from the on-board continuous seawater supply, samples were taken every 10 min for nutrients and chlorophyll. Primary productivity was also measured at St. 1 in the western North Pacific and St. 4 in the Sulu Sea for comparison. Low temperature and high nutrients condition was observed at St. U-4 near the Sulu group of Islands (Fig. 1), indicating supply of subsurface water (around 50 m depth) to near surface due to eastward surface current from the Sulu group of Islands to the Celebes Sea and/or a northward current along the steep continental slope near the islands. Vertical cross-section of water temperature also indicates weak upwelling near 200 m depth at St. U-3. Maximum chlorophyll was found at St. U-2, 15 km east of active upwelling (or vertical mixing) area. Microscopic observation of these high chlorophyll waters showed the dominance of chain-forming large centric diatoms. Together with the data on phytoplankton species composition and P vs E curves, we will address the importance of these chlorophyll-rich waters in phytoplankton population dynamics and primary productivity in the Sulu and Celebes Seas.

Spatial variability in phytoplankton composition in the Sulu Sea and adjacent waters: Water samples were collected from surface to 200 m depth at stations 1, 2, 3, 4, 6, 10 and 17 for taxon-specific phytoplankton accessory pigment analysis by high-performance liquid chromatography (HPLC) to estimate the abundance of major phytoplankton groups. Samples were filtered (Whatman GF/F) and frozen in liquid nitrogen for onshore analysis. Pigment data will be analyzed using the ChemTax program (Mackey et al. 1996) to estimate the abundance of specific taxonomic groups of algae relative to the total chlorophyll *a* present. Samples were also taken for chlorophyll *a* (fluorometry), phycoerythrin (in vivo glycerol-uncoupling fluorescence), and species identification and cell counts (microscopic counts and flow cytometry). Surface water samples were obtained for Diazotrophic cyanobacterium *Trichodesmium* study at each stations in the Sulu and Celebes Seas. *Trichodesmium* colonies were isolated and incubated in culture media placed in running seawater bath to establish a laboratory culture collection. Isolated colonies were also filtered onto membrane filters and kept frozen for future pigment and chemical analyses. There were few *Trichodesmium* colonies in the Sulu Sea, usually 2 colonies in one liter of surface water, while higher numbers of *Trichodesmium* colony were observed in the Celebes Sea. Under calm weather condition, we also found accumulation of large diatom *Rhizosolenia* sp. at the sea surface, but endosymbiont *Richelia* was not recognized in the cell under the microscopic observation.

Spatial distribution of transparent exopolymer particles (TEP) in the Sulu and Celebes Seas: TEP are sulfated polysaccharide particles that are not visible unless specifically stained by Alcian Blue (Alldredge et al., 1993). TEP are formed from organic precursors less than 0.2 μm and form the mucus matrix of most marine snow. Based on vertical distributions of TEP in the Sulu Sea observed during the KH-00-1 cruise, it becomes pertinent to obtain more data on spatio-temporal variations of TEP in the Sulu Sea and adjacent waters to elucidate why the deep water concentrations of TEP, which formed in the surface layer from DOM excreted from phytoplankton, are so high and uniform in the Sulu Sea. During this cruise we collected TEP samples from rosette/CTD casts from surface to the bottom at stations1, 2, 3, 4, 6, and 10. TEP were collected onto 0.4 μm Nuclepore filters, stained with Alcian Blue. The dye complexed with TEP was then dissolved in acid and measured spectrophotometrically onboard Hakuho-Maru. We deployed sediment trap mooring at St. 2 in the Celebes Sea and St. 4 in the Sulu Sea to estimate the sinking flux of TEP in these areas. Each trap mooring had four simple cylinder type traps at 50 and 150 m, and a conical time-series trap at 300 m. Sinking particles were fixed in formalin and zooplankton swimmers were removed before analysis of TEP. Deep-water incubation experiments were performed using 500 and 4500 m water samples collected at St. 10 in the Sulu Sea. Time series variation in TEP concentration was monitored to asses the biological degradation of TEP in the deep water.

Chemical speciation of iron in seawater and its distribution in the Sulu and Celebes Seas: Iron in seawater exists as particulate form (such as plankton, detritus and inorganic mineral), and dissolved form (such as organic and inorganic colloids, organic and inorganic complexes, and free inorganic ions). Amounts of each chemical forms changes due to the chemical processes (e.g. coastal and atmospheric inputs, precipitation of iron hydroxide, aggregation of colloids, photochemical reduction) as well as biological processes (e.g. iron uptake and release of organic ligands by phytoplankton and bacteria, grazing and excretion by zooplankton, cell lysis by virus). Marine phytoplankton have been generally supposed to only acquire the free ion chemical species, while some of the prokaryotic phytoplankton, which have a wide distribution in the subtropical and tropical oligotrophic waters, are now known to have ability to obtain iron bound to natural organic ligands like siderophores. Thus, spatial distributions of iron and its chemical species may play a role in the variability of phytoplankton assemblage in the Sulu and Celebes Seas. During the KH-02-4 cruise, water samples were collected in waters with wide variety of phytoplankton assemblage at St. 1 in the western North Pacific, St. 2 in Celebes Sea, St, 4, 5 and 10 in Sulu Sea, and St. 17 in South China Sea for analyses of dissolved iron and natural organic iron ligand concentrations in the water column from 5 to 5000 m depth using trace metal clean techniques. Seawater samples were passed through 0.22 μm Durapore PVDF membrane filter unit (Millipak 100, Millipore) attached directly to trace metal clean Niskin-X sampling bottles. Filtered seawater samples for dissolved Fe analysis were acidified to pH <2 with quartz-distilled HCl. The water samples will be stored for more than one month and then analysis of iron (III) concentration will be done by a chelating resin concentration and chemiluminescence detection method. Concentration of natural organic iron ligands was measured using competitive ligand exchange-cathodic stripping voltammetry with the ligands TAC (2-(2-Thioazolylazo)-p-cresol). Samples obtained from 10, 100, 500 and 2000 m depths were determined on board in a class-1000 clean room. Other filtered seawater samples were stored frozen under –20°C, and will be analyzed in onshore laboratory. Iron (III) speciation will be estimated from measured concentrations of total dissolved iron and iron binding organic ligands, and conditional stability constants.

10-3. Phytoplankton community structure in the Sulu Sea and adjacent areas

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Phytoplankton community structure was investigated in the Sulu Sea and adjacent areas on board the RV *Hakuho Maru* (Cruise No. KH-00-1) during January and February 2000, and spatial diversity of phytoplankton community composition was observed. In the present study, the information of phytoplankton size composition will be added to understand community structure of phytoplankton intensively. Sampling was conducted at Stn.1, 2, 3, 4, 6, 10, 17. Seawater samples were collected from 10-12 layers in the water column above 200 m depth. Analyses described below will be conducted.

Estimate of phytoplankton community composition using marker pigments: Between 2 and 3.5 l of seawater were filtered through Whatman GF/F filters. The filters were blotted and frozen in liquid nitrogen, stored in freezer at -84℃ for return to Japan. Lipid photosynthesis pigments of phytoplankton will be separated and quantified using the high performance liquid chromatography (HPLC) method[1]. After determination of each pigment, the contributions of each algal class to total chlorophyll *a* will be estimated by the CHEMTAX program[2] using marker pigments.

Size composition of nano- and pico- phytoplankton: 4.90 ml of seawater were fixed with 0.10 ml of 50% glutaraldehyde, frozen in liquid nitrogen, and stored in freezer at -84℃ for return to Japan. Size composition of nano- and pico- phytoplankton will be analyzed by flowcytometer.

Microscopic observation: 50 0ml of seawater were fixed with acetic Lugol solution and stored at room temperature for return to Japan. These samples will be concentrated and, key phytoplankton species will be identified and enumerated.

References

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10-4. Biological and ecological studies on zooplankton and micronekton in the Sulu Sea and its adjacent seas

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The Sulu Sea is a semi-enclosed equatorial basin, rimmed by sills shallower than ca. 400 m, and is characterized by a homogeneous, warm (ca. 10 °C) water from the mesopelagic zone to the sea bottom of ca. 5000 m, while the adjacent seas, i.e. the Celebes Sea and the South China Sea show more 'normal' oceanic conditions. Although the pelagic communities in the Sulu Sea may have unique characteristics in biodiversity, biomass/abundance, vertical structure, and genetic composition under these 'special' hydrographic conditions of meso- and bathy-pelagic layers, little knowledge have been accumulated. In this cruise the following studies have been made in relation to the biology and ecology of zooplankton and micronekton for better understanding of the pelagic ecosystems in the Sulu Sea and its adjacent seas.

Vertical distributions and biodiversities of meso- and macro- zooplankton: To clarify biomass/abundance, diversities, and vertical distributions of meso- and macro- zooplankton, oblique tows of a MOCNESS (mesh size: 0.33 mm) and vertical tows of a new VMPS (mesh size: 0.1 mm) was carried out. By the MOCNESS, plankton samples were collected from 16 discrete layers in the upper 1000 m both day and night at staions in the Pacific Ocean (Stn 1), Celebes Sea (Stn 2), Sulu Sea (Stn 4), and South China Sea (Stn 16). The VMPS samplings are designed to collect smaller zooplankton and to cover deeper layers (down to 3500 m). Seven discrete layers both day and night were sampled at stations in the Pacific Ocean (Stn 1), Celebes Sea (Stns 2, 3), Sulu Sea (Stns 4, 11), and South China Sea (Stns 16, 17). Samples collected by both gears were fixed with 10% buffered formalin/seawater solution, or a half of samples frozen for the later analysis. At stns 2 and 4, sediment trap experiments were carried out to know the quantitative and qualitative information of vertical flux (see Nagao and Minagawa, this volume), which will make comparison with the biodiversity of zooplankton together with other environmental factors.

Temporal variations in biomass and community composition of epipelagic plankton: Day and night plankton samples were collected in the Sulu Sea (11 stations) and adjacent Celebes (two stations) and South China Seas (two stations) to compare variations in epipelagic zooplankton density, composition, and biomass. Zooplankton samples collected using a Norpac-twin net (mesh size: 110 and 330 μm) from 0 to 200m were fixed immediately after collection in 10% buffered formalin/seawater solution. In the laboratory, the samples will be further fractionated using 200 μm and 2.0 mm mesh sieves, whenever appropriate, to obtain three size fractions. Composition (density per main taxonomic group) and biomass (dry weight) of each fraction will be determined.

Ecology of the deep-sea pelagic copepods of the genus *Euaugaptilus*: The calanoid copepods of the genus *Euaugaptilus* primarily inhabit the meso- and bathypelagic zones of the world oceans, and occur in low abundance and sympatrically with many congeneric species. Many species of *Euaugaptilus* have specialized sucker-like structure on the setae of their feeding appendages. These structure suggest a specialization in their food habit in the resource-limited deep sea. During the present cruise, the plankton samples were collected by oblique tows with either an ORI net (mesh size: 0.33 mm) or an IKMT net (mesh size: 1 mm). The specimens of *Euaugaptilus* spp. were sorted from the plankton samples and fixed in 2 % glutaraldehyde and 2.5 % paraformaldehyde (phosphate buffer, pH 7.4) at 4 °C, and frozen for later analyses of food habits and functional morphology. In the Sulu Sea, by the IKMT deep tows (7000 m wire out; ca. 2000 – 3000 m depth), 2 species of *Euaugaptilus* were collected, which is not collected in the upper 1000 m on the past cruise (KH 00-1). An analysis of the vertical distribution of *Euaugaptilus* spp. below 1000 m of the Sulu Sea is now in progress on the basis of the vertically stratified day-night series of samples taken by the VMPS.

Molecular phylogeny and population genetics studies of copepods: The Copepoda, one of the subclass of the phylum Crustacea, are one of the most diverse animals in the pelagic realm. In this study, we are going to analyze phylogenetic relationships of copepods (e.g. Oithonidae, Augaptillidae, Heterorhabdidae). In addition, we will carry out population genetics studies of the copepods, which inhabit both epi-pelagic and meso-pelagic waters. Samples of small, epi-pelagic copepods were collected by Norpac net and meso-pelagic copepods were collected by MOCNESS, IKMT, and ORI net. Samples were preserved by 99% ethanol and will be analyzed in the laboratory.

Fish larvae from epipelagic waters of Sulu Sea: Existing information on fish larvae in the Sulu Sea is limited to those occurring within the upper 1 m of the surface, owing to the Neuston Katamaran Plankton sampler used in previous surveys. Information from the current samples will provide a more complete characterization of larval fish groups in the epipelagic zone of the Sulu Sea, and is comparable with more recent data for other internal water basins of the country. Ichthyoplankton samples were collected at eleven stations located in the Sulu Sea and South China Sea during Leg II of the Cruise KH02-4. All samples were collected at night. The first set of samples were collected with the use of the ORI-Side net (mesh size: 0.33 mm) towed at the surface alongside the vessel for 15 minutes. The second set of samples were collected by means of oblique tows with an IKMT (mesh size: 1.0 mm) to depths of about 150 m, effectively covering the epipelagic zone. All samples were fixed in 10% buffered formalin/seawater solution and taken back to the laboratory for identification.

Micronektonic crustaceans: As major components of macrozooplankton and micronekton, the abundance, biomass, and species composition of the euphausiid, mysid and decapod crustaceans were investigated on the basis of the samples collected by a 10-ft IKMT. Immediately after collection larger (> ca, 1 cm) specimens of these crustaceans were sorted from the original samples and fixed and preserved in 5% formalin/seawater solution for taxonomic identification. Other smaller specimens will be sorted on land laboratory for further enumeration and identification.

Collection of hyperbenthic copepods with baited traps: During the deployment of the cage-type baited trap by the Benthos Group at St. 11, small bottle-type baited traps were attached to the main trap for collection of hyperbenthic copepods. The traps were made of plastic bottles (9-cm diam., 11.5-cm height) with either 2- or 5-mm pores on the top. Antarctic krill (ca. 20 g) was used as bait and were wrapped in a 20-μm gauze and put in each trap.The traps were filled with filtered (GF/F) seawater before deployment. Three 2-mm pore traps and three 5-mm pore traps were attached either to the frames or to the ropes between the frames of the main trap. A total of 11 copepods of the family Tharybidae were collected alive, of which 4 copepods were fixed in glutaraldehyde/formaldehyde (phosphate buffer, pH:7.4) for histology and the others were fixed in 5% formalin/seawater solution for taxonomic examination.

Accumulaltion of pollutants in deep-sea animals (cooperative with M. Yamaguchi, S. Ohta, S. Yeh, and K. Suetsugu): While considerable body of knowledge is available on the accumulation of pollutants in the animals, still little is known of the deep-sea animals and on the processes of accumulation through the food chain. To fill this gap representatives of deep-sea plankton and micronekton were collected for the analysis of levels of pollutants (heavy metals, PCBs, and BTs). Selected micronektonic crustaceans (decapods, mysids and euphausiids) and fishes were sorted form the fresh catch of the IKMT tows at Sts. 1-17. Samples representing lower trophic levels were obtained by sorting or sieving (0.33-5 mm fraction) mesozooplankters from the catches of the ORI-net or IKMT tows. Additional samples for deep benthic or demersal fauna were collected from the catches of a 3-m or a 4-m beam trawl (see reports of Benthos Group, this volume). All samples were identified or coded, put in a polyethylene bag, and frozen at ca. –85°C for chemical analyses on land.

10-5. Preliminary systematic studies on hyperbenthic/planktonic copepods and crustacean parasites infesting zooplankton/benthos in the Sulu Sea and the South China Sea

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Hyperbenthic copepods and crustacean parasites infesting zooplankton have rarely been investigated in the Sulu Sea and the South China Sea. Hence I preliminarily tried to collect these with several gears [IK midwater trawl (IKMT); ORE beam trawls (BT) (width 3, 4 m); ORI net (mesh size 0.3 mm); NORPAC nets (mesh size 0.1, 0.3 mm)]. A brief examination during the cruise (KH-02-4 Leg 2: December 2-18, 2002) revealed the following things. Hyperbenthic calanoids and misophrioids were collected with the BT and IKMT. Four undescribed species of truly hyperbenthic arietellids (Calanoida) were collected at St. 13: *Paraugaptiloides* sp., *Sarsarietellus* sp., and two undescribed genera. *Metacalanus* sp. (Arietellidae) and Misophrioida sp. were also captured from the near-bottom at St. SA-2 (about 400 m deep) with the BT. At Cebu two species of the genus *Pseudodiaptomus*, which are known to migrate upward at night, were collected, using an underwater light. Three mesoparasitic pennellid copepods were found on deep-sea pelagic fishes at Sts. 14 and 16 (Dr. M. Yamaguchi, personal communication). Two unknown parasitic epicaridean isopods infesting euphausiids and benthic decapods both were collected at St. 15, using the BT. Further detailed examination of samples taken at nine stations in the Sulu Sea and the South China Sea may provide us with more taxonomic and zoogeographical information on hyperbenthic copepods and crustacean parasites.

In addition the primitive calanoid copepod superfamily Arietelloidea were collected for molecular phylogenetic studies, using the IKMT/ORI net. In particular, since the phylogeny of the deep-sea pelagic calanoid family Heterorhabdidae belonging to the superfamily, which accommodate both suspension-feeders and carnivores with intermediate types, is constructed on the basis of the morphology (Ohtsuka et al., 1997), we have an intention to reconfirm it based on molecular techniques. Almost all heterorhabdid genera *Disseta*, *Mesorhabdus*, *Heterostylites*, *Hemirhabdus*, *Neorhabdus*, and *Heterorhabdus*, except for an enigmatic deep-sea genus *Microdisseta*, were collected during this cruise, and their mtDNA will be analyzed in the future

10-6. Spatial and temporal fluctuation of the surface layer biomass in the Sulu Sea measured by acoustics

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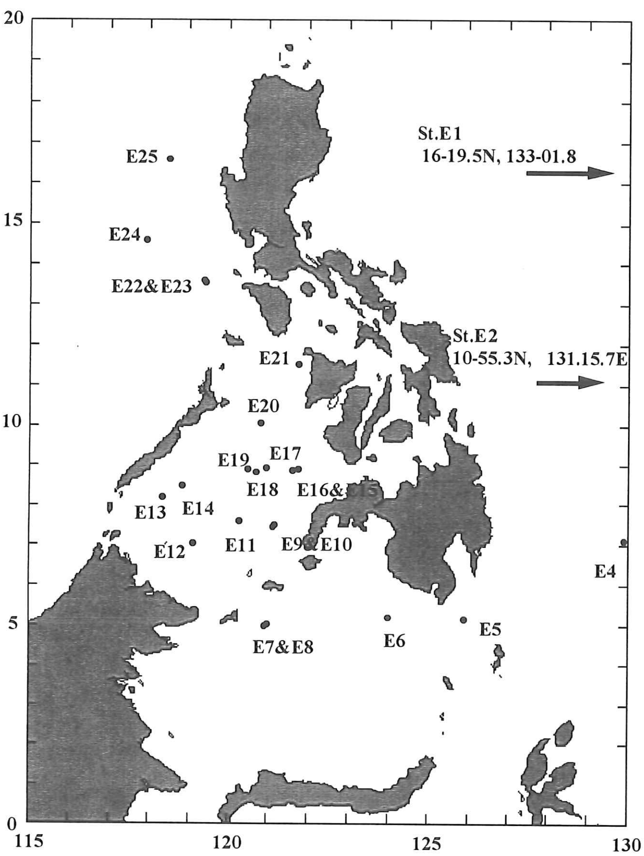


Figure 1. Locations of IKMT (IK-E) stations.

Analysis of the biomass fluctuation in the surface layer (0-200 m) where leptocephali are most abundant at night was carried out using acoustic measurements. These acoustic measurements were made continuously along the cruise track in the Sulu Sea (see the track chart). In addition, acoustic measurements were also made in the Pacific Ocean, Celebes Sea and South China Sea for comparison. The zooplankton and micronekton that migrated up into the surface layer at night were collected with the IKMT (IK-E: 500 m or 600 m oblique).

The equipment used for the acoustic measurements were the FQ80 (38 and 70 kHz, split beam type: Furuno) and the FQ81 (120 and 200 kHz, ideal beam type: Furuno). The acoustic data acquired by these four frequencies is analyzed as a relative fluctuation of the biomass. Inaddition, the size distributions of the organisms that make up the scattering layers can be estimated by comparing the SV of the different frequencies.

Examples of the results of these acoustic measurements are shown in Figs 1 and 2.

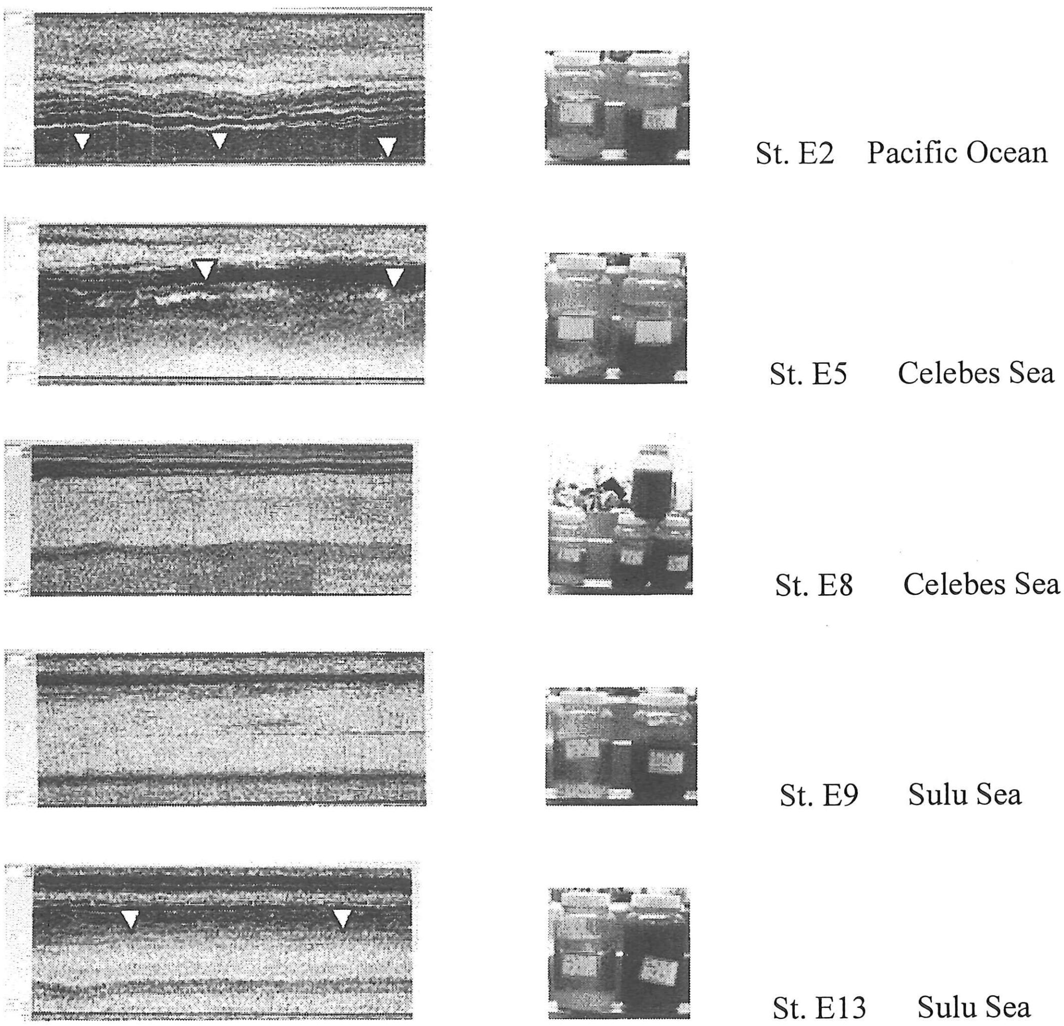
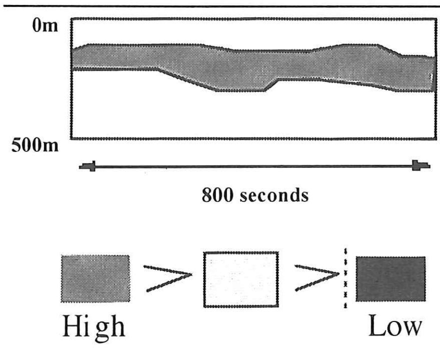


Figure 2. Examples of the 38 kHz echo sounder image at IKMT (IK-E) operation points and the organisms that were collected (right side: IK-E, left side: ORI-side) in Leg 1.



Echo sounder image: the vertical axis shows sea depth 0 m to 500 m and the horizontal axis shows elapsed time. In the actual image display, the intensity of the biomass is shown by the color.
In this report, the intensity of the biomass is shown as light and dark. However, the biomass is low for the most dark parts shown by the ▽.

10-7. Leptocephali collected in the Sulu Sea and surrounding regions

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Introduction: A total of 2,595 leptocephali of at least 17 families of eels and their close relatives were collected in the Sulu Sea and surrounding areas during the KH-02-4 cruise (Figure 1, Table 1). The family Congridae was the most abundant (N = 1,570), followed by the Ophichthidae (N = 351), Muraenidae (N = 334) and the Chopsidae (N = 111). Leptocephali of a variety of other families of anguilliform eels were collected in small numbers, along with some of the other orders of fishes that have a leptocephalus larva. The leptocephali of the catadromous eels of the family Anguillidae were genetically identified after the cruise. In this paper we briefly report on the species identifications and catch locations of the anguillid leptocephali collected during the cruise, which included a specimen of *A. japonica* collected in the Celebes Sea, and briefly outline the catches of all types of leptocephali in relation to gear types and region.

Methods and materials: Leptocephali were collected with several types of gear that included the IKMT, ORI plankton nets and the beam trawl (Table 1). Most leptocephali were collected with the IKMT (8.7 m^2 mouth opening, 1 mm mesh) that was fished in the upper 200 m for targeting leptocephali (Figure 1), with

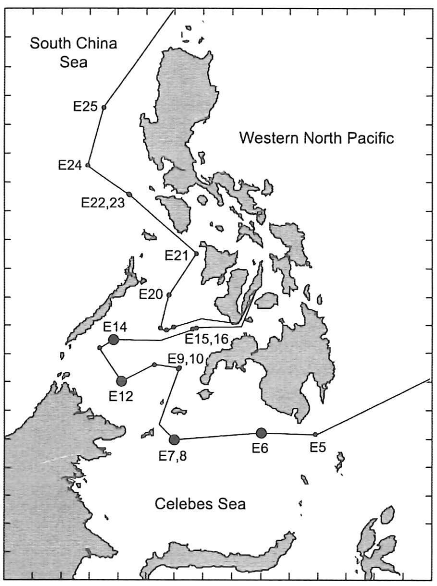

Figure 1. Map showing the locations of night tows of the IKMT that targeted leptocephali, and the catch locations of *Anguilla* leptocephali shown with the large black circles. Stations E1 – E4 in the western North Pacific are not shown. The lines between stations show the order of sampling but not the exact cruise track.

either 500 or 600 meters of wire (maximum depth: 117 – 201 m), or as incidental catches in tows that fished much deeper to collect mesopelagic fishes. Some leptocephali were also collected with the ORI net (2.0 m^2 mouth opening, 0.69 mm mesh) fished at the surface next to the side of the ship or in deep oblique tows, and a leptocephalus was collected incidentally by the beam trawl.

The IKMT was fished for leptocephali during nighttime at 25 stations in the western North Pacific, Celebes Sea, Sulu Sea, and South China Sea (Figure 1). It was also fished in deep oblique tows at most of the other designated stations during the cruise. Most leptocephali were identified on board before preservation and identified to the lowest possible taxonomic level following Tabeta and Mochioka (1988) and Böhlke (1989). The specimens of the freshwater eels of the family Anguillidae (genus *Anguilla*) were tentatively identified on board while fresh and then preserved in 99 % ethanol for subsequent genetic identification in the laboratory using the methods described by Aoyama et al. (2001).

Results and discussion: A total of five leptocephali the genus *Anguilla* were collected in the Celebes and Sulu Seas during KH-02-4. A 27.2 mm TL longfin species of *Anguilla* was collected at St. E6 in the northeast Celebes Sea, which could have been either *A. marmorata*, *A. celebesensis*, or *A. borneensis* based on morphology because of the overlapping characteristics of tropical anguillid species. Subsequent genetic identification confirmed that this leptocephalus was *A. borneensis*. Two anguillid leptocephali were also collected at St. E8 in the northwest side of the Celebes Sea. Interestingly, one of these leptocephali had the meristic and morphological characteristics that only matched *A. japonica* (Figure 2).

Table 1. The number of leptocephali of the different families of eels of the order Anguilliformes and of the other orders of fishes of the superorder Elopomorpha that were collected with different types of gear and towing methods. The IKMT was fished in shallow oblique tows with 500 or 600 m of wire or with 2000-7000 m of wire (IK-DO). The ORI net was fished at the surface next to the ship (ORI-S), in deep oblique tows to various depths (ORI-DO). The life history style of each taxa is indicated as either catadromous (CT), shelf or shallow water (SH), slope (SL), or oceanic (OC), which live in the meso- or bathy- pelagic zones.

Order/Family		IK-O(500m)	IK-O(600m)	IK-DO	ORI-S	ORI-DO	BT	Total
Anguilliformes								
Anguillidae	CT	4	2					6
Congridae	SH	752	137	151	497	33		1570
Chlopsidae	SH	74	16	18		3		111
Derichthyidae	OC	1						1
Moringuidae	SH	12	3	3		3		21
Muraenidae	SH	217	21	42	18	35	1	334
Nemichthyidae	OC	33	10	9	2	3		57
Nettastomatidae	SL	22	1	6				29
Ophichthidae	SH	263	23	40	15	10		351
Serrivomeridae	OC	38	11	8	1	2		60
Synaphobranchidae	SL	6		4		2		12
Other Orders								
Cyematidae	OC	1						1
Eurypharngidae	OC	1						1
Notacanthiform	OC	4		2				6
Elopiform	SH	28		3	1	2		34
Not Identified						1		1
Total		1456	224	286	534	94	1	2595

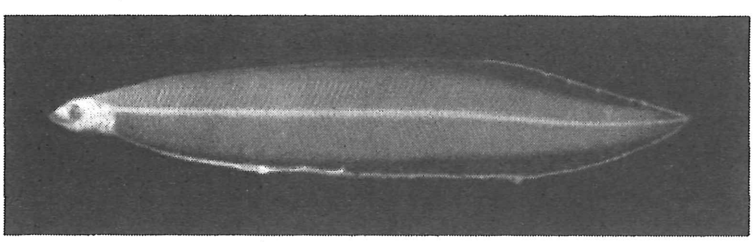

Figure 2. A 42.8 mm *Anguilla japonica* leptocephalus that was collected at St. E8 on 19 November 2002 in the northwest Celebes Sea.

This 42.8 mm leptocephali had 115 total myomeres (TM) and about 9 ano-doral myomeres, which meant it was a longfin species. Therefore based on morphology, this leptocephali appeared to be *A. japonica* (TM: 112 – 119). The only other species in the region that almost have such a high range of TM are the shortfin leptocephali of *A. bicolor pacifica* (TM: 103 – 111) or *A. bicolor bicolor* (TM: 106 – 114), but it is north of the known range of the latter subspecies. However, subsequent genetic identification confirmed that this leptocephalus was indeed *A. japonica*. The other leptocephalus collected at St. E8 was a 46.3 mm leptocephalus that was undergoing the process of metamorphosis into the glass eel stage and was genetically identified as *A. bicolor pacifica*. During this process the gut and dorsal fin move forward, the teeth are lost, the body thickens, and a pigment patch forms on the tail. This specimen had all these characteristics (Figure 3).

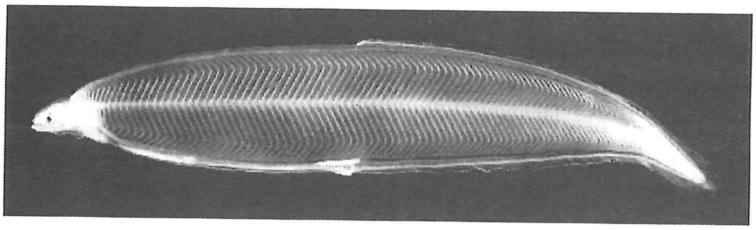

Figure 3. A 46.3 mm metamorphosing *Anguilla bicolor pacifica* leptocephali collected at St. E8 on 19 November 2002 in the northwest Celebes Sea.

Two other fully grown anguillid leptocephali were collected in the southwestern Sulu Sea, where none have been collected before. No anguillid leptocephali were collected in the eastern Sulu Sea during the KH-00-1 cruise that sampled there in February (Aoyama et al., 2003), and none were collected in the Sulu Sea in 1929 except at one station at the far northern margin close to the Philippines (Jespersen 1942). During KH-02-4 there was a 49.1 metamorphosing *A. borneensis* leptocephalus collected at St. E12 (see the *A. bicolor pacifica* in Figure 3) and another 48.3 mm *A. borneensis* leptocephalus was collected at St. E14 in the Sulu Sea (Table 2).

Table 2. Catch locations and morphological characteristics of the anguillid leptocephali that were collected in the Celebes (St. E6 and E8) and Sulu Seas (St. E12, E14) during the KH-02-4 cruise. Two specimens were metamorphosing (meta).

Station	Date	Net	Total length (mm)	TM	Species
E6	15-Nov-02	IK-O	27.2	107	*Anguilla borneensis*
E8	19-Nov-02	IK-O(600)	42.8	115	*Anguilla japonica*
E8	19-Nov-02	IK-O(600)	46.3	105	*A. bicolor pacifica* (meta)
E12	22-Nov-02	IK-O	49.1	103	*Anguilla borneensis* (meta)
E14	24-Nov-02	IK-O	48.3	102	*Anguilla borneensis*

The collection of an *A. japonica* leptocephalus in the Celebes Sea is the first record of this species outside of its typical larval transport and recruitment area. Based on the distribution of the small leptocephali of *A. japonica*, this species has been found to spawn within the westward flowing North Equatorial Current (NEC), somewhere near or to the west of seamounts of the West Mariana Ridge (Tsukamoto, 1992; Ishikawa et al., 2001). Most of the leptocephali of this species collected near the spawning area have been between a relatively narrow range of latitudes from about 12 – 17°N (Tsukamoto et al., 2003), which corresponds to the typical latitude of the main part of the NEC (Reverdin, 1996; Kawabe and Taira, 1998; Kaneko et al., 1998). However, the southern part of the flow of the NEC separates from the rest and flows to the south to form the Mindanao Current, which then flows into the Celebes Sea (Toole et al., 1990; Wijffels et al., 1995; Qu and Lukas, 2003). The leptocephalus collected in the Celebes Sea must have failed to enter the northward flowing branch of the NEC that flows into the Kuroshio Current and was entrained into the Mindanao Current and then into the Celebes Sea. The possible mechanisms influencing how the leptocephali of the Japanese eel may entrain primarily into the Kuroshio system have been discussed (Kimura et al., 1994, 1999) as well as the effects of changes in the ocean-atmosphere system (Kimura et al., 2001). However, this specimen of *A. japonica* collected in the Celebes Sea provides the first definitive evidence that the leptocephali of this species may sometimes fail to recruit after being entrained into the Mindanao Current.

In addition to *Anguilla*, the distribution and ecology of the leptocephali of the marine eel families collected during the cruise also will be analyzed, but there were some clear patterns apparent in the catch data. For example, the numbers of leptocephali were lowest in the western North Pacific and to the south of Mindanao Island, where less than a total of 30 leptocephali were collected at five stations combined. In contrast, 43 - 53 leptocephali were collected at each station in the Celebes Sea and 44 - 170 were collected at each station in the Sulu Sea. There were also some differences in species composition between areas, such as *Ariosoma* being more abundant in the Sulu Sea than other areas, and *Serrivomer* being most abundant in the South China Sea and almost completely absent in the Celebes and Sulu Seas.

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10-8. A sampling journey: collection building for the study on natural history, new style

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Objective of the collection building: The collection building, which mean the accumulation of the evidence at the moment from the nature, is the most important activity for the study on natural history. For a marine life, we already have some large scale collections around the world. These collections were made by many famous expedition cruises (*e.g. Challenger*, *Garathea*, *Dana*, *Albatross etc.*) and have been completely managed until now. However, we have felt the limitation of these collections for the study with developing the methodology for natural history during the past decade. The most characterized proceeding is the development and generalization of molecular biological techniques. Recently, we use the molecular data, mainly DNA data, for describing the population structure, estimating the phylogeny, and so on. Unfortunately, for these new style of the studies, great collections described above are quite unsuitable because almost all specimens were fixed by formaline, which break DNA. So, our primary objective of the collection building is accumulating the specimens of marine organisms, mainly deep-sea fishes, for the new style study of natural history. In this cruise, we could successfully collect the specimens for the purpose. The specimens in the collection made by this cruise will be identified, catalogued, and utilized for the studies. Brief summary of the collection are described below.

Midwater fishes: The pelagic zone in the ocean occupy about 70% area on the earth. In this zone, midwater layer has the most rich fauna and this mean that understanding the history of faunal formation in this layer is important for understanding the oceans. During the cruise, we could collect some thousands individuals of midwater fishes. These specimens may utilized for molecular phylogeographic studies.

Solivomer arenidens: This species is classified into the family Neoscopelidae, which is comprised the three genera *Neoscopelus*, *Scopelengys*, and *Solivomer*. Among these genera, only *Solivomer* is the monotypic and show endemic pattern of distribution. *Solivemer arenidens* was described at 1947 (Miller, 1947) based on the specimen collected from the Sulu Sea and has been reported exclusively from this area. Because it is supposed that the evolutionary history of *Solivomer* may be related to the geographic history of the Sulu Sea, estimation of divergence time between *Solivomer* and its sister species based on the molecular clock is interested. In this cruise, we could get the nine specimens of *Solivomer*. These specimens may be the first collection utilizing for the molecular work. The molecular phylogenetic work on this species may light on the question of geographic history of the Sulu Sea. On the other hand, one of the author (MY) will study some basic biological aspects (*e.g.* morphology and ecology) on this rare species.

Rabitfish sampling: The following ten species (47 individuals), all members of family Siganidae, were collected at the local fish market in Cebu City: *Siganus canaliculatus*, *S. argenteus*, *S.* sp. (Japanese name is Sedaka-hana-aigo), *S. guttatus*, *S. virgatus*, *S. corallinus*, *S. puellus*, *S. punctatissimus*, *S. punctatus*, *S. vulpinus*. In addition, one individual, which is inferred as the natural hybridize individual between *S. punctatissimus* and some other species, was collected. These will be utilized for molecular phylogenetic analyses.

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10-9. Comparisons of diversity and community structures of protozoan and metazoan meiofauna from the Celebes, Sulu and South China Seas

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Introduction: Spatial variations in deep-sea species diversity represents an integration of ecological and evolutionary processes that operate at different spatial scales, namely 1) Global scale, 2) Regional scale, and 3) Local scale (Levin et al. 2001). While local-scale patterns are regulated by local-ecological processes, those at regional scales are regulated by both Local/regional process, the latter including evolutionary components (Tokeshi, 1999).

One of factors that are expected to regulate regional scale patterns of organisms compositions is water mass. For example, there are bathymetrical patterns in species composition of demersal fish in Pacific Ocean side of Japan, on the other hand, no bathymetrical pattern could be seen in Sea of Japan, where environmental factors are homogeneous spatially (Yeh, 2001). Thus, the author hypothesizes that water mass regulates species composition of demersal fish and expects that there are few bathymetrical zonations in species composition of demersal fish in Sulu Sea because of uniformity of bottom water temperature, salinities and DO levels below 1000 m (personal communications).

In case of benthic foraminiferans, however, significant faunal differences exist at different water depths in the Sulu Sea basin despite of the uniformity of environmental factors (Rathburn & Corliss, 1994). Furthermore, species components of the organisms are different from those in South China Sea. Faunal differences appear to result from those of the bottom-water temperatures (Rathburn et al., 1996).

Although we do not have any systematic information about spatial patterns of the other organisms in the Sulu Sea for the time being, spatial patterns of different taxa should be regulated by different environmental/evolutional factors at different scales. Thus, we need to investigate vertical/horizontal patterns of diversity and species composition of various megafaunal, macrofaunal, and meiofaunal taxa around the Sulu Sea, and their relationships with environmental factors (primary production: temperature: salinity: oxygen level, etc.) to identify common or similar process regulating these spatial patterns. In this study, we will focus on communities of benthic copepods and foraminiferans, which are dominant groups in meiofauna. Especially, in case of foraminiferans, their DNA sequences will be compared between species from different sites.

Materials & Methods: Sampling was conducted using a multiple corer (MC). Sampling locations and depths are listed in Table MC1.

Cores for analyzing meiofauna were sliced horizontally into 5 mm layers from top to 3 cm sediment depth and into 1 cm layers from 3 cm to 15 cm sediment depth to study their vertical distribution. The sliced sediment samples were fixed immediately and preserved separately in 5 % neutralized seawater formalin. Rose Bengal (0.5 g/l) was added to this solution to stain the samples. For the DNA analyses of benthic foraminiferans, top sediments of cores were packed into plastic bags and stored in refrigerators, or fixed by 70 % ethanol. Researchers and analyses for the cores are listed in table MC2.In laboratory, these samples will be investigated as soon as possible.

Table MC1. Locations and depths of multiple-corer-sampling stations

Station	Cast Name	Date	Latitude	Longitude	Depth* (m)	W. O. (m)	Characters
1	PH-1aMC	Nov. 12	7 ° 02.66	129 ° 59.10	*5510*	5575	silty clay
1	PH-1bMC	Nov. 13	6 ° 59.50	129 ° 59.14	*5503*	5569	silty clay
2	CE-1aMC	Nov. 16	5 ° 11.01	124 ° 04.87	*4488*	5204	silty clay
2	CE-1bMC	Nov. 17	5 ° 11.84	124 ° 04.63	*4730*	5209	silty clay
3	CE-2MC	Nov. 18	5 ° 00.37	121 ° 01.31	*3580*	4206	fine-sandy mud
4	SU-1MC	Nov. 20	7 ° 25.00	121 ° 12.63	*4135*	4635	silty clay
5	SU-2MC	Nov. 22	7 ° 33.80	120 ° 19.47	*3512*	4074	silty clay
6	SU-3MC	Nov. 22	6 ° 54.47	119 ° 10.30	*3032*	3059	calcareous ooze
7	SU-4MC	Nov. 23	8 ° 05.74	118 ° 21.65	*520*	534	calcareous ooze
8B	SU-5MC	Nov. 24	8 ° 07.64	118 ° 35.17	1042	1053	calcareous ooze
9	SU-6MC	Nov. 24	8 ° 23.25	119 ° 02.99	2028	2055	calcareous ooze
11	SU-8MC	Dec. 4	8 ° 49.99	121 ° 05.72	*3668*	3774	calcareous ooze
12	SU-9MC	Dec. 6	8 ° 46.90	120 ° 43.02	*3000*	2993	calcareous ooze
13	SU-10MC	Dec. 6	8 ° 57.39	120 ° 11.54	*1890*	1881	calcareous ooze
14	SU-11MC	Dec. 7	9 ° 58.88	120 ° 53.75	*1500*	1521	calcareous mud
15	SU-12MC	Dec. 8	10 ° 10.72	121 ° 27.69	*1077*	1095	calcareous mud
18	SC-1MC	Dec. 12	15 ° 34.38	118 ° 20.29	*4180*	4251	silty clay with volcanic ash

* Italic numbers and under-lined numbers denote depths measured with PDR, and Sea beam, resp
PDR sometimes showed error values when a pinger was active. Thus W.O. values appear to be mo
real values of the bottom depth.

Table MC2. List of researchers and analyses on core samples

Cast	Core Number	Depth of core	Researchers	Analysis	Storage of the sediment
PH-1aMC	1	4 cm	Nomaki & Shimanaga	Meiofauna	ORI. Univ. Tokyo
	2	4 cm	Minami	Bacteria	Hokkaido Tokai Univ.
	3	4 cm	Murayama	Grain size	Kochi Univ.
	4	4 cm	Minami	Bacteria	Hokkaido Tokai Univ.
	5	4 cm	Murayama	Grain size	Kochi Univ.
	6	4 cm	Nomaki	Culturing	ORI. Univ. Tokyo
	7				
	8	4 cm	Nomaki & Shimanaga	Meiofauna	ORI. Univ. Tokyo

Cast	Core Number	Depth of core	Researcher	Analysis	Storage of the sediment
PH-1bMC	1	44 cm	Minami	Porewater	Hokkaido Tokai Univ.
	2	45 cm	Nagao	Metal, Radionuclides	Hokkaido Univ.
	3	44 cm	Minami	Metal and Water content	Hokkaido Tokai Univ.
	4	44 cm	Murayama	Description/Physical propaty	Kochi Univ.
	5	No data	Nomaki & Shimanaga	Meiofauna	ORI. Univ. Tokyo
	6	No data	Nomaki	Culturing	ORI. Univ. Tokyo
	7	44 cm	Murayama	Grain size	Kochi Univ.
	8	No data	Nomaki & Shimanaga	Meiofauna	ORI. Univ. Tokyo

Cast	Core Number	Depth of core	Researcher	Analysis	Storage of the sediment
CE-1aMC	1	36 cm	Nagao	Metal, Radionuclides	Hokkaido Univ.
	2	36 cm	Nagao	Organic Components	Hokkaido Univ.
	3	36 cm	Yamaguchi	Selenium and Water content	Kinki Univ.
	4	36 cm	Murayama	14C	Kochi Univ.
	5	35 cm	Minami	Porewater	Hokkaido Tokai Univ.
	6	34 cm	Nomaki & Shimanaga	Meiofauna	ORI. Univ. Tokyo
	7	36 cm	Nomaki	Culturing	ORI. Univ. Tokyo
	8	37 cm	Murayama	Description/Physical propaty	Kochi Univ.

Cast	Core Number	Depth of core	Researcher	Analysis	Storage of the sediment
CE-1bMC	1	35 cm	Murayama	Description/Physical propaty	Kochi Univ.
	2	35 cm	Nomaki & Shimanaga	Meiofauna	ORI. Univ. Tokyo
	3				
	4				
	5	36 cm	Kato	Barium	Tokai Univ.
	6				
	7	No data	Nomaki	DNA analysis	ORI. Univ. Tokyo
	8	36 cm	Minami	Metal	Hokkaido Tokai Univ.

Cast	Core Number	Depth of core	Researcher	Analysis	Storage of the sediment
CE-2MC	1	31 cm	Nagao	Organic Components	Hokkaido Univ.
	2	32 cm	Nagao	Metal, Radionuclides	Hokkaido Univ.
	3	30 cm	Minami	Metal and Water content	Hokkaido Tokai Univ.
	4	32 cm	Minami	Porewater	Hokkaido Tokai Univ.
	5	32 cm	Murayama	14C	Kochi Univ.
	6	34.5 cm	Murayama	Description/Physical propaty	Kochi Univ.
	7	32 cm	Minami	Bacteria	Hokkaido Tokai Univ.
	8				

Table MC2. List of researchers and analyses on core samples (continue1)

Cast	Core Number	Depth of core	Researcher	Analysis	Storage of the sediment
SU-1MC	1	47.5 cm	Nomaki	DNA analysis	ORI. Univ. Tokyo
	2	46 cm	Nagao	Organic Components	Hokkaido Univ.
	3	48 cm	Nagao	Metal, Radionuclides	Hokkaido Univ.
	4	47 cm	Murayama	14C	Kochi Univ.
	5	48 cm	Minami	Porewater	Hokkaido Tokai Univ.
	6	47 cm	Nomaki & Shimanaga	Meiofauna	ORI. Univ. Tokyo
	7	49 cm	Murayama	Description/Physical propaty	Kochi Univ.
	8	48 cm	Minami	Metal and Water content	Hokkaido Tokai Univ.

Cast	Core Number	Depth of core	Researcher	Analysis	Storage of the sediment
SU-2MC	1				
	2	32 cm	Nagao & Murayama	Metals,Radionuclides/14C	Hokkaido Univ./ Kochi Univ.
	3	33 cm	Nomaki & Shimanaga	Meiofauna	ORI. Univ. Tokyo
	4	34 cm	Murayama	Description/Physical propaty	Kochi Univ.
	5	31 cm	Nagao	Metal, Radionuclides	Hokkaido Univ.
	6				
	7	32 cm	Nomaki	Culturing	ORI. Univ. Tokyo
	8				

Cast	Core Number	Depth of core	Researcher	Analysis	Storage of the sediment
SU-3MC	1	29 cm	Nomaki & Shimanaga	Meiofauna	ORI. Univ. Tokyo
	2	28 cm	Nagao	Metal, Radionuclides	Hokkaido Univ.
	3	29 cm	Nomaki	Culturing	ORI. Univ. Tokyo
	4	29 cm	Minami	Metal and Water content	Hokkaido Tokai Univ.
	5	29 cm	Murayama	14C	Kochi Univ.
	6	28 cm	Minami	Porewater	Hokkaido Tokai Univ.
	7	28 cm	Nagao	Organic Components	Hokkaido Univ.
	8	31cm	Murayama	Description/Physical propaty	Kochi Univ.

Cast	Core Number	Depth of core	Researcher	Analysis	Storage of the sediment
SU-4MC	1	29 cm	Minami	Porewater	Hokkaido Tokai Univ.
	2	29 cm	Murayama	14C	Kochi Univ.
	3	29 cm	Nagao	Organic Components	Hokkaido Univ.
	4	29 cm	Minami	Metal and Water content	Hokkaido Tokai Univ.
	5	31 cm	Murayama	Description/Physical propaty	Kochi Univ.
	6	29 cm	Nagao	Metal, Radionuclides	Hokkaido Univ.
	7	28 cm	Nomaki	Culturing	ORI. Univ. Tokyo
	8	28 cm	Nomaki & Shimanaga	Meiofauna	ORI. Univ. Tokyo

Cast	Core Number	Depth of core	Researcher	Analysis	Storage of the sediment
SU-5MC	1	29 cm	Nomaki	Culturing	ORI. Univ. Tokyo
	2	33 cm	Murayama	Description/Physical propaty	Kochi Univ.
	3	30 cm	Minami	Bacteria	Hokkaido Tokai Univ.
	4	31 cm	Nomaki & Shimanaga	Meiofauna	ORI. Univ. Tokyo
	5	30 cm	Murayama	14C	Kochi Univ.
	6	29 cm	Nomaki & Shimanaga	Meiofauna	ORI. Univ. Tokyo
	7	28 cm	Minami	Metal and Water content	Hokkaido Tokai Univ.
	8	29 cm	Nagao	Metal, Radionuclides	Hokkaido Univ.

Table MC2. List of researchers and analyses on core samples (continue2)

Cast	Core Number	Depth of core	Researcher	Analysis	Storage of the sediment
SU-6MC	1	27 cm	Nagao	Organic Components	Hokkaido Univ.
	2	26 cm	Nomaki & Shimanaga	Meiofauna	ORI. Univ. Tokyo
	3	28 cm	Nomaki	Culturing	ORI. Univ. Tokyo
	4	28 cm	Murayama	Description/Physical propaty	Kochi Univ.
	5	27 cm	Murayama	14C	Kochi Univ.
	6	27 cm	Minami	Metal and Water content	Hokkaido Tokai Univ.
	7	27 cm	Minami	Porewater	Hokkaido Tokai Univ.
	8	27 cm	Nagao	Metal, Radionuclides	Hokkaido Univ.

Cast	Core Number	Depth of core	Researcher	Analysis	Storage of the sediment
SU-8MC	1	41 cm	Nagao	Organic components	Hokkaido Univ.
	2	40 cm	Nagao & Murayama	Metal/radionuclides/C14 /Benthic foram	Hokkaido Univ./Kochi Univ.
	3	43 cm	Kato	$CaCO_3/SiO_2$	Tokai Univ.
	4	37 cm	Nomaki & Shimanaga	Meiofauna	ORI. Univ. Tokyo
	5	45 cm	Murayama	Description/Physical propaty	Kochi Univ.
	6	40 cm	Nagao	Organic components	Hokkaido Univ.
	7	42 cm	Yamaguchi	Se	Kinkki Univ.
	8	43 cm	Nomaki & Shimanaga	Meiofauna	ORI. Univ. Tokyo

Cast	Core Number	Depth of core	Researcher	Analysis	Storage of the sediment
SU-9MC	1	35 cm	Murayama	Description/Physical property	Kochi Univ.
	2	35 cm	Murayama	14C	Kochi Univ.
	3	34 cm	Minami	Metal	Hokkaido Tokai Univ.
	4	34 cm	Kato	$CaCO_3/SiO_2$	Tokai Univ.
	5	35 cm	Nagao	Metal/Radionuclides	Hokkaido Univ.
	6	33 cm	Nagao	Organic components	Hokkaido Univ.
	7				
	8	33 cm	Kato	Porewater	Tokai Univ.

Cast	Core Number	Depth of core	Researcher	Analysis	Storage of the sediment
SU-10MC	1	26 cm	Kato	$CaCO_3/SiO_2$	Tokai Univ.
	2	32.5 cm	Murayama	Description/Physical property	Kochi Univ.
	3	29 cm	Murayama	14C	Kochi Univ.
	4	27 cm	Yamaguchi	Se	Kinkki Univ.
	5	25 cm	Nagao	Metal/Radionuclides	Hokkaido Univ.
	6	21 cm	Minami	Metal	Hokkaido Tokai Univ.
	7	19.5 cm	Kato	Porewater	Tokai Univ.
	8	20 cm	Nagao	Organic components	Hokkaido Univ.

Cast	Core Number	Depth of core	Researcher	Analysis	Storage of the sediment
SU-11MC	1	32.5 cm	Nomaki	DNA analysis (foram)	ORI. Univ. Tokyo
	2	32.5 cm	Nomaki	DNA analysis (foram)	ORI. Univ. Tokyo
	3	35 cm	Kato	$CaCO_3/SiO_2$	Tokai Univ.
	4	33 cm	Nomaki	DNA analysis (foram)	ORI. Univ. Tokyo
	5	34 cm	Murayama	Description/Physical property	Kochi Univ.
	6	32 cm	Murayama	14C	Kochi Univ.
	7	32 cm	Nagao	Metal/Radionuclides	Hokkaido Univ.
	8	32.5 cm	Nomaki	DNA analysis (foram)	ORI. Univ. Tokyo

Table MC2. List of researchers and analyses on core samples (continue3)

Cast	Core Number	Depth of core	Researcher	Analysis	Storage of the sediment
SU-12MC	1	32 cm	Kato	$CaCO_3/SiO_2$	Tokai Univ.
	2	33.5 cm	Murayama	Description/Physical property	Kochi Univ.
	3	31.5 cm	Nomaki	DNA analysis (foram)	ORI. Univ. Tokyo
	4	31 cm	Murayama	14C	Kochi Univ.
	5	32.5 cm	Nomaki	DNA analysis (foram)	ORI. Univ. Tokyo
	6	33.5 cm	Nomaki	DNA analysis (foram)	ORI. Univ. Tokyo
	7	33 cm	Nagao	Metal/Radionuclides	Hokkaido Univ.
	8	32.5 cm	Nomaki	DNA analysis (foram)	ORI. Univ. Tokyo

Cast	Core Number	Depth of core	Researcher	Analysis	Storage of the sediment
SC-1MC	1	26 cm	Nomaki & Shimanaga	Meiofauna	ORI. Univ. Tokyo
	2	23.5 cm	Nomaki & Shimanaga	Meiofauna	ORI. Univ. Tokyo
	3	26 cm	Nagao	Metal/Radionuclides	Hokkaido Univ.
	4	26.5 cm	Murayama	Description/Physical property	Kochi Univ.
	5	24 cm	Murayama	Tephra/Grain size	Kochi Univ.
	6	24 cm	Yamaguchi	Se	Kinkki Univ.
	7	25 cm	Nagao	Organic components	Hokkaido Univ.
	8	19 cm	Nomaki	DNA analysis (foram)	ORI. Univ. Tokyo

10-10. Deep-sea trawling in the Sulu Sea

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1. Community structure and faunal zonation of deep-sea demersal fish in the Sulu Sea, and their relationships with environmental parameters and water masses

Menzies et al. (1973) presented that the evidence of deep-sea benthic fauna zoned world wide, with the specifics of zones varying among geographic locations. Thereafter, the concept of zonation has apparently been accepted to various taxonomic groups. The zonation patterns have also been observed for the demersal fish fauna worldwide. However, the interpretation and explanation of zonation have been changed as more data became available, and concepts of community ecology gradually replaced early dependence on physiological explanation for distribution. The explanations for vertical distributions have centered primarily on physical factor (e.g. depth, temperature, oxygen, hydrographic pressure, and sediment type) or biological interactions.

Among those explanations, Haedrich and kreff (1978) suggested that the distribution of demersal fish assemblages might follow the water masses. Recently Koslow et al. (1994) compared the mid-slope (800 m – 2000 m) demersal fish community of Southeast Australia with those at the similar latitude and depths in the North Pacific and the North Atlantic, and they proposed the water mass hypothesis to explain the biogeographic patterns of demersal fish communities. The latter water mass hypothesis was confirmed by the studies of the vertical patterns of the demersal fish assemblages on the continental slope off Western Australia (Williams et al. 2001) and the vertical and horizontal patterns of demersal fish assemblages around Japan (Yeh 2001).

The Sea of Japan exhibits unique hydrography such that potential temperature is between 0.2 and 2°C and salinity is around 34 ‰ below 200 m depth where the normal temperature of deep-sea water is not less than 2 - 3°C. Yeh (2001) identified only one faunal zone on the continental slope in the Sea of Japan, but at least four faunal zones were distinguished on the continental slope in the Pacific side of Japan. The uniform community structure of demersal fish along the depth is consistent with the uniform temperature and salinity of deep water originated from the same water mass in the Sea of Japan. The faunal zonation and biogeography of deep-sea demersal fish around Japan coincided with the local hydrography, and these results supported the water mass hypothesis.

The Sulu Sea exhibits another unique hydrography such that potential temperature is higher than 9.8°C throughout the water column of ~ 5000 m. The shallow sill depths (<400 m) of the Mindoro, Sibutu, and other straits prevent deep water of the Sulu Sea from communicating with that of other deep-sea basins, such as the South China, Philippine, and Celebes Seas. Because of this, the Sulu Sea provides an excellent opportunity to study vertical pattern of demersal fish, and its relationship with hydrography, especially with water mass, that may govern the faunal zonation of deep-sea demersal fish. According to local hydrography (Nozaki et al. 1999), the boundaries between zones should be found at 700 m, 1100 m and 3200 m that were suspected by the water mass hypothesis.

The main objective of this study is 1) to compare the boundaries between the faunal zones of deep-sea demersal fish with those of water masses in the Sulu Sea; 2) to compare the community structure of deep-sea demersal fish inhabiting the same water mass between the Sulu Sea and the neighboring basins; 3) to compare faunistic composition, abundance, biomass and diversity of deep-sea demersal fish in the Sulu Sea with those in the normal deep-sea. [H-M. Yeh, K. Suetsugu and S. Ohta]

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2. Endemism of megabenthos in the Sulu Sea

The Sulu Sea is also well known for its semi-enclosed deep basin rimmed, at least present, by sills shallower than 450m. Although its tectonics and historical geology are not well reported, the endemism and characteristics in its faunal composition, especially along the depth gradient, should be worthwhile to be treated on the basis of past database and present good samples. 17 effective trawl stations established during this cruise in the Sulu Sea, covering about 200 and 5000m (see List of trawl operation) were also selected in this context.

The faunal composition along the bathymetry should be compiled on the species level. Though the trawl catches during this cruise are not ample enough, especially in the deeper parts, ophiuroids, among others, were consistent constituents of the trawl catch, and also well documented in the past works. The data must be supplemented by the collection of the KH-72-1 and KH-79-1 cruises exploring the Sulu Sea, Celebes Sea, South China Sea and the Pacific Basin east off Mindanao Is. Reports such as US Fisheries Steamer Albatross exploring the seas around the Philippine Archipelago during 1907-10, the MUSORSTOM campagnes by Coriolis in 1976 and 1980, and other available reports such as Challenger, Siboga and Dana expedition must be referred and utilized as the general background.

The general impressions through this cruise are that, 1) the deeper parts of the Sulu Basin are apparently poor in the biomass and species richness, 2) skewed in faunal composition lacking or depauperate in several members, and 3) eurybathic species predominate. [S. OHTA]

3. Gas analysis of the air bladders of deep-sea demersal fish

The content of the air bladders of the deep-sea demersal fish was inspected for as many species as possible by a gas-chromatograph (Hitachi® G-3900). The relative composition of O_2 and N_2 gases is a good indicator whether the gas control (buoyancy regulation) is active or not at the time of sampling. The needle of a gas syringe was inserted into the air bladder through body wall as soon as possible. The procedure was done immersed in seawater after the retrieval of the sample on deck, minimizing degassing from the blood and tissues and the contamination of room air.

Most deep-sea fishes collected from the stations shallower than 3000m had high content of O_2 (around 92% O_2 : 8% N_2), with the exception of some triglids and sebastids usually sitting and gliding on the sea floor. Deep-sea macrourids collected below 4500m showed relatively low content of O_2 (less than 50%) and did not show strong intumescence of the body cavity, suggesting not inactive gas control of their air bladders. However, the gas accumulated in the meantime in the eyeball and/or cranium, which must originate from blood through the decompression, showed always high content of O_2 over 93%. [S. OHTA]

4. Preliminary faunistic survey on deep-sea benthic/benthopelagic microarthropods in the Sulu Sea

and the South China Sea

Faunistic surveys on deep-sea benthic/benthopelagic microarthropods in the Sulu Sea and its neighboring waters have never been carried out in detail. Hence we preliminarily tried to collect those using ORE beam trawls (width: 3m, 4m). During KH-02-4 cruise, small plankton nets (diameter: 30cm and 40cm; mesh size: 0.33, 0.5, 1.0 mm) were attached to the mouth of the 3m- and 4m-ORE beam trawls to collect small benthic/benthopelagic arthropods such as copepods, cumaceans, and pycnogonids.

Most of the samples successfully contained these arthropods. Arthropods were preserved in 10 or 5 % neutralized formalin sea-water or 70 % ethanol. Some specimens were preliminarily identified and listed below. The copepod genera *Benthomisophria*, *Paramisophria*, *Metacalanus*, and *Neoscolecithrix* are first recorded from the Sulu Sea. Misophrioida sp. from St. SA-2 may be a genus that has hitherto recorded only from the Atlantic. Further investigations will be made to reveal some aspects of the biodiversity in the Sulu Sea and the South China Sea. [T. Akiyama, S. Ohtsuka and K. Nakamura]

[List of samples identified preliminarily on board]

Station 6	
Benthomisophria sp.	(Copepoda: Misophrioida)
Station S1-A	
Neoscolecithrix sp.	(Copepoda: Calanoida)
Paramisophria sp.	(Copepoda: Calanoida)
Macandrewella sp.	(Copepoda: Calanoida)
Cyclaspis sp.	(Cumacea: Bodotriinae)
Leucon sp.	(Cumacea: Leuconidae)
Campylaspis sp.	(Cumacea: Nannastacidae)
Hemilamplops sp.	(Cumacea: Lampropidae)
Pallenopsis sp.	(Pycnogonida)
Station 9	
Campylaspis sp.	(Cumacea: Nannastacidae)
Nymphon sp.	(Pycnogonida: Nymphonidae)
Station SA-2	
Metacalanus sp.	(Copepoda: Calanoida)
Misophrioida sp.	(Copepoda: Misophrioida)
Campylaspis sp.	(Cumacea: Nannastacidae)
Hemilamprops sp.	(Cumacea: Lampropodae)
Makrokylindrus sp.	(Cumacea: Diastylidae)
Leptostylis sp.	(Cumacea: Diastylidae)

10-11. Baited-trap experiment in the Sulu Sea

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A bottom moored baited trap system was set about 1 day at a deeper part of the Sulu Sea (St. 11). The main objective is to supplement fast moving and scavenging demersal organisms, which are hardly collected by beam trawls in the depauperate part of the Sulu Sea. The system consists of a main drum-shaped trap pot, deep-sea camera and a Doppler-sonar current meter mounted on a main frame of acoustic releaser and ballast-buoy unit (see Photo 1). 6 miniature traps were also attached to the lower part of the main frame for the collection of near-bottom copepods (see the article of Prof. Nishida).

The main specification and parameters are enumerated below;

Main trap pot: 1m phi, 1.5m long, two 20cm phi entrance cones, 1-cm mesh netting
Bait: 1kg of saury blocks in a plastic net bag
Camera: exposure interval: 5-min, up to 400 frames on 50-foot long color negative film
Current meter: Aanderaa® RCM-11, every 1 min sampling, sensor altitude 1m above bottom
Launch: Dec04 '02, 13:48 (Philippine LT), 08°50.904'N, 121°04.918'E, 3667m (PDR)
Release command [code-5A]: Dec05 '02, 14:00, 08°50.48'N, 121°04.92'E, 3668m (PDR)
Surface: Dec05 '02, 15:28, 08°50.88'N, 121°04.46'E, 3652m (PDR)
Descent velocity: ca. 60m/sec
Ascent velocity: ca. 45m/sec

The megabenthos catch consisted of only 2 species and 4 individuals; a 70cm class deep-sea somniodid shark akin to 'Ondenzame', and 2 huge-sized and 1 medium-size isopods, *Bathynomus* cf. *septemspinosum* (Photos 2 & 3). The bait bag was torn completely probably by the biting of the shark and netting of the trap was broken through at least 3 points, probably by the isopods. The bait was totally consumed, and only 3 skulls of the sauries were remained in the trap, which were totally cleaned probably by small amphipods and/or isopods. The time-course events and other attracted members will be elucidated by the inspection of bottom photos taken every 5 min after development. The bottom current scheme also awaits the reading and analysis of data pack on land-based laboratory. The shark was kept deep-frozen for the analysis of stomach content and identification, and the isopods were fixed in SW formalin and preserved in ethanol.

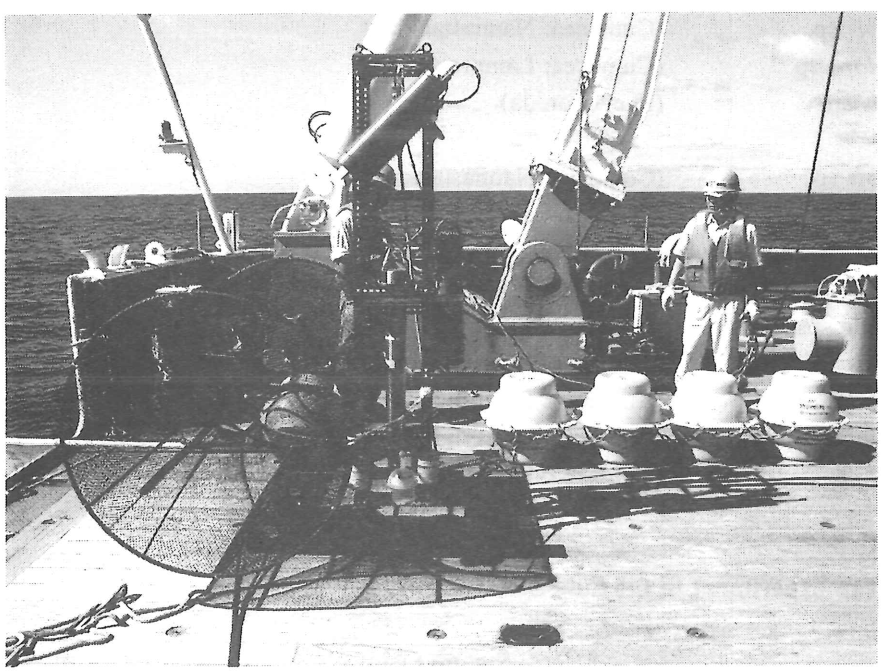

Photo 1. The baited trap-camera-current meter system just to be launched.

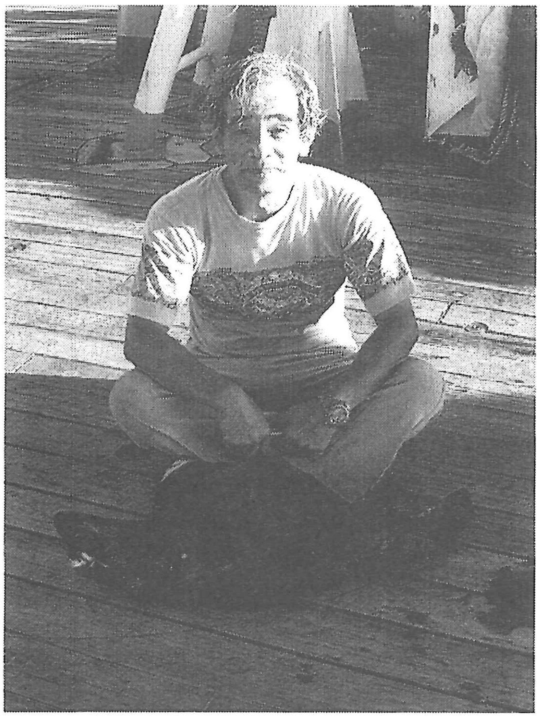

Photo 2. The somniodid shark.

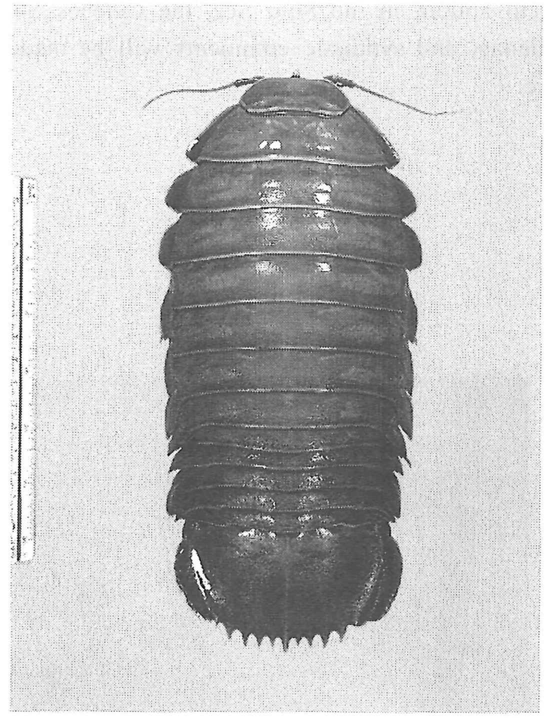

Photo 3. *Bathynomus* cf. *septemspinosum*.

10-12. Photographic observations of megabenthos and bottom environment in the Sulu Sea

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Underwater stereoscopic photography was carried out in order to observe and describe the life forms and behavior of large epibenthic and demersal organisms in their natural condition together with the bottom features and indications of bottom water movements. Quantitative estimation of density and biomass, analysis of spatial distribution of mega-epibenthic organisms can also be done through geometrical analysis of stereo photographs and measurements of specimens collected by ORE-type beam trawls operated at the same or comparable stations. Observations of traces made by living organisms, remains of terrestrial plants, and orientation analysis of organisms against bottom water movements are also the favorite items of bottom photography.

The suspended-type stereo-camera system consists of two identical deep-sea cameras (Benthos® Model 372 standard cameras; with parallel optic axes separated by 202mm and oriented perpendicular to the field of view), an underwater electronic flash (Benthos® Model 382; 100 wsec) and an acoustic pinger (burst pulse 2msec) mounted on a frame.

The camera system was suspended on No.2 winch cable equipped with swell-compensator, and shot distance was kept around 2m above the bottom aided by the monitoring of the acoustic pinger and winch operation. The cameras were triggered automatically at 6-sec intervals, and took about 800 stereo pairs on 100-foot long films (Konica® Centuria: ASA 800) over 80 min of drifting. Compass pendulum suspended 150cm below the lens will afford the cue for the orientation of photographed objects.

The camera system was operated at 5 stations (St. 7-A, ca. 520m; St. 8, ca. 1000m; St. 9, ca. 2000m; St. 10, ca, 4800m and St. 11, ca. 2500m; see List of UC Stations) in the Sulu Sea.

Analysis, dimensioning and identification of photographed objects will be carried out in the laboratory on land after the development of the films.

We have already about 20 camera stations established during the KH-72-1 and KH-79-1 cruises covering 60m to 5500m in the Sulu Sea, the Celebes Sea, the South China Sea and the Pacific Basin east off Mindanao, and synthetic comments will be made based on these data and newly obtained ones in near future.

Photo : The IKMT, Isaacs-Kidd midwater trawl have collected zooplankton and micronekton in the Sulu Sea. (Taken by J. Nishikawa.)