Cruise Report ONR Japan/East Sea

Hydrographic survey

R/V Revelle HNRO7 24 June 1999 – 17 July 1999

November 1999; CTD updated April 2006

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A. Cruise narrative

A.1. Highlights

a. Expedition
HNRO7 (Expedition Hahnaro Leg 7)

b. Chief Scientist
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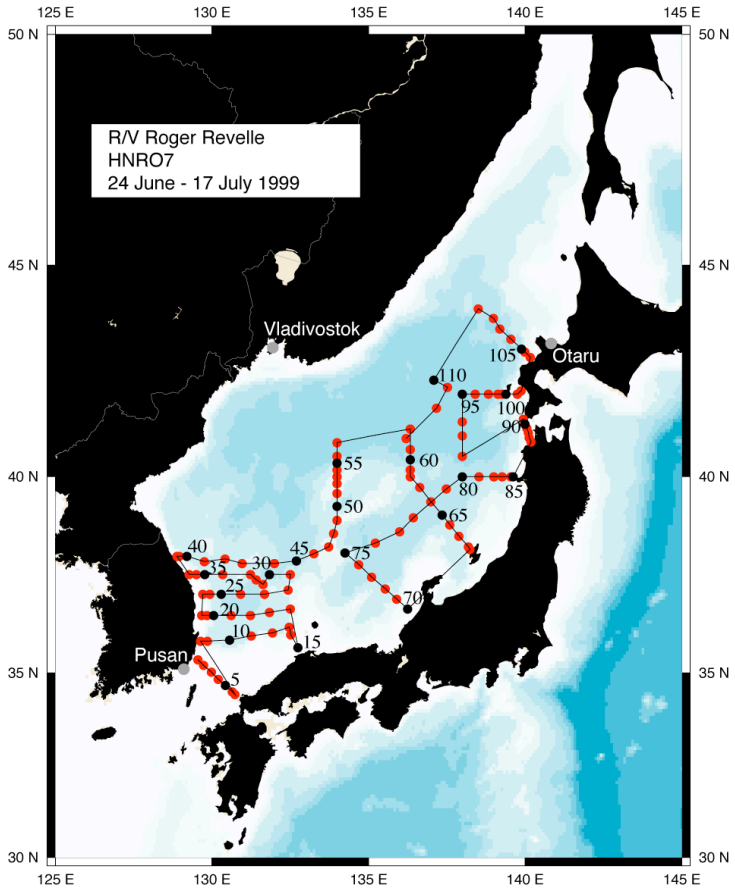
c. Ship
R/V Revelle, Captain David Murline

d. Ports of Call
Pusan, Korea

e. Cruise dates
24 June 1999 - 17 July 1999

A.2. Cruise summary

a. Cruise track (Fig. A.1)



Link to list of events, from ship's officers, with all station (CTD, optical, net tow) and VPR towing times.

Station locations and times in WOCE Hydrographic Programme format. (Link is to complete file; Table is compressed with some information removed, and in small font)

JES SUMMER 99 (TALLEY) RV REVELLE HNRO LEG 7

SHIP/CRUISE EXPOCODE	STNNBR	CASTNO	DATE	UTC TIME	CODE	POSITION LATITUDE	POSITION LONGITUDE	NAV	UNC DEPTH	HT ABOVE BOTTOM	METER WHEEL	NO.OF BOTTL	PARAM	COMMENTS
33RRHNRO/7	001	01	062499	1255	BO	35 21.0 N	129 33.0 E	GPS	120	8	110	8	1-8,20,24,26,27,53	CTD#
33RRHNRO/7	002	01	062499	1608	BO	35 11.8 N	129 44.2 E	GPS	140	6	130	9	1-8,20,24,26,27,53	CTD#
33RRHNRO/7	003	01	062499	1846	BO	35 00.5 N	129 58.7 E	GPS	133	8	125	9	1-8,24,26,27,53	CTD#
33RRHNRO/7	004	01	062499	2119	BO	34 49.9 N	130 11.9 E	GPS	124	6	124	9	1-10,15,17,20,24,26,27,53	CTD#
33RRHNRO/7	005	01	062499	2358	BO	34 40.0 N	130 26.1 E	GPS	131	7	122	10	1-8,24,26,27	CTD#
33RRHNRO/7	006	02	062599	0303	BO	34 30.2 N	130 39.0 E	GPS	118	18	100	17	1-8,24,26,27	CTD#
33RRHNRO/7	007	01	062599	0439	BO	34 25.55 N	130 43.88 E	GPS	96	8	85	8	1-6,24,26	CTD#
33RRHNRO/7	008	01	062599	1317	BO	35 50.05 N	129 38.04 E	GPS	122	6	113	11	1-8,24,26,27,53	CTD#
33RRHNRO/7	009	02	062599	1714	BO	35 50.3 N	129 51.4 E	GPS	995	8	987	20	1-8,24,26,27,53	CTD#
33RRHNRO/7	010	01	062599	2303	BO	35 52.06 N	130 34.0 E	GPS	1393	5	1360	24	1-10,15,17,24,26,27,53	CTD#
33RRHNRO/7	011	02	062699	0430	BO	35 57.5 N	131 14.99 E	GPS	1253	6	1220	24	1-8,24,26,27	CTD#
33RRHNRO/7	012	02	062699	1020	BO	36 02.98 N	131 55.79 E	GPS	1157	8	1128	20	1-8,24,26,27	CTD#
33RRHNRO/7	013	01	062699	1436	BO	36 12. N	132 27.6 E	GPS	1074	7	1045	19	1-10,15,17,20,24,26,27	CTD#
33RRHNRO/7	014	01	062699	1739	BO	36 00.2 N	132 31.8 E	GPS	269	7	258	9	1-8,20,24,26,27,53	CTD#
33RRHNRO/7	015	01	062699	2100	BO	35 40.12 N	132 45. E	GPS	132	8	128	8	1-8,24,26,27	CTD#
33RRHNRO/7	016	02	062799	0332	BO	36 40.33 N	132 30.03 E	GPS	1120	7	1187	24	1-8,24,26,27	CTD#
33RRHNRO/7	017	02	062799	0948	BO	36 35.4 N	131 50.1 E	GPS	1834	7	1790	24	1-8,24,26,27	CTD#
33RRHNRO/7	018	01	062799	1457	BO	36 30.3 N	131 14.0 E	GPS	2051	7	2007	24	1-8,20,24,26,27,53	CTD#
33RRHNRO/7	019	01	062799	2015	BO	36 30.25 N	130 37.38 E	GPS	2033	5	1992	24	1-8,24,26,27,53	CTD#
33RRHNRO/7	020	02	062899	0117	BO	36 30.29 N	130 02.99 E	GPS	1380	6	1335	23	1-8,20,24,26,27	CTD#
33RRHNRO/7	021	01	062899	0330	BO	36 30.03 N	129 50.2 E	GPS	329	8	320	12	1-8,24,26,27,53	CTD#
33RRHNRO/7	022	01	062899	0506	BO	36 30.1 N	129 40.4 E	GPS	118	7	112	14	1-8,24,26,27	CTD#

33RRHNRO/7	023	01	062899	0832	BO	37	03.4	N	129	42.3	E	GPS	298	7	289	9	1-10,15,17,24,26,27,53	CTD#
33RRHNRO/7	024	01	062899	1027	BO	37	03.4	N	129	56.4	E	GPS	1010	6	989	19	1-8,24,26,27,53	CTD#
33RRHNRO/7	025	01	062899	1303	BO	37	03.4	N	130	18.7	E	GPS	2200	7	2159	24	1-8,24,26,27,53	CTD#
33RRHNRO/7	026	01	062899	1858	BO	37	03.45	N	130	56.18	E	GPS	2207	6	2170	24	1-10,12,15,17,20,24,26,27,53 #	
33RRHNRO/7	027	01	062999	0105	BO	37	03.4	N	131	41.0	E	GPS	2170	7	2117	24	1-8,24,26,27	CTD#
33RRHNRO/7	028	02	062999	0757	BO	37	09.9	N	132	26.6	E	GPS	775	8	755	21	1-8,24,26,27,53	CTD#
33RRHNRO/7	029	01	062999	1121	BO	37	33.4	N	132	30.	E	GPS	1670	10	1655	21	1-8,24,26,27,53	CTD#
33RRHNRO/7	030	01	062999	1648	BO	37	33.2	N	131	50.1	E	GPS	2376	4	2329	24	1-10,15,17,24,26,27,53	CTD#
33RRHNRO/7	031	01	062999	2112	BO	37	18.0	N	131	38.0	E	GPS	2230	6	2192	24	1-8,24,26,27	CTD#
33RRHNRO/7	032	01	063099	0021	BO	37	25.0	N	131	25.0	E	GPS	2240	8	2200	24	1-8,24,26,27,53	CTD#
33RRHNRO/7	033	02	063099	0401	BO	37	33.2	N	131	14.5	E	GPS	2167	7	-9	24	1-8,24,26,27,53	CTD#
33RRHNRO/7	034	02	063099	1059	BO	37	33.3	N	130	21.2	E	GPS	1599	8	-9	22	1-8,24,26,27,53	CTD#
33RRHNRO/7	035	01	063099	1532	BO	37	33.3	N	129	45.3	E	GPS	1062	7	1038	19	1-8,24,26,27	CTD#
33RRHNRO/7	036	01	063099	1800	BO	37	33.0	N	129	30.2	E	GPS	570	6	568	16	1-8,24,26,27,53	CTD#
33RRHNRO/7	037	01	063099	2006	BO	37	33.0	N	129	16.0	E	GPS	227	6	220	15	1-8,20,24,26,27	CTD#
33RRHNRO/7	038	01	063099	2324	BO	38	01.0	N	128	53.0	E	GPS	501	6	485	18	1-10,15,17,24,26,27	CTD#
33RRHNRO/7	039	01	070199	0117	BO	38	01.0	N	128	56.8	E	GPS	1077	7	1040	16	1-8,24,26,27,53	CTD#
33RRHNRO/7	040	02	070199	0439	BO	38	01.5	N	129	11.8	E	GPS	1154	6	-9	24	1-8,24,26,27,53	CTD#
33RRHNRO/7	041	01	070199	0905	BO	37	53.7	N	129	44.1	E	GPS	1626	7	1619	24	1-8,20,24,26,27	CTD#
33RRHNRO/7	042	01	070199	1402	BO	37	57.	N	130	25.	E	GPS	1845	7	1838	24	1-8,24,26,27,53	CTD#
33RRHNRO/7	043	01	070199	1832	BO	37	49.9	N	130	58.3	E	GPS	1250	7	1319	24	1-8,24,26,27,53	CTD#
33RRHNRO/7	044	01	070299	0151	BO	37	50.0	N	132	00.0	E	GPS	2636	7	2595	24	1-8,24,26,27,53	CTD#
33RRHNRO/7	045	02	070299	0842	BO	37	53.8	N	132	41.8	E	GPS	2530	7	2487	24	1-10,15,17,20,24,26,27	CTD#
33RRHNRO/7	046	01	070299	1321	BO	38	05.	N	133	15.	E	GPS	1756	8	1748	23	1-8,24,26,27,53	CTD#
33RRHNRO/7	047	01	070299	1707	BO	38	14.8	N	133	44.4	E	GPS	934	6	907	18	1-10,15,17,20,24,26,27,53	CTD#
33RRHNRO/7	048	01	070299	2123	BO	38	35.0	N	133	53.0	E	GPS	1359	8	1327	23	1-8,24,26,27,53	CTD#
33RRHNRO/7	049	01	070399	0037	BO	38	55.0	N	134	00.0	E	GPS	744	6	730	20	1-8,24,26,27,53	CTD#
33RRHNRO/7	050	02	070399	0512	BO	39	15.8	N	133	59.9	E	GPS	2114	8	2074	24	1-10,15,17,24,26,27,53	CTD#
33RRHNRO/7	051	01	070399	0848	BO	39	44.7	N	134	00.0	E	GPS	1004	7	982	18	1-8,24,26,27,53	CTD#
33RRHNRO/7	052	01	070399	1113	BO	39	50.	N	134	00.	E	GPS	560	8	543	15	1-8,24,26,27,53	CTD#
33RRHNRO/7	053	01	070399	1319	BO	40	00.	N	134	00.	E	GPS	1033	8	999	19	1-8,24,26,27,53	CTD#
33RRHNRO/7	054	01	070399	1530	BO	40	09.8	N	134	00.1	E	GPS	1132	10	1090	24	1-8,24,26,27	CTD#
33RRHNRO/7	055	01	070399	1820	BO	40	19.9	N	133	59.9	E	GPS	2452	6	2435	22	1-8,20,24,26,27	CTD#
33RRHNRO/7	056	01	070399	2136	BO	40	30.0	N	134	00.0	E	GPS	3140	6	3095	24	1-8,24,26,27	CTD#
33RRHNRO/7	057	01	070499	0155	BO	40	50.0	N	134	00.0	E	GPS	3530	7	3487	24	1-10,12,15,17,20,24,26,27	CTD#
33RRHNRO/7	058	01	070499	1322	BO	41	10.	N	136	20.	E	GPS	3450	8	3405	24	1-10,15,17,20,24,26,27,53	CTD#
33RRHNRO/7	059	01	070499	1909	BO	40	40.2	N	136	20.0	E	GPS	3217	7	3175	24	1-8,24,26,27,53	CTD#
33RRHNRO/7	060	01	070499	2252	BO	40	25.0	N	136	20.0	E	GPS	2900	7	2900	24	1-8,20,24,26,27,53	CTD#
33RRHNRO/7	061	02	070599	0250	BO	40	10.0	N	136	20.0	E	GPS	1773	7	1735	24	1-8,24,26,27,53	CTD#
33RRHNRO/7	062	02	070599	0601	BO	40	00.1	N	136	20.1	E	GPS	1783	7	1749	24	1-8,24,26,27,53	CTD#
33RRHNRO/7	063	01	070599	0948	BO	39	44.1	N	136	37.8	E	GPS	2214	8	2168	22	1-8,24,26,27,53	CTD#
33RRHNRO/7	064	01	070599	1506	BO	39	23.	N	136	59.	E	GPS	2522	7	2476	24	1-10,15,17,24,26,27,53	CTD#
33RRHNRO/7	065	01	070599	2018	BO	39	02.2	N	137	21.1	E	GPS	2274	7	2242	24	1-8,24,26,27,53	CTD#
33RRHNRO/7	066	01	070599	2358	BO	38	48.0	N	137	36.0	E	GPS	2178	7	2153	24	1-8,20,24,26,27	CTD#
33RRHNRO/7	067	02	070699	0436	BO	38	31.	N	137	58.8	E	GPS	1905	8	1862	24	1-10,15,17,24,26,27,53	CTD#
33RRHNRO/7	068	02	070699	0929	BO	38	14.6	N	138	10.5	E	GPS	1356	7	1313	24	1-8,24,26,27,53	CTD#
33RRHNRO/7	069	01	070699	1106	BO	38	11.	N	138	14.3	E	GPS	280	7	262	14	1-8,24,26,27,53	CTD#
33RRHNRO/7	070	01	070699	2157	BO	36	40.0	N	136	15.0	E	GPS	222	8	222	18	1-8,24,26,27	CTD#
33RRHNRO/7	071	02	070799	0209	BO	36	55.1	N	135	53.9	E	GPS	626	6	615	21	1-8,24,26,27,53	CTD#
33RRHNRO/7	072	01	070799	0549	BO	37	11.	N	135	32.1	E	GPS	1739	8	1702	24	1-8,20,24,26,27	CTD#
33RRHNRO/7	073	01	070799	1043	BO	37	29.1	N	135	06.	E	GPS	2933	8	2890	24	1-8,24,26,27,53	CTD#
33RRHNRO/7	074	01	070799	1539	BO	37	48.0	N	134	40.9	E	GPS	2983	6	2942	24	1-10,15,17,24,26,27	CTD#
33RRHNRO/7	075	01	070799	2024	BO	38	06.1	N	134	14.9	E	GPS	473	7	464	16	1-8,24,26,27,53	CTD#
33RRHNRO/7	076	01	070899	0306	BO	38	21.	N	135	13.	E	GPS	3005	8	2964	23	1-10,12,15,17,20,24,26,27	CTD#
33RRHNRO/7	077	02	070899	1053	BO	38	38.	N	136	00.	E	GPS	2725	6	2682	24	1-10,15,17,24,26,27,53	CTD#
33RRHNRO/7	078	01	070899	1558	BO	38	59.1	N	136	27.0	E	GPS	2658	7	2615	24	1-8,24,26,27	CTD#
33RRHNRO/7	079	01	070999	0043	BO	39	42.0	N	137	29.0	E	GPS	2586	7	2548	24	1-8,20,24,26,27	CTD#
33RRHNRO/7	080	02	070999	0720	BO	39	59.8	N	138	00.1	E	GPS	2420	8	2378	24	1-10,15,17,20,24,26,27,53	CTD#
33RRHNRO/7	081	01	070999	1149	BO	40	00.	N	138	32.	E	GPS	2272	8	2226	24	1-8,24,26,27	CTD#
33RRHNRO/7	082	01	070999	1548	BO	40	00.1	N	138	59.8	E	GPS	1974	6	1940	24	1-8,24,26,27,53	CTD#
33RRHNRO/7	083	01	070999	1846	BO	40	00.0	N	139	15.8	E	GPS	1635	6	1610	24	1-8,24,26,27,53	CTD#
33RRHNRO/7	084	01	070999	2118	BO	40	00.0	N	139	32.5	E	GPS	972	7	958	24	1-8,24,26,27,53	CTD#
33RRHNRO/7	085	01	070999	2252	BO	40	00.0	N	139	37.1	E	GPS	315	7	358	22	1-8,24,26,27,53	CTD#
33RRHNRO/7	086	01	071099	0453	BO	40	51.	N	140	10.9	E	GPS	64	8	58	7	1-8,24,26,27,53	CTD#
33RRHNRO/7	087	02	071099	0627	BO	40	56.9	N	140	08.1	E	GPS	119	7	116	13	1-8,24,26,27,53	CTD#
33RRHNRO/7	088	01	071099	0739	BO	41	03.9	N	140	06.1	E	GPS	152	7	148	8	1-10,15,17,20,24,26,27,53	CTD#
33RRHNRO/7	089	01	071099	0855	BO	41	11.	N	140	03.2	E	GPS	121	7	120	8	1-10,15,17,20,24,26,27	CTD#
33RRHNRO/7	090	01	071099	1001	BO	41	17.	N	139	59.9	E	GPS	160	8	158	8	1-8,24,26,27,53	CTD#
33RRHNRO/7	091	01	071099	1115	BO	41	24.	N	139	57.	E	GPS	120	8	115	8	1-10,15,17,24,26,27,53	CTD#
33RRHNRO/7	092	01	071099	2048	BO	40	30.0	N	138	00.0	E	GPS	3328	7	3280	24	1-8,24,26,27,53	CTD#
33RRHNRO/7	093	01	071199	0209	BO	41	00.0	N	138	00.0	E	GPS	3675	7	3630	24	1-10,15,17,24,26,27	CTD#
33RRHNRO/7	094	02	071199	0909	BO	41	29.9	N	138	00.	E	GPS	3693	9	3646	24	1-10,15,17,24,26,27,53	CTD#
33RRHNRO/7	095	01	071199	1443	BO	41	59.7	N	138	00.4	E	GPS	3685	8	3647	24	1-10,12,15,17,20,24,26,27	CTD#
33RRHNRO/7	096	01	071199	1938	BO	42	00.0	N	138	24.9	E	GPS	3696	8	3648	24	1-10,15,17,24,26,27,55	CTD#
33RRHNRO/7	097	01	071199	2353	BO	42	00.0	N	138	50.0	E	GPS	3618	4	3585	24	1-8,24,26,27,53	CTD#
33RRHNRO/7	098	02	071299	0429	BO	42	00.	N	139	08.	E	GPS	3333	9	3283	24	1-8,24,26,27,53	CTD#
33RRHNRO/7	099	02	071299	0750	BO	42	00.	N	139	15.8	E	GPS	2405	10	2350	24	1-8,24,26,27,53	CTD#
33RRHNRO/7	100	01	071299	1004	BO	42	00.	N	139	22.8	E	GPS	1111	8	1104	21	1-8,24,26,27,53	CTD#
33RRHNRO/7	101	01	071299	1307	BO	42	00.	N	139	44.9	E	GPS	1206	8	1170	20	1-8,24,26,27,53	CTD#
33RRHNRO/7	102	01	071299	1435	BO	42	04.5	N	139	52.3	E	GPS	136	8	133	10	1-8,24,26,27,53	CTD#
33RRHNRO/7	103	01	071299	1943	BO	42	52.0	N	140	10.0	E	GPS	124	5	121	14	1-10,15,17,24,26,27,53	CTD#
33RRHNRO/7	104	01	071299	2152	BO	42	59.6	N	139	59.5	E	GPS	1340	6	1317	24	1-8,24,26,27	CTD#
33RRHNRO/7	105	01	071399	0004	BO	43	04.0	N	139	53.0	E	GPS	2189	7	2119	24	1-8,20,24,26,27	CTD#

33RRHNRO/7	106	02	071399	0500	BO	43 18.1	N	139 33.	E	GPS	2596	8	2582	24	1-8,24,26,27	CTD#
33RRHNRO/7	107	01	071399	0910	BO	43 32.1	N	139 12.1	E	GPS	3213	8	3170	24	1-10,15,17,24,26,27	CTD#
33RRHNRO/7	108	01	071399	1340	BO	43 47.	N	138 50.	E	GPS	3474	8	3426	24	1-8,12,24,26,27	CTD#
33RRHNRO/7	109	01	071399	1800	BO	43 59.9	N	138 30.1	E	GPS	3173	6	3126	24	1-10,15,17,20,24,26,27	CTD#
33RRHNRO/7	110	02	071499	0645	BO	42 19.9	N	137 04.9	E	GPS	3681	9	3626	24	1-8,24,26,27	CTD#
33RRHNRO/7	111	01	071499	1130	BO	42 10.1	N	137 30.9	E	GPS	3680	8	3632	24	1-10,15,17,24,26,27	CTD#
33RRHNRO/7	112	01	071499	2133	BO	41 40.0	N	137 10.0	E	GPS	3637	8	3580	24	1-8,24,26,27,53	CTD#
33RRHNRO/7	113	01	071599	0420	BO	40 56.0	N	136 11.7	E	GPS	3394	-9	800	24	1	CTD#

b. Station sampling
113 CTD/24-bottle rosette stations; 112 stations included LADCP
(2156 bottles tripped)
Water sampling to the bottom for temperature, salinity, oxygen, transmissometer, nitrate, phosphate, silicate, nitrite, CFC's, pH, alkalinity, C14, del18O, helium, tritium, argon, neon. Surface sampling at selected station locations for delta-C13, phytoplankton growth rates and calcite. Average depth of cast: 2500 m.
37 Bio-optical casts
15 Net tows near the surface

c. Underway sampling

towed VPR (Video Plankton Recorder), with planktonic taxonomic type and abundance, temperature, conductivity, fluorescence, light attenuation and PAR yoyoing to 80 meters depth once or twice between CTD stations.
pCO2
surface temperature and salinity
Seabeam center beam bathymetry
Knudsen echo sounder bathymetry
ADCP (Acoustic Doppler Current Profiling)
meteorology

d. Floats and drifters
2 Minimet surface drifters
2 Profiling ALACE floats ballasted to 800 meters

A.3. Narrative

The R/V Revelle departed Pusan, Korea on June 24, 1999 at 1600 in good weather and returned on July 17. This was the seventh leg of the Hahnaro (HNRO) expedition. Generally calm to moderate seas throughout the cruise. Air temperature was in the 16-22 C range. There was occasional rain. Three separate sampling programs were aboard: CTD/rosette/chemistry, bio-optics, and VPR (Video Plankton Recorder). The cruise leg covered the Korean and Japanese sectors of the Japan/East Sea. The purposes of the cruise leg were to map the water properties and geostrophic circulation of the Japan/East Sea from top to bottom, the bio-optical properties, and the plankton distribution. The water properties and circulation of the Russian sector were measured in a companion cruise on the Khromov, following the Revelle leg.

CTD/rosette station sampling was to the bottom at each of the 112 stations. Most stations were separated by 10 to 30 nautical miles. The station pattern covered most of the southern and eastern Japan/East Sea. One station near Dok Do was abandoned because the local Korean patrol was not aware of our clearance to work. One extra station (113) to 800 m was made on the return to Pusan in order to test the CTD which will be the backup CTD on the Khromov. On most stations, 24 samples were collected from top to bottom. Maximum bottle spacing in the deep waers was 250 meters with some exceptions. Most sampling in the upper waters was based on the many features in the CTD salinity and oxygen and the transmissometer. An altimeter on the CTD/rosette frame was used for the bottom approach on most stations. A pinger on the CTD/rosette frame was used for several stations. A lowered acoustic doppler current profiler was used on every station.

The VPR was towed between most station pairs except for the longer steams between sections. On most days two separate casts for bio-optics were made. At these stations, extra samples for bio-optical properties were often collected from near-surface rosette bottles from the CTD cast.

A plankton net tow was done at 15 stations.

A.4. Interlaboratory comparisons of chemistry methods

Alkalinity and pH: A comparison of alkalinity and pH methods between the Seoul National University group under Kyung-Ryul Kim (Dong-Jin Kang aboard the Revelle) and the Pacific Oceanological Institute group under Pavel Tishchenko was carried out during the cruise. POI sampling for pH and alkalinity was at every station. SNU sampling was at 15 stations for comparison of methods. The results of the comparison are included in section B.6.c.

CFC: Samples for CFCs were collected in glass ampoules for analysis at the UW laboratory and comparison with analyses carried out on the Revelle. All CFC sampling on the Khromov will be using these glass ampoules.

A.5. List of principal investigators

1. Lynne Talley: Temperature, salinity, oxygen, nutrients (CTD and rosette): SIO/UCSD
2. Lynne Talley and Peter Hacker: Lowered Acoustic Doppler Current Profiling: SIO/UCSD and U. Hawaii
3. Lynne Talley: Shipmounted Acoustic Doppler Current Profiling: SIO/UCSD
4. Steve Riser: Subsurface PALACE floats: UW
5. Dong-Kyu Lee and Peter Niiler: Minimet surface drifters: Pusan University and SIO/UCSD
6. Pavel Tischenko: Alkalinity, pH: POI
7. Kyung-Ryul Kim: Alkalinity, pH: SNU
8. Kyung-Ryul Kim: Carbon 14: SNU
9. Kyung-Ryul Kim: Delta 18O: SNU
10. William Jenkins: Delta 18O: SOC
11. Mark Warner: Chlorofluorocarbons: UW
12. William Jenkins: Helium-3, tritium, neon, argon, krypton: SOC
13. Kyung-Ryul Kim: Surface pCO2, T, S, chlorophyll, (pN2O): SNU
14. Clive Dorman and Robert Beardsley: Shipbased meteorological measurements (WHOI ASIMET): SIO/UCSD and WHOI
15. Greg Mitchell: Bio-optical profiles: SIO/UCSD
16. Greg Mitchell: Water particle size, absorption, pigments: SIO/UCSD
17. Carin Ashjian: Towed video plankton recorder and temperature/salinity: WHOI
18. Carin Ashjian: Plankton net tows: WHOI

A.6. Cruise participants

1. Lynne Talley (SIO) - Chief scientist - ltalley@ucsd.edu
2. David Newton (SIO) - Programmer, LADCP, deck watch - dnewton@ucsd.edu
3. Carl Mattson (SIO/ODF) - ODF Tech-in-Charge/Electronics/Deck watch - cmattson@ucsd.edu
4. Doug Masten (SIO/ODF) - Nutrient analyst/data processing - dmasten@ucsd.edu
5. Ron Patrick (SIO/ODF) - Oxygen/Bottle data - rpatrick@ucsd.edu
6. Alexander Nedashkovskiy (POI) - Nutrients
7. Sergey Sagalaev (POI) - Oxygen
8. Joe Martin (SIO) - Salinity, deck watch, underway ADCP - jmartin@ucsd.edu
9. Michael Gorelkin (FERHRI) - Salinity
10. Igor Titov (FERHRI) - Electronics, Deck watch
11. Vladimir Luchin (FERHRI) - CTD/rosette operations, CTD console - hydromet@online.ru

12. Nikolay Rykov (FERHRI) - CTD/rosette operations
13. Vladimir Kraynev (FERHRI) - CTD/rosette operations
14. Igor Zhabin (POI) - CTD/hydrographic data management, software, processing,deck
15. Vladimir Ponamarev (POI)- CTD/hydrographic data management, software, processing
16. Pavel Tischenko (POI) - POI chemistry head, CO2 (pH by EMF)
17. Ruslan Chichkin (POI) - CO2 (pH by EMF)
18. Dong-Jin Kang (SNU) - underway chemistry, CO2 (pH by spectro.)
19. Doshik Hahm (SNU) - CO2 (pH by spectro.)
20. Elena Ilyina (POI) - CO2 (Alkalinity)
21. Maria Shvetsova (POI) - CO2 (Alkalinity)
22. Mark Warner (UW) - CFC
23. DongHa Min (UW) - CFC
24. Clare Postlethwaite (SOC) - helium, tritium, neon, argon
25. Carin Ashjian (WHOI) - VPR
26. Cabell Davis (WHOI) - VPR
27. Larry Costello (WHOI) - VPR
28. Philip Alatalo (WHOI) - VPR
29. Andrew Girard (WHOI) - VPR
30. Gregory McGrath (WHOI) - VPR
31. Greg Mitchell (SIO) - Bio-optics
32. John Wieland (SIO) - Bio-optics
33. Sergei Zakharkov (POI) - Bio-optics
34. Jeong-Eon Moon (KORDI) - Bio-optics
35. Dan Jacobson (SIO) - Revelle computer technician
36. Tammy Koonce (SIO) - Revelle resident marine technician, Deck Watch

Institution acronyms

1. FERHRHI - Far-Eastern Regional Hydrometeorological Research Institute, Vladivostok, Russia
2. SOC - Southampton Oceanograpy Centre, Southampton, UK
3. KORDI - Korea Ocean Research and Development Institute, Seoul, Korea
4. POI - Pacific Oceanological Institute, Far Eastern Branch Russian Academy of Sciences, Vladivostok, Russia
5. SIO - Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA USA
6. SIO/ODF - SIO Oceanographic Data Facility
7. SNU - Seoul National University, Seoul, Republic of Korea
8. UW - University of Washington, School of Oceanography, Box 357940, Seattle, WA 98195 USA
9. WHOI - Woods Hole Oceanographic Institution, Woods Hole, MA USA

B. Description of measurement techniques and calibration

B.1. CTD (conductivity-temperature-depth): (SIO/ODF)

B.1.1 Shipboard CTD report: Carl Mattson (SIO/ODF)

CTD data were recorded on IBM PC's. Digital backups were made on CDROMS and Zip disks. Analog backups were made on VCR cassettes.

CTDs used:
NBIS Model MKIII ODF CTD#3 stations 1-8, 9 (cast 1), 113
NBIS Model MKIII ODF CTD#5 stations 9 (cast 2)-112

The rosette consisted of:

NBIS MKIIIB CTD s/n 01-1095 (ODF ctd#3) sta 1-8, 113
NBIS MKIIIB CTD s/n 01-1070 (ODF ctd#5) sta 9-112
Sensormedics Oxygen Sensor s/n 6-12-07 sta 1-108
Sensormedics Oxygen Sensor s/n 6-12-08 sta 109
Sensormedics Oxygen Sensor s/n 6-02-08 sta 110-113
FSI OTM s/n 1322 sta 113
STS 24 bottle rosette frame
24pl Seabird pylon model SBE32 s/n 3212613-0164
Seabird Temperature Sensor SBE35 s/n 3516590-0011
SIO made Bullister style 10 liter bottles
Benthos Pinger model 2216 s/n 1275
Simrad Altimeter model 807 s/n 0711090
STS Battery Pack for Altimeter
RDI LADCP CS-150KHZ s/n 1546
LADCP Battery Pack
Wetlabs Cstar 25cm transmissometer c/n CST-244DB
Wetlabs Cstar 25cm transmissometer c/n CST-245DB

Comments:

CTD#3:

Conductivity sensor failed during Sta 9 cast 1.
Ctd#3 was replaced by CTD#5 prior to sta 9 cast 2.
FSI OTM #1322 was the second temp sensor on sta 113
The conductivity sensor drifted again on sta 113.

CTD#5:

CTD #5 has dual sensors mounted on twin turrets - two identical Temperature channels and two identical conductivity channels. CTD sensors soaked in distilled water between all casts.
Swapped sensor pair in config file starting sta 59.
PRT#2 and COND#2 were the most stable sensor pair so these were used in onboard data processing operations for both CTD and bottle data reports.
PRT#1 (after about sta92) was observed to jump about 0.0008 deg on casts greater that 3200M. It was usually observed on the upcasts coming through about 3300M then jumped back to overlap downcast trace when it comes back up - around 3000M. Could be a digital bit sticking in that channel (bit #5?).
Cond#1 sensor has a pressure effect on deep casts and will require a pressure fit correction.

Bottles:

10L Bullister style, SIO manufactured.
Bottles serial numbered 1-24 corresponded to the pylon tripping sequence 1-24 with the first bottle tripped being bottle #1.
Bottles serial numbered 1-24 were used on all casts.

Thermometers:

The SBE35 Ref temp sensor data was recorded on all bottle trips.
No DSRT's

CTD oxygen:

Oxygen data interfaced with the CTD and incorporated into the CTD data stream using a:
Sensormedics Oxygen Sensor s/n 6-12-07 sta 1-108
Sensormedics Oxygen Sensor s/n 6-12-08 sta 109
Sensormedics Oxygen Sensor s/n 6-02-08 sta 110-113

Transmissometer:

Wetlabs Cstar 25cm (Blue) Transmissometer c/n CST-244DB
Wetlabs Cstar 25cm (RED) Transmissometer c/n CST-245DB

Winches:

Forward Markey CTD winch used on all casts
No wire or winch problems throughout the cruise.

Station-Cast number assignments:

Cast numbers were assigned between the CTD and the Bio-Optical profiler depending on which was deployed first. Station 9 was the only station that the CTD was deployed on two casts.

B.1.2. CTDO (conductivity-temperature-depth-oxygen) final calibrations: Mary C. Johnson (SIO/ODF)

General comments. These HNRO7 CTD data are final. Calibrations have been carefully checked, using overlays of deep theta-salinity profiles plus surface salinity and sigma theta plots vs. pressure. The missing data from some of the steeper thermoclines have been interpolated; all interpolated/extrapolated data are quality-coded 6. Oxygen corrections from the preliminary data sent in 1999 have been applied here as a courtesy; all CTD oxygen data are coded 1 (uncalibrated).

The CTD-5 secondary T/C sensors were used as the "better" pair; both sensor pairs had significant noise on their upcasts. The numerous offsets and higher noise level on the T1/C1 downcasts outweighed the down/up "split" seen on the T2/C2 pair: upcast salinity data were typically 0 to -0.001 PSU vs downcasts below the thermocline on this leg. The calibrated downcast CTD data appear to be consistent, and the bottle salinity data were fairly well centered over the CTD data on the deep theta-salinity plots.

CTD-3 was used for the first 8 casts, then CTD-5 (with dual T/C sensors) was used for stations 9-112. A new C sensor was installed and tested during station 113. This new sensor had a large + drift with time on both down and up casts. Its calibration was brought into the realm of probability by applying an extra S(P**2) correction to the downcast salinity, based on comparison of "final" corrected salinity to the upcast bottle data.

Comments on individual station problems are found in Appendix A.

Detailed calibration comments:

```
HNRO7 CTD Configurations:

   NBIS MKIIIB CTD: s/n 01-1095 (ODF CTD#3) sta 1-8,9/1,113
      Pressure s/n 77011
      T1 s/n 15778 (T1 apparently has a long response time of 1+ seconds)
      T2 NOT PRESENT stas 1-9/1
      T2 FSI OTM s/n 1322 sta 113
```

C1 s/n O17 - cracked/failed sta 9/1 at 270mwo
C1 s/n NEW/UNKNOWN - sta 113/TEST, big + drift
C2 NONE

NBIS MKIIIB CTD: s/n 01-1070 (ODF CTD#5) sta 9/2-112
Pressure s/n 77017
Dual T/C Sensors mounted on twin turrets:
T1 s/n 15407 (sta.92: T1 jumps abt. +0.001 3300m down/back 3000m up)
C1 s/n O16 (Prs. effect on deep casts, requires a C(P) corrxn).
T2 s/n 17534
C2 s/n O24

Dual Wetlabs Cstar 25cm transmissometers - only on CTD-5 casts
(Blue) c/n CST-244DB
(RED) c/n CST-245DB

Sensormedics Oxygen Sensors:
O2 s/n 6-12-07 sta 1-108 ("new O2 sensor" sta.2 COLog)
O2 s/n 6-12-08 sta 109 ("new sensor offscale 2020db down")
O2 s/n 6-02-08 sta 110-113

Seabird Temperature Sensor SBE35 s/n 3516590-0011

CTD Sensor Calibrations:

CTD-3:
Pressure Sensor s/n 77011 (Paine):
P Calibs:
May 1999 - 0.09/29.88 deg.C bath to 6080/1191 db
Dec.1999 - 0.04/26.93/30.93 deg.C bath to 6080/1191/1191 db
cold cals: shifted -1.25 db from pre- to post-cruise calibration
warm cals: shifted -1.3+ db from pre- to post-cruise calibration
Correction used: pre-cruise P calib with 0.65 offset
(in effect, averaging the two calibs)

Temperature Sensor s/n 15778 (Rosemount PRT):
T Calibs: May 1999/June 1999/Dec.1999
(June 1999 was only a 2-point cal to re-check Tcal)
large/~0.18 deg.C slope from 0-30 deg.C
cold end fairly similar pre- to post-cruise
warm drops ~0.015 deg.C change? (Hard to tell with steep slope)
Correction used: equally weighted May + Dec. 1999 Tcals
(same #pts at each level, same # of levels) - then averaged

Conductivity Sensor s/n O17 (GO): stations 1-8
Calibrated to bottle salts taken during cruise.
Stations 1-7 were off by themselves across a channel at the
south end of the cruise track. Station 8 was between
the coast and station 9. All 8 casts were less than
140 db in depth, so a simple offset was applied to
Conductivity in 4 groups of 1-3 casts. The bottle-CTD
differences were extremely inconsistent, as typical
for shallow casts with high gradients. The most
weight was given to lowest-gradient areas; residual
salinity differences have at least 2 near-0 values
for all but station 1. Station 1 was offset the same
as station 2, based on past experience with the slow

drift typically seen over the first few casts a
conductivity sensor is used.

Conductivity Sensor s/n UNKNOWN (GO?): station 113
Calibrated to bottle salts taken during cruise.
This sensor had a large + Conductivity drift with time during
the cast, and it was only used once. The upcast data
were noisy, but needed for values reported with bottle
data. The down cast data clearly required a different
correction than the up cast.
1. A first-order dC(C) slope based on bottle-CTD (up cast)
differences was determined, then applied to both down
and up cast CTD data.
2. Residual bottle-CTD (down cast) Salinity differences were
visually grabbed from a theta-salinity plot. A
second-order pressure-dependent fit (dS(P**2)) was
generated and applied separately for down and up casts.
These fits were applied IN ADDITION TO the dC(C) slope
determined in step 1.
3. A deep Theta-Salinity overlay of stations 113, 58 and 59
was checked for consistency. Station 113 was positioned
between stations 58 and 59.

CTD-5:
Pressure Sensor s/n 77017 (Paine):
P Calibs:
May 1999 - 0.075/29.695 deg.C bath to 6080/1191 db
Oct.1999 - 0.1/28.85 deg.C bath to 6080/1191 db
cold cal: shifted -0.35/-0.5/-0.6 db top 1000db/mid-range/4000db
from pre- to post-cruise calibration
warm cal: shifted +0.3 top 1000db/mid-range and no change at bottom
Correction used: average pre-/post-cruise cold and warm P calibs

(T2) Temperature Sensor s/n 17534 (Rosemount PRT):
T Calibs: May 1999/Oct.1999
+0.0007 deg.C at 0 deg.C, +0.0002 deg.C at 11 and 30 deg.C
from pre- to post-cruise calibration
Correction used: equally weighted May + Dec. 1999 Tcals
(same #pts at each level, same # of levels) - then averaged

(C2) Conductivity Sensor s/n O24 (GO):
Calibrated to bottle salts taken during cruises (HNRO7+KH36 used same
sensors for this CTD, Cond. corrections determined in tandem)
1. For each cruise, generated first-order dC(C) fits with a (4,2)
std.dev. rejection using Bottle-CTD Cond. differences outside
the high gradient areas (used pressures < 25 db or > 200 db).
This omitted most of the high-gradient bottle-CTD scatter.
Also, numerous KH36 casts were omitted from these fits because
their down-up CTD differences were more than +/-0.0015 mS/cm.
2. An average of the coefficients for HNRO7 and KH36 (from the dC(C)
fits done in step 1) was applied to both data sets, then
residual offsets were plotted and checked.
3. Offsets seemed to slowly but steadily increase within each leg.
For each cruise, generated and applied a first-order fit of
the residual Conductivity offsets, using only differences
below 400db with a (4,2) std.dev. rejection. Additionally,
a few large bottle-CTD differences were manually omitted
from these fits.

4. Offsets were then manually adjusted from the smoothed values based on deep theta-salinity consistency. Numerous Autosal runs were disregarded because of standardization issues caused by instrument problems and operator inexperience (frequent standard dial changes and drifts on many stations, espec. the first 20 stations of KH36). If the CTD data were consistent before adjustment, they were generally not shifted apart merely to match bottle data. Some data were shifted due to down vs. up cast differences (down cast CTD data are reported, but bottles are compared to up cast CTD data at the time of the bottle trips.)
5. A residual pressure-dependent slope was quite apparent at this point. A first-order dC(P) fit was determined for each cruise, based only on differences deeper than 250 db and using a (4,2) std.dev. rejection. (Thermocline and surface bottles, often also in high gradients, distorted the fits, so only deeper pressures were used.)
6. The HNRO7 and KH36 dC(P) coefficients from step 5 were averaged together, and then applied to CTD-5 data from both cruises. The dC(P) and dC(C) coefficients were both used, with the two Conductivity offsets added together.
7. Deep Theta-Salinity overlays of 8 consecutive casts, as well as non-consecutive stations in close proximity to each other based on position and/or depth, were checked for consistency.

B.2. Salinity analyses: Carl Mattson (SIO/ODF)

SALINOMETER TYPES SERIAL NUMBERS

Guildline 8400A Autosal 55-503
Guildline 8400A Autosal 48-263

WORMLEY standard water used:

Batch P-134
203 vials used
2 bad vials

Comments:

Autosals were configured for computer-aided measurement. The data were acquired on a PC.

#48-263 stations 1-113 24 deg bath temp

B.3. Oxygen water sample analyses: Carl Mattson and Ron Patrick (SIO/ODF)

Oxygens were run on all stations using a Dosimat UV-endpoint detection automatic titration system.

Comments:

No major problems, hardly any problems.
The titrator employed a Brinkman Dosimat 665 automatic burette and an Ultraviolet detection system interfaced with a PC for data acquisition and control.

B.4. Nutrient analyses: Carl Mattson and Doug Masten (SIO/ODF)

Nutrients were measured on all stations using a Technicon AA-II CFA system with a PC based acquisition system. Nutrients measured - NO2, NO3, PO4, SIO3.

Comments:

The system performed well with few problems. Data were reviewed by analysts and transferred to the processing computer for integration with other water sample data.

B.5. Chlorofluorocarbon measurements: Mark Warner and DongHa Min (UW)

The measurement of chlorofluorocarbons, CFC-11 and CFC-12, in seawater and the overlying atmosphere during the JES expedition (Hahnaro 7) were made using standard analytical techniques. The analysis was based upon the purge-and-trap technique described by Bullister and Weiss (1988) with a few modifications. The same volume of water for every sample was purged through the use of a glass sample chamber with a calibrated volume. Ultra high purity nitrogen (99.999% pure) was used as the carrier gas. (An analysis of the CFC content found less than 1 part per trillion of both CFC-11 and CFC-12). A Hewlett- Packard 5890-II gas chromatograph with electron capture detector was used to detect the CFCs. The analog output (voltage) of the detector was converted to a digital signal by a Hewlett-Packard 35900E and the digital chromatograms analyzed on a Sun Sparcstation LX using software developed by Peter Salameh for the AGAGE program. The results are reported on the SIO 1993 scale using a calibrated standard gas cylinder (#39765).

Only minor analytical difficulties were encountered during the cruise. The water sample is introduced into the sparging chamber through the glass frit. After Station 8, the stripping chamber was replaced due to the frit having become clogged with particles (probably from previous measurements of estuarine waters with high sediment loads). This greatly improved the flow through the stripping chamber and hence the efficiency with which gases were sparged from the sample. The sensitivity of the detector to an injection of a calibrated volume of the standard gas was steady during the cruise with a standard deviation of +/-0.90% for CFC-12 and +/-1.31% for CFC-11. Calibration curves were prepared while in port in Pusan and additional points were added to the curves during the course of the expedition. These additional points fitted the initial curve so that one calibration curve could be used for the entire 23 days.

The CFC concentrations in approximately 1220 seawater samples were analyzed during the expedition. Samples were collected from 111 of the 112 stations with the typical sampling strategy of alternating casts with complete coverage of the water column (16 to 20 samples) and casts where only 6 to 10 samples were collected at target depths (usually the bottom or the East Sea Intermediate Water layer). Of these 1220 samples, approximately 40 were duplicates from the same Niskin to establish the measurement precision. The shipboard measurements have been merged into the .SEA files. The precision appears to meet or exceed WOCE standards (standard deviation of 1.5% or 0.005 pmol/kg, whichever is greater). Surface CFC concentrations are at or slightly above the expected values based on Warner and Weiss (1985) solubilities. Since there are CFCs throughout the entire water column, the typical method of using the measured CFC concentrations in waters which should be CFC-free to estimate the sampling blank cannot be applied. Instead, the results of a experiment where CFC-free water in a Niskin, produced by bubbling nitrogen through the sample, is allowed to sit. By measuring the change in CFC concentration with time, the amount of contamination due to desorption can be estimated.

In preparation for the collection of samples during the expedition of the Professor Khromov, seawater samples were also collected in glass ampoules and flame-sealed for later analysis at the University of Washington. Ampoule samples were collected from 137 bottles immediately after the syringe sample for shipboard analysis was drawn. We plan for the Russians to collect approximately 700 samples during the Khromov trip. The comparison of the ampoules and shipboard measurements from this expedition will be critical to our interpretation of the stored samples.

The atmospheric concentrations of the CFCs were determined at 20 locations and times during the cruise. Air samples were pumped from the bow through Decabon tubing to the analytical system. The measured atmospheric concentrations of CFC-11 and CFC-12 both decreased with increasing latitude. The mean and standard deviations for the atmospheric CFC concentrations (in ppt) are:

CFC-11: 256.5 +/- 5.3
CFC-12: 538.8 +/- 8.3
CFC-113: 81.5 +/- 2.4

B.6. Alkalinity and pH: Pavel Tischenko (POI) and Dong-Jin Kang (SNU)

B.6.a. Pacific Oceanological institute (Pavel Tishchenko)

Samples were collected and analyzed for pH and alkalinity from every station. The methods and results of a comparison with the SNU system are described in B.6.c.

B.6.b. Seoul National University (Dong-Jin Kang)

Samples were collected and analyzed from 15 stations for comparison with the POI analysis. The methods and results are described in B.6.c.

B.6.c. Intercomparison of Alkalinity and pH measurements between SNU and POI: Preliminary Report (Dong-Jin Kang and Pavel Tischenko)

Introduction

The carbonate system in seawater is one of the most complex topics in oceanography. More recently the fate of fossil fuel CO_2 in the ocean has promoted interests in the study of carbonate chemistry in the ocean. The biogeochemical cycle of CO_2 in the ocean is controlled by its special pumping mechanism such as solubility, biological, carbonate, and dynamic pumps (Volk and Hoffer, 1985; Sarmiento et al., 1995). Among these pumps, dynamic pump is strongly related with circulation and/or ventilation of seawater. In order to quantify the dynamic pump, precise understanding the distribution of CO_2 parameters is essential.

Four CO_2 parameters can be measured, which are total dissolved inorganic carbon (C_T), total alkalinity (TA), fugacity of CO_2 (fCO_2), and total hydrogen ion concentration (pH). These are used together with ancillary information to obtain a complete description of the carbonate system in seawater. It is only necessary to know two parameters from the four above to have a complete description of the system (Park, 1969; Skirrow, 1975). TA and pH are usually chosen since their procedures are simple to be carried out on board.

There are several methods to determine TA and pH in seawater. Methods for TA determination are single point titration, open-cell potentiometric titration, closed-cell potentiometric titration, colorimetric titration and so on. Potentiometric and spectrophotometric methods are used for pH determination in seawater.

The potentiometric titration measuring EMF in a closed cell (Dickson, 1981; Bradshaw and Brewer, 1988; Millero et al., 1993; DOE, 1994) and s pectrophotometry using an indicator dye are, in general, accepted as modern analytical methods for the measurement of TA in seawater, respectively. Although it is considered that these methods give accurate information on the carbonate chemistry of seawater, those have some disadvantages when those are carried out on board. As for pH, the spectrophotometric performance of the instrument is not easy on board, which is one of the most important factors for precise determination of pH (DOE, 1994). It takes long time to analysis TA since the electrode needs times to adjust to changing EMF.

Seoul National University (SNU) uses spectrophotometry and closed-cell potentiometric titration for pH and TA measurements, respectively. The potentiometric pH measurement and direct colorimetric titration for TA are used by Pacific Oceanological Institute (POI).

On board intercomparison study was carried out during the Hahnaro-7 expedition on the East/Japan Sea. Around 130 seawater samples from surface to more than 3000 m depth were analyzed by both methods. The preliminary results are reported in here.

Methods and Materials

Total Hydrogen Ion Concentration (pH)

SNU used spectrophotometry using m-cresol purple as an indicator dye (Clayton and Byrn, 1993). The absorbances of seawater and sea water with dye are measured at three wavelengths (434, 578, and 730 nm) which are corresponding to the absorption maxima of acid (434 nm) and base (578 nm) forms of the dye and a non-absorbing wavelength (730 nm). The pH values are calculated from the absorbance of seawater and seawater + dye at three wavelength using the following equation.

$$pH = pK_2 + \log\left(\frac{A_1/A_2 - \varepsilon_1(HI^-)/\varepsilon_2(HI^-)}{\varepsilon_1(I^{2-})/\varepsilon_2(HI^-) - (A_1/A_2)\varepsilon_2(I^{2-})/\varepsilon_2(HI^-)}\right)$$

A_1 and A_2 are the corrected absorbances measured at the wavelengths of 578 and 434 nm, respectively. pK_2 is the acid dissociation constant for the species HI^- which is a function of salinity and temperature (in K);

$$pK_2 = \frac{1245.69}{T} + 3.8275 + 0.00211(35 - S)$$

The various extinction coefficient ratios for *m*-cresol purple are as follows:

$$epsilon_1(HI^-)/\ epsilon_2(HI^-) = 0.0069$$

$$epsilon_1(I^{2-})/\ epsilon_2(HI^-) = 2.222$$

$$epsilon_2(I^{2-})/\ epsilon_2(HI^-) = 0.133$$

All SNU data reported here are averaged value of duplicate analysis. The average precision of duplicate analysis is 0.006 pH unit is one standard deviation.

POI used potentiometric measurement in a potential cell without liquid junction for pH measurements of seawater, since it was reported that unreproducibility and loss of accuracy of potentiometric pH measurement are caused by liquid junction potential (Tishchenko and Pavlova, 1999).

ss-electrode-Na^+	Test (standard) solution	H^+-glass-electrode	(A)

The cell (A) was calibrated by T RIS-buffer (DelValls and Dickson, 1998) at 25 ^oC and pH is calculated by formula:

$$pH = 8.0936 + \frac{Es - Ex}{59.16} + \log(\gamma_{Na} m_{Na})_s - \log(\gamma_{Na} m_{Na})_x$$

where E, m_{Na}, and g_{Na} are EMF, sodium ion molality and activity coefficient of sodium ion, respectively; subscript indices s, x denote standard and test solutions, respectively. Activity coefficients of sodium ion have been calculated by Pitzer method (Pitzer, 1992) and approximated by empirical formula below.

Properties of sodium ion as follows

$(m_{Na})_s = 0.44618$

$(g_{Na})_s = 0.6412$

$$(m_{Na})_x = \frac{13.872 \cdot S}{1000 - 1.00511 \cdot S}$$

$$\ln(\gamma_{Na})_x = -1.16136538\, I^{\frac{1}{2}} + 1.42600287\, I - 1.296741\, I^{\frac{3}{2}} + 0.74600499\, I^2 - 0.183781317\, I^{\frac{5}{2}}$$

where *S* is salinity; *I* is an ionic strength which calculated by equation

$$I = \frac{19.9273 \cdot S}{1000 - 1.00511 \cdot S}$$

Shift of a standard EMF of the cell (A) was less then 0.5 mV/ per day. The precision of pH measurement by means of the cell (A) is about ± 0.004 pH unit.

Total Alkalinity (TA)

SNU used potentiometric titration measuring EMF in a completely closed cell (Millero et al., 1993). The system is composed by a motor driven piston burette (5 mL, scale ± 0.01 mL) with anti-diffusion tip, titration cell assembly, and personal 0.02 computer for controlling burette and data acquisition from pH meter. Orion double junction Ag/AgCl reference electrode and ROSS glass electrode are used as reference and EMF electrodes, respectively. The titration cell and burette piston are inco rporated with outer water jackets which constant temperature (25.0 +- 0.1C) water circulates through. The titration procedure is controlled by personal computer through serial ports. Total alkalinity is calculated by non-linear least squares approach method (Dickson, 1981; Johansson and Wedborg, 1982; DOE, 1994).

Total alkalinity is normalized by Dicksons CRMs (Batch #46) which are measured at every station. It take 40 to 50 minutes to complete titration including flushing. The average precision of duplicate analysis is 4.5 umol kg^{-1} in one standad deviation.

POI used Bruevich's Method. In Russia a determination of total alkalinity is direct colorimetric titration by hydrochloric acid in an open system using a mixed indicator (methylene blue and methyl red). The titration is carried out under flow of CO_2-free air (or nitrogen). The change of the sample color from green to light-pink at the equivalence point is detected by visually. The pH at the end point is about 5.4-5.5. The method is well-known as Bruevich's method (Bruevich, 1944) and recommended as standard operating procedure among Russian oceanographers (The methods..., 1978). The titration procedure is presented below.

The acid (~0.03 N) is standardized daily with Dickson's CRM. The calibrated 0.04 volumetric pipette (25 mL) is used. Twenty-five milliliters of the primary standard is placed in a titration cell. Three drops of the mixed indicator are added and the sample is flushed with nitrogen for 3 min to remove all the carbon dioxide. CRM is then titrated with hydrochloric acid using Dosimat 665 motor driven piston burette (5 mL, scale ± 0.01 mL). The equivalence point of the titration is determined 0.02 colorimetrically. The solution color at the end point of the titration must be light pink and quite stable (no change for 1 min). Seawater samples are analyzed using the same procedure. Total titration time takes about 7 min. Alkalinity is calculated by formula

$TA=N_aV_a/(V_{sw}\ d_{sw})$

Here, N_a, and V_a, are normality and volume of acid, respectively; V_{sw} and d_{sw} are volume and density of seawater. Estimated precision is about 0.2% (4 ~ 5 umol kg^{-1}).

The both methods are summarized briefly in Table 1.

Table 1. Summary of the methods for total alkalinity (TA) and pH by Seoul National University (SNU) and Pacific Oceanography Institute (POI)

		SNU	POI
TA	Cell type	Closed	Open
	End Pt detection	EMF	Visual Indicator
	Calculation	Non-linear Least Square < /TD>	Algebraic formula
	Acid	~ 0.25 N HCl	~ 0.02 N HCl
	Acid Std.	Na_2CO_3 and CRM	Na_2CO_3 and CRM
	Precision	4.5 umol kg^{-1}	4 ~ 5 umol kg^{-1}
PH		Spectrophotometry Using mCP	EMF Without liquid junction
	Precision	0.006	0.004

Materials

During the Hahnaro-7 expedition in the East(Japan) Sea from 24th June to 17th July, 1999, around 130 real seawater samples from the surface to more than 3500 m depth at 12 stations were used for intercomparison (Table 2).

Table 2. Locations, water depth (in meters), and number of samples of each station for intercomparison of total alkalinity and pH measurements between SNU and POI.

ta. #	Latitude	Longitude	Depth	No. of Samples
4	34 49.9 N	130 11.9 E	124	7
13	36 12.0 N	132 27.6 E	1074	10
26	37 3.45 N	130 56.2 E	2207	7
41	37 53.7 N	129 44.1 E	1626	8
45	37 53.8 N	132 41.8 E	2530	11
57	40 50.0 N	134 00.0 E	3530	13
58	41 10.0 N	136 20.0 E	3450	13
72	37 11.0 N	135 32.1 E	1739	13
77	38 38.0 N	136 00.0 E	2725	12
80	39 59.8	138 00.1 E	2420	11
95	42 0.00 N	138 00.0 E	3585	13
08	43 47 N	138 50 E	2970	?

Results

Total Hydrogen Ion Concentration (pH). The pH values of two laboratories are in a good agreement (Fig. 1). However, the slope between two data sets is about 5 % greater than equivalence (pH_{POI} = 1.056 x pH_{SNU} - 0.479, r^2=0.991). The differences between two are almost within 0 +- 0.1 when pH value is higher than 7.8 with some exceptions. While, in the case of smaller pH values than 7.8, the differences increase linearly as pH values decrease. It becomes about 0.35 at pH value of 7.5 (Fig. 2). This difference (0.35) is not negligible compared with precisions of both methods (0.004 ~ 0.006). Since typical profile of pH in the region (East/Japan Sea) shows around 7.5 of pH from 200 ~ 300 m depth to the bottom (Fig. 3), it can be said that there are differences in vertical distributions between two methods. The reason of the difference is to be studied carefully in the future.

Total Alkalinity (TA). Normalized total alkalinity (NTA = TA x 35/S; S represents salinity) values of two laboratories show linear relationship, in general. How ever, it is seemed that there is a systematic difference between two methods (Fig. 4). POI values (open cell) are smaller to about 5 ~ 10 umol kg^{-1} than SNU values (closed cell). In the PICES WG13 intercomparison workshop, which was held at Tsukuba, Japan in April, 1999, the closed system

shows higher values and open system shows lower than mean values for samples of high pCO_2 concentration. This study gives coincident results with those of the PICES intercomparison workshop.

The differences between two methods increase as NTA increases until NTA reaches around 2330 ~ 2340 umol kg^{-1}, and then it can be said that the differences keep constant in the range of NTA higher than 2340 umol kg^{-1} (Fig. 5). From the vertical profiles, NTA of this range is found within 100 and 500 m (Fig. 3), which is similar with the depth which shows constant pH differences.

The causes of the differences between two methods will be studied carefully in the future.

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Figures (SNU)

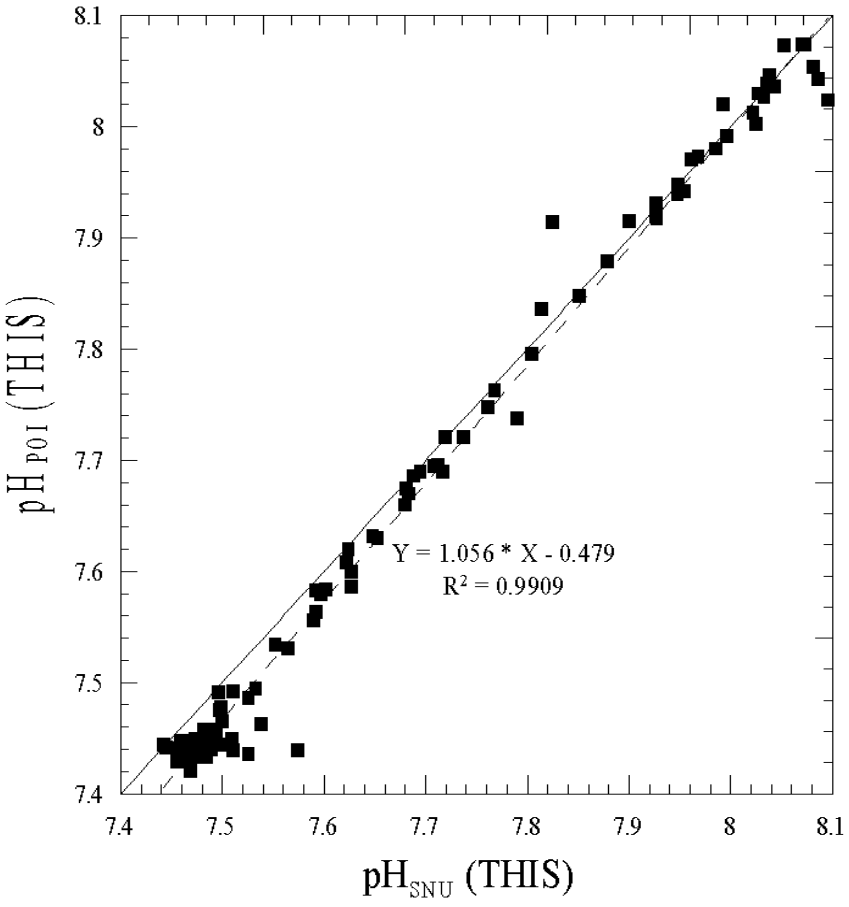

Fig. 1

Figure 1. A plot of pH values from SNU and POI. The units are in total hydrogen ion scale (THIS).

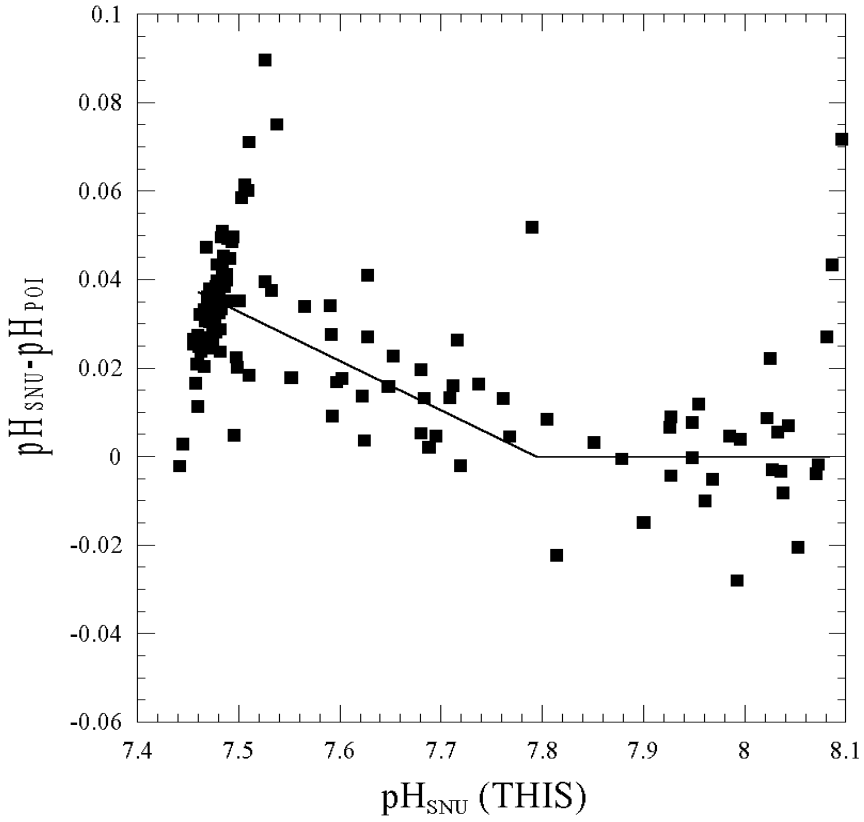

Fig. 2

Figure 2. A plot of pH differences between two methods vs. pH values of SNU. The units are same as Fig. 1.

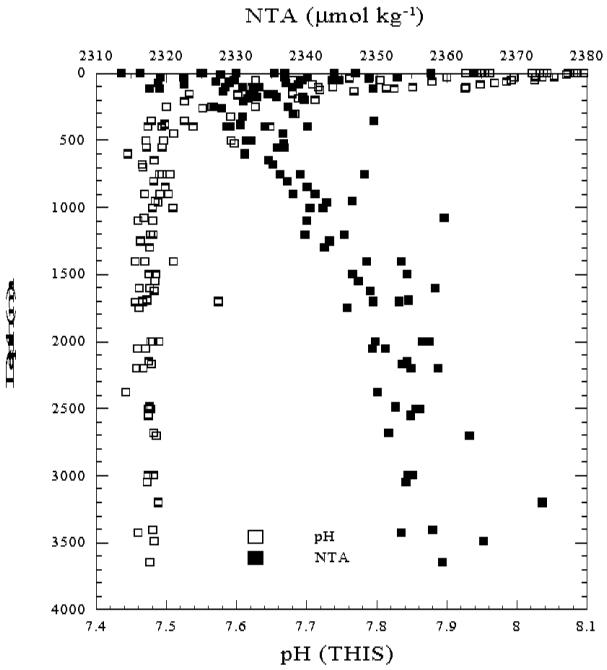

Fig. 3

Figure 3. Vertical distributions of pH and normalized total alkalinity (NTA) for all stations. The units of NTA are in umol kg^{-1}. The depths are from the wire out data.

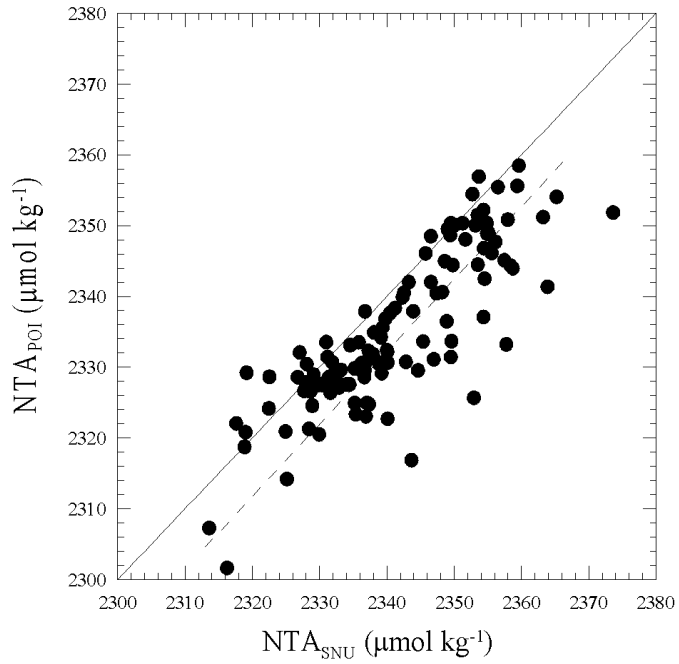

Fig. 4

Figure 4. A plot of normalized total alkalinity (NTA) values from SNU and POI. The units are same as Fig. 3.

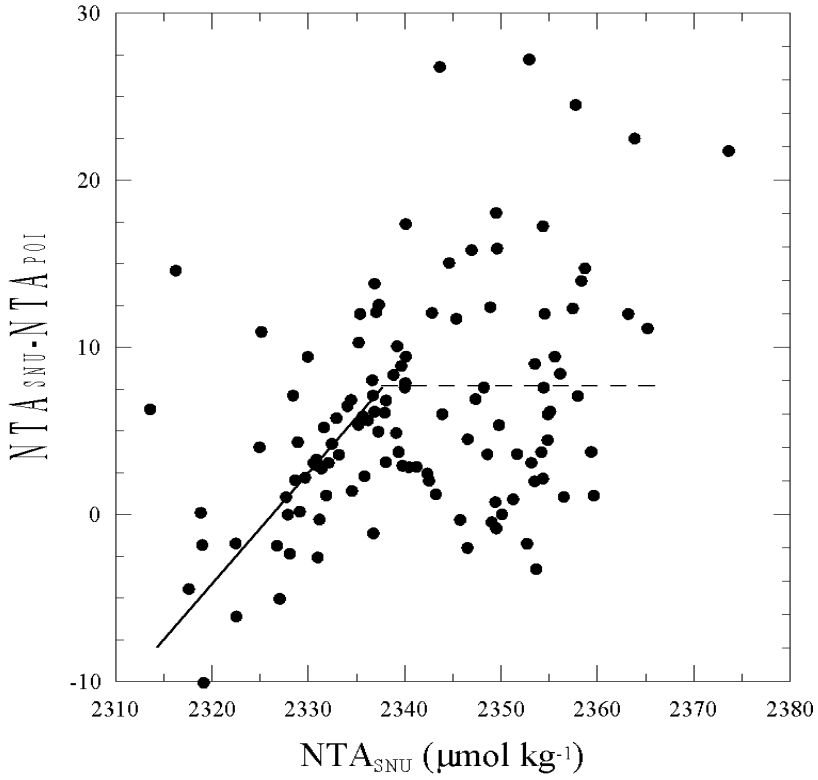

Fig. 5

Figure 5. A plot of NTA differences between two methods vs. NTA values of SNU. The units are same as Fig. 3.

B.7. Noble Gas and Tritium Sampling: Clare Postlethwaite (SOC)

280 water samples from 22 stations, located mainly in the deepest parts of the basins and also in the straits, were collected for noble gas and tritium analysis. Water samples were collected from the rosette in 15mm diameter copper tube for analysis of helium, neon, argon and possibly krypton and xenon. The copper tube was cold sealed and the samples were packed safely for later analysis. All noble gas samples were collected in duplicate and several samples were collected in quadruplicate. The noble gas measurements will help to quantify the influence that the seasonal sea ice in the Tatarskiy Strait has on water mass formation in the Japan/East Sea.

Samples for tritium analysis were collected concurrently to the noble gas samples so that tritium/helium dating is possible. These samples were collected in one litre glass bottles that had been pretreated by heating to 200 degrees centigrade in an argon atmosphere. During sampling the bottles were not rinsed and a head space was left. These samples were also packed for later analysis at the Noble Gas Laboratory at the University of Southampton, U.K.

B.8. Oxygen Isotope Sampling: Clare Postlethwaite (SOC)

100 water samples from 11 stations were collected in 300ml glass bottles for the analysis of oxygen isotopes. The glass bottles had been treated in the same way as those for tritium analysis. The stations chosen for the noble gas and tritium analysis as the volumes of water taken in the samples may be sufficient to allow both tritium and oxygen isotope analysis from both the 1 litre and 300 ml bottles thereby providing more data.

B.9. Other SNU sampling (helium, tritium, D-14, Del 18O, SF6): Dong-Jin Kang (SNU)

Samples for other tracers were collected for SNU. The numbers of stations for each tracer are 9 for helium and tritium, 6 for C-14, 23 for Del 18O of water, and 1 for SF6. All of these will be measured in the laboratory. Helium and tritium will be determined by noble gas mass spectrometer after series of pretreatment. C-14 will be measured by Accelerating Mass Spectrometer from CO2 extracted in seawater. Del 18O will be analyzed using stable isotope ratio mass spectrometer. SF6 will be measured by GC/ECD.

B.10. Underway pCO2 measurements: Dong-Jin Kang, Doshik Hahm (SNU)

B.10.a. pCO2 measurements. Continuous measurements of pCO2 in surface water and marine air were made with a laboratory made system. The system is composed with an NDIR (Licor LI-6252), valve sets, and Weiss type equilibrator. The system is controlled and data are acquired at every second by laboratory made program in LabVIEW on a PC. Two kinds of standard gas were measured every day. Marine air and equilibrated air with surface seawater were measured alternatively was measured at every other cycle of marine and equilibrated air.

B.10.b. Thermosalinograph measurements. Salinity, temperature, and chlorophyll fluorescence were measured at every minute with Seabird thermosalinograph (SBE 21) with Wet Lab fluorometer. The location was recorded at every minute with GPS (Trimble NT100). The temperature and conductivity sensors were calibrated two months before the cruise by manufacturer.

B.10.c. Underway chlorophyll sampling. To calibrate the fluorometer, chlorophyll samples were taken every 12 hours. About 4 liters of samples were collected from the outlet of fluorometer, and filtered immediately using GF/F. After more than 24 hour extraction with 90 % acetone, chlorophyll concentration was determined by Turner design fluorometer by Dr. G. Mitchell.

B.11. Acoustic doppler current profiling (ADCP): Lynne Talley (SIO) and Peter Hacker (U. Hawaii)

B.11.a. Lowered ADCP.

A 150 KHz RD Instruments acoustic doppler current profiler was integrated with the CTD/rosette package. The LADCP makes direct current measurements at the depth of the CTD, thus providing a full profile of velocity. The LADCP was used at every station. The shipboard data acquisition system for the LADCP permits data acquisition on a laptop PC and very preliminary processing on a small Sparc workstation. When the data set is returned to SIO and the U. of Hawaii, preliminary processing will determine if the data set is useful for processing. Criteria include the presence of scatterers in the water column and good data profiles. Assuming that the data set is useful, data processing will be carried out by Scripps and U. Hawaii researchers. Preliminary profiles plotted from the LADCP at sea indicate that the data set looks promising and useful. (Talley group at SIO; Hacker/Firing group at U. Hawaii).

B.11.b. Underway ADCP.

ADCP data were recorded by the Revelle computer system. Rudimentary processing was carried out during the cruise to ensure that data files were complete. Preliminary checks suggest that no data were recorded for the interval between CTD stations 57 and 58.

B.12. Meteorology: R/V Revelle (Talley; SIO)

IMET data were recorded at 30 sec intervals on the ship's underway system. Final data can be accessed from website of Robert Beardsley and Richard Limeburner http://www.whoi.edu/science/PO/japan_sea, under Ship-based Met Measurements.

Sensors: Air Temp, RH, Barometric pressure, SWR, LWR, Precipitation, Wind Speed/Direction, Sea Surface Temperature/Conductivity. Data merged with Ships navigation, gyro and time server.

B.13. Navigation: R/V Revelle (Talley; SIO)

Navigation was recorded from both a P-code GPS and an Ashtech GPS. The P-code recorded data were corrupted for the period July 7, 1999 at 1043 to July 7, 1999 at 2356. Positions were restored from the Ashtech GPS for this period for the data file that was distributed at the conclusion of the cruise. There was apparently no problem with the real-time positions displayed on the bridge and in the lab, and so the station positions are correct.

B.14. Bathymetry: R/V Revelle (Talley; SIO)

Underway bathymetry from the center return of the Revelle's Seabeam was recorded and stored for use with the vertical sections. Bathymetry from the Knudsen echosounder was also recorded, and was used to restore portions of the Seabeam bathymetry which were not recorded. These include the Tsushima Strait section (stations 1 to 7) and the segment between stations 27 and 29, at times 990629 0453, June 29 to 0939, June 29. The Knudsen echosounder also was not functioning for a portion of the missing Tsushima Strait section and so detailed underway bathymetry is not available for this portion.

B.15. Video Plankton Recorder (VPR): Carin Ashjian (WHOI)

We described aspects of the biological oceanography of the Japan/East Sea, in particular how plankton communities and abundances changed in the different hydrographic regimes. Our research had three primary objectives: 1) To characterize the zooplankton community of the Japan Sea in terms of taxonomic composition and size structure, 2) To characterize the scales of variability of the zooplankton over distances from centimeters to hundreds of kilometers, and 3) to determine the relationship between zooplankton taxa and associated environmental variables over scales from centimeters to hundreds of kilometers. To achieve these goals, we conducted a survey of the southern Japan Sea using the Video Plankton Recorder. The Video Plankton Recorder (VPR) is essentially an underwater microscope which images plankton at two different magnifications. The instrument is mounted on a V-fin which was towed behind the ship, undulating between the surface and a selected depth. Video images and associated hydrographic and biological data are transmitted from the towed vehicle to the ship via fiber optic cable. In-focus images of plankton are extracted from the video and identified to taxa in real time. Plankton abundances and hydrography are plotted in real time.

During the survey of the JES, we towed the VPR at ~9 knots between all CTD stations along the transect lines. We sampled over a total distance of 356 2 kilometers and collected and processed over 240 hours of video and associated data. The instrument sampled between near surface and 80 m for much of the survey with an inter- profile distance of ~7 kilometers.

In addition to the plankton images, we collected pressure, temperature, conductivity, fluorescence, light transmission, and ambient light data as well as logging P-Code GPS position and time (UTC) and Knudsen Echo Sounder depth. Real-time plots of hydrographic (T, S, density) and biological (fluorescence, light transmission, unidentified copepods, diatom chains, and Oithona) showed strong vertical structure in plankton distributions that were associated with the physical environment (e.g., thermocline) and regional differences in the type and abundance of plankton.

Future analyses will include: 1) describing the size distribution of taxa, 2) quantifying associations between different taxa and between taxa and environmental conditions, 3) examining the scale of variability of the distributions of zooplankton taxa, and4) incorporating instantaneous velocity measurements collected with the shipboard acoustic Doppler current profiler to estimate of flux of plankton between different hydrographic regions and in and out of the JES.

B.16. Plankton net tows: Carin Ashjian and Cabell Davis (WHOI)

We conducted 15 plankton tows using a 1-m2 (mouth area), 150 B5m mesh ring net towed obliquely between the surface and 80 m. Initial inspection of the samples indicated strong variation in taxonomic composition between the different regions. The plankton samples assisted us in identifying exotic taxa that were seen in the video images.

B.17. Bio-optical studies: Greg Mitchell (SIO)

There are three primary goals of the work:

1. Calibration and validation of SeaWiFS Ocean Color satellite. Above water spectral reflectance and atmospheric optical depth was collected with a SIMBAD hand-held radiometer during day-time CTD profiles. The SIMBAD views the ocean surface from above, and the direct beam of the sun to derive spectral reflectance. This above-water optics was supported by water samples including preparations for chlorophyll a, HPLC pigments, absorption by particles and soluble material, particulate organic carbon and inorganic minerals.

2. Parameterizations of ocean attenuation and chlorophyll specific absorption for ocean photosynthesis models. Samples were collected within the euphotic zone, as determined by Secchi Depth, to characterize both particle and soluble absorption coefficients. The particulate material was partitioned to phytoplankton and detrital components using methanol extraction and difference spectroscopy. Chlorophyll-specific phytoplankton absorption coefficients will be used for photosynthesis models. The total particle and soluble absorption will be used to model spectral attenuation coefficients of the euphotic zone.

3. Application of beam attenuation coefficient as an augmentation to CTD hydrographic profiles for determining water mass structure and circulation. Red and blue wavelength beam attenuation meters (transmissometers) are integrated with the SIO CTD system and data were collected for all CTD profiles. Water samples through out the full depth of the profiles were collected from selected stations and selected depths to characterize particulate organic carbon, particle and soluble absorption, and presence of different mineral components. Attenuation coefficients will be correlated to vertical structure in hydrographic parameters including oxygen, nutrients, salinity and temperature.

Typical station plan Water from the CTD Rosette system was collected for the surface and selected depths for selected stations (usually daytime only stations to support SIMBAD and SeaWiFS). Water was prepared by vacuum filtration in the lab. Absorption samples were analyzed on the ship. Other samples have been stored in liquid nitrogen for return shipment to SIO for analysis.. Mineral optics water samples were preserved with glutaraldehyde in glass bottles for return shipment to SIO.

Equipment

Wet Labs Cstar beam attenuation meter (red) CST-245DR
Wet Labs Cstar beam attenuation meter (blue) CST-244DB
Varian Cary 1E UV/Visible spectrophotometer 95061306
Univ. Lille SIMBAD ocean reflectance radiometer 972308

C. Distribution of data and samples to groups other than originating principal investigators

CTD data: Pavel Tischenko (POI), Vladimir Luchin (FERHRI) (7/18/99)

Water sample data (salinity, oxygen nutrients, CFCs, alkalinity, pH): Pavel Tischenko (POI), Vladimir Luchin (FERHRI), Lynne Talley (SIO), Mark Warner (UW), DongHa Min (UW), Clare Postlethwaite (SOC), Dong-Jin Kang (SNU) (7/18/99)

Lowered ADCP data: Pavel Tischenko (POI), Vladimir Luchin (FERHRI) (7/18/99)

Underway meteorology (IMET) and surface temperature/conductivity, bathymetry, navigation: Pavel Tischenko (POI), Vladimir Luchin (FERHRI), Carin Ashjian (WHOI), Dong-Jin Kang (7/18/99)

Underway ADCP data: Carin Ashjian (WHOI) (7/18/99)

pCO2 data: to be processed and distributable by 1/1/00.

Appendix A: CTD data quality comments

```
## HNRO7 notes:

071/02  hit bottom after bottle trip; truncated pseq data before hit

076/01  stopped approx. 2650m down to clear fouled Csensor: brought back up approx 50m
          (bad data started at 2606db, reversed at 2680db/back to 2619db, then down)
        solution: cut out original/fouled section and reverse/up part of yoyo
          included un-fouled second down.  Data missing from yoyo-back segment
          (2606-2618db) filled by interpolation during pressure sequencing.

## Pressure levels interpolated (missing data, or omitted instabilities at surface):

 004/01     40 db
 007/01      0 db
 009/02      0 db
 012/02      0 db
 015/01      0 db
 016/02      0 db
 018/01      0 db
 029/01      0 db
 030/01      0 db
 031/01      0 db
 048/01      0 db
 051/01      0 db
 076/01      26-28,2606-2618 db
 087/02      32 db
 093/01      0,16-22 db
 095/01      16 db
 096/01      0 db
 097/01      14-18 db
 098/02      0 db
 101/01      28-38 db
 108/01      18 db
 110/02      18-20 db
 111/01      22-24 db
 112/01      0,18 db
 113/01      0,20-22 db
   113 casts/49 levels interpolated


## Conductivity offsets:  OC = Offset Conductivity

025/01    0-2176 db    #OC +0.005 mS/cm       ## maxp = 2178

030/01 1350-1378 db    #OC +0.0015 mS/cm      ## maxp = 2352

033/02 1606-1610 db    #OC +0.003 mS/cm
033/02 1606-1614 db    #OC +0.002 mS/cm
033/02 1606-1642 db    #OC +0.0015 mS/cm
033/02 1606-1732 db    #OC +0.0015 mS/cm      ## maxp = 2180

052/01  500-546  db    #OC +0.0045 mS/cm      ## maxp = 546

057/01    0-1520 db    #OC -0.001 mS/cm       ## maxp = 3530

065/01 1202-1238 db    #OC +0.0005 mS/cm
065/01 1202-1288 db    #OC +0.0005 mS/cm
065/01 1202-1500 db    #OC +0.0085 mS/cm      ## maxp = 2262

083/01 1462-1492 db    #OC +0.0005 mS/cm
```

```
083/01 1462-1624 db    #OC +0.0005 mS/cm      ## maxp = 1624

093/01  876-914  db    #OC -0.0005 mS/cm
093/01  916-974  db    #OC +0.0005 mS/cm      ## maxp = 3676

094/02    0-1772 db    #OC -0.0015 mS/cm      ## maxp = 3694

097/01 1742-3630 db    #OC +0.0005 mS/cm      ## maxp = 3630

098/02  332-628  db    #OC -0.001 mS/cm       ## maxp = 3324

104/01    0-1328 db    #OC +0.004 mS/cm       ## maxp = 1328

105/01 1400-1454 db    #OC +0.001 mS/cm       ## maxp = 2142

106/02    0-800  db    #OC +0.0025 mS/cm
106/02    0-2610 db    #OC +0.0055 mS/cm      ## maxp = 2610


## winch stops/yoyos on down casts (not at surface or bottom of cast):

(stas 65 and 76 yoyos to clear fouled Conductivity sensor)
065/01   11 db yoyo (1501 back to 1490 db down; 3.5 mins.)   ## maxp = 2262
076/01   60 db yoyo (2680 back to 2619 db down; 4.8 mins.)   ## maxp = 2994
108/01   stop 1 min. at 324-328 db                           ## maxp = 3474
```

Appendix B: Bottle data quality comments

```
Japan East Sea
Summer 1999
R/V Roger Revelle  HNRO7
Bottle data quality comments
Contact:  Lynne D. Talley  ltalley@ucsd.edu

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Bottle Quality Comments

Remarks for deleted samples, missing samples, PI  data  com-
ments,  and  WOCE codes other than 2 from HNRO7 (HAHNARO Leg
7).  Investigation of data may include comparison of  bottle
salinity and oxygen data with CTD data, review of data plots
of the station profile and adjoining stations, and rereading
of  charts (i.e., nutrients).  Comments from the Sample Logs
and the results of ODF's investigations are included in this
report.   Units stated in these comments are degrees Celsius
for temperature, Practical Salinity Units for salinity,  and
unless otherwise noted, milliliters per liter for oxygen and
micromoles per liter for  Silicate,  Nitrate,  Nitrite,  and
Phosphate.   The first number before the comment is the cast
number (CASTNO) times 100 plus the bottle number (BTLNBR).

Station 001

Cast 1          CTD oxygen very noisy.  CTD  salinity  spikes
                in  strong T gradient.  Autosal bad, switched
                after run.

107             Delta-C  at  14db  is  0.0262.  Salinity   is
                33.769.   Sample  from  gradient  area,  salt
                analysis looks ok.

102             Sample Log: "NB2, air leak  before  venting."
                Salt  analysis  required 4 attempts.  Delta-C
                at 100db is 0.022. Footnote questionable.

Station 002

Cast 1          New CTD oxygen sensor installed  before  sta-
                tion.   CTD:  salinity  spikes.  Autosal bad,
```

switched after run.

107 Salt analysis required 4 attempts; Using first value only. Delta-C at 33db is .0053.

106 Salt much too high, delete value (qflg=4) ldt. Original salt data deleted, not backed up in ORIG directory.

104 Salt analysis required 4 attempts; Using first value only. Delta-C at 89db is -0.0005.

101 Salt too high, in gradient, suspicious (qflg = 3) ldt. Delta-C at 132db is 0.0743. Salinity is 34.401.

Station 003

107 Salt low, in gradient, probably OK (qflg=2) ldt. Delta-C at 28db is -0.0275. Salinity is 33.997. Salt analysis ok.

106 Salt high, in gradient, probably OK (qflg = 2) ldt. Salt analysis required 4 attempts; value seems high.

105 Salt too low (in constant S layer) (qflg = 4) ldt. Delta-C at 58db is -0.0942. Salinity is 34.223.

104 Delta-C at 78db is -0.0398. Salinity is 34.311. Salt analysis ok.

Station 005

106 Salt high, but in gradient, OK (qflg=2) ldt.

105 Delta-C at 72db is -0.0575. Salinity is 34.406. Salt too low, should be like 104 & 103. No notes. (qflg=4) ldt.

102 Salt sample drawn, but not analyzed. Oxygen high by ~0.13ml/L; no notes; no feature in other parameters

Station 006

Cast 1 Samples were only drawn for Bio-optics. Double samples collected for Mitchell First sample fired well above bottom

217 Samples were only drawn for Bio-optics.

214 O2 data sheet: "Oxy contaminated water, would not titrate." Delta-C at 13db is -0.0277. Salinity is 34.221. Salt analysis ok. Sample from gradient area.

215 Samples were only drawn for Bio-optics.

213 Samples were only drawn for Bio-optics.

212 Salt low, but in gradient, OK (qflg=2) ldt. Delta-C at 28db is -0.0462. Salinity is 34.407.

211 Samples were only drawn for Bio-optics.

209 Samples were only drawn for Bio-optics.

207 Samples were only drawn for Bio-optics.

205 Samples were only drawn for Bio-optics.

203 Samples were only drawn for Bio-optics.

201 Oxygen 0.02-0.03 higher than 202 & 204; no feature in other parameters for these bottles which are same.

Station 007

106 Salt high, in gradient, probably OK (qflg=2) ldt.

105 Salt low, in gradient, probably OK (qflg=2) ldt. Delta-C at 38db is -0.1277. Salinity is 34.374. Salt analysis ok.

103 Oxygen high by ~0.03ml/L vs other bottles at same theta; no feature in other parameters

Station 008

111 O-ring not seated properly." Sample Log: "Bottle 11 air leak prior to venting,

110 Delta-C at 14db is 0.0509. Salinity is 33.758. Salt analysis ok. Sample in gradient area.

106 Delta-C at 65db is -0.0871. Salinity is 34.361. Salt analysis ok. Sample in gradient area.

105 Delta-C at 75db is -0.0313. Salinity is 34.234. Salt analysis ok. Sample in gradient area.

102 Salt analysis required 4 attempts. Using first value only. Delta-C at 104db is 0.0320. Salinity is 34.082.

Station 009

Cast 1 CTD: conductivity failed at about 270 m downcast. Cast aborted. CTD: cracked conductivity sensor.

220 Delta-C at 2db is 0.4997. Salinity is 34.148. Salt analysis ok.

219 Delta-C at 15db is 0.1506. Salinity is 34.148. Salt analysis ok.

215 Delta-C at 106db is 0.1348. Salinity is 34.358. Salt analysis ok. Sample from gradient area.

213 Delta-C at 151db is 0.0238. Sample from gradient area. Salt analysis ok.

Station 010

124 Sample Log: "Bottle 24 leaker (when stopcock pushed in & vent closed)."

109 Delta-C at 755db is -0.1446. Salinity is 33.880. Analytical problems, sample reran per log.

108 Delta-C at 856db is -0.1417. Salinity is 33.883. Analytical problems, sample reran per log.

Station 011

223 Samples were only drawn for Bio-optics. Error was made with nutrient sample numbers. Duplicate samples were drawn from 24, but one was assigned to 23. Nutrient values deleted from NB23

221 Samples were only drawn for Bio-optics.

220 Delta-C at 55db is -0.0693. Salinity is 34.294. Salt analysis ok. Sample taken from gradient area.

219 Samples were only drawn for Bio-optics.

Station 012

219 Samples were only drawn for Bio-optics. Error was made with nutrient sample numbers. Duplicate samples were drawn from 20, but one was assigned to 19. Nutrient values deleted from NB19

218 Oxygen high; no notes; no feature in other parameters.

217 Delta-C at 55db is 0.0359. Salinity is 34.289. Salt analysis ok. Overlays well w/ same depth from Sta. 011.

Station 013

117 Delta-C at 29db is -0.0691. Salinity is 34.303. Salt analysis ok. Sample from gradient area.

116 Delta-C at 69db is -0.0229. Salt analysis ok. Sample from gradient area.

113 Delta-C at 130db is 0.0358. Salinity is 34.260. Salt analysis ok. Sample from gradient area.

105 Delta-C at 755 db is 0.0038, in non-gradient area.

Station 014

108 Oxygen looks high by ~0.03ml/L vs other parameters and CTDO trace; no notes Delta-C at 24db is 0.0474. Salinity is 34.099. Sample taken in gradient area. Similar feature in sta. 016 at same depth.

104 Delta-C at 144db is 0.0775. Salinity is 34.154. Sample taken in gradient area. Similar feature in Station 016 at same depth.

Station 015

108 Corrected trip file 8 was reported as 7. Shipboard processing did not update .bot file.

107 Corrected trip file 7 was reported as 6. Shipboard processing did not update .bot file.

106 DLOG - missed trip at 43.9dbar, values from .scr

105 Delta-C is -.0229. Salt analysis ok.

Station 016

Cast 2 CTD: cast 1 optics. Some double samples for optics. CTD: 01602.bot only 23 trips. Duplicated surface trip values for 23 + 24 in h00 file.

223 Samples were only drawn for Bio-optics. Error was made with nutrient sample numbers. Duplicate samples were drawn from 24, but one was assigned to 23. Nutrient values deleted from NB23 Sample Log: "Optic samplers found N23 had smaller water volume than N19 and N21 for this cast and a previous cast for which the sampler completely drained the untapped 19, 21, and 23." Possibly tripped in the air?

221 Samples were only drawn for Bio-optics.

219 Samples were only drawn for Bio-optics.

202 Delta-C is 0.0031,in non-gradient area. Salt analysis ok. Overlays well w/ sta. 017&019 vs. theta.

Station 017

223 Samples were only drawn for Bio-optics. Error was made with nutrient sample numbers. Duplicate samples were drawn from 24, but one was assigned to 23 and the other deleted. Nutrient values deleted from NB23 & reassigned to NB24

221 Delta-C is -0.0177. Sample from gradient area. Salt analysis ok. 000110 SRA

220 Sample Log: "Bottle 20 spigot pushed in on boarding." CTD: only 23 trips. need to dup surface. Delta-C at 88db is 0.0262. Salinity is 34.140. Salt analysis ok. Value overlays well w/ sta. 016 (vs theta). Salt sample taken in gradient.

209 Delta-C at 945db is 0.0537. Salinity is 34.067. Salt analysis ok. Value overlays well w/ sta. 016&018. Salt sample taken in gradient. 000110 SRA.

Station 018

123 Delta-C at 28db is 0.0256. Salinity is 34.168. Salt analysis ok. Sample from gradient area.

122 Delta-C is -0.019. Salt analysis ok. Salt sample from gradient area.

121 Salt analysis required 3 attempts, using first value only. Delta-C at 88db is 0.024. Sample from gradient area.

Station 019

123 Oxygen looks high vs other parameters and CTDO

122 Delta-C at 48db is -0.0467. Salinity is 34.392. Salt analysis ok. Sample from gradient area.

121	Oxygen looks high vs other parameters and CTDO. Salt analysis required 5 attempts. Delta-C is -.0063. Sample overlays well with Sta. 018 value from same theta and pressure.
120	Oxygen looks like duplicate of 119 and looks low vs other parameters and CTDO Delta-C at 149db is -.0243. Salt analysis ok. Salt sample from gradient area.
Station 020	
223	Samples were only drawn for Bio-optics.
220	Delta-C at 20db is 0.0312. Salinity is 34.308. Salt analysis ok. Sample from gradient area.
221	Samples were only drawn for Bio-optics.
219	Samples were only drawn for Bio-optics.
216	Delta-C at 40db is -0.0297. Salinity is 34.402. Salt analysis ok. Sample from gradient area.
217	Samples were only drawn for Bio-optics.
Station 021	
Cast 1	Sample Log: "MIN tried new sampling instrument for Freon as an exercise."
Station 022	
Cast 1	CTD: cast 2 was optics. Some double samples on cast 1. DLOG - 8 bottle trips in bot, 14 bottles? Edited .bot file and duplicated missing pressure levels.
113	Samples were only drawn for Bio-optics.
114	Delta-C at 3db is -0.05. Salinity is 33.699. Salt analysis ok. Sample from gradient area.
111	Samples were only drawn for Bio-optics.
109	Samples were only drawn for Bio-optics.
107	Samples were only drawn for Bio-optics.
105	Samples were only drawn for Bio-optics.
103	Samples were only drawn for Bio-optics.
101	Samples were only drawn for Bio-optics.
Station 023	
109	Delta-C at 3db is -0.0828. Salinity is 33.930. Salt analysis ok. Sample from gradient area.
Station 024	
102	Salt analysis required 3 attempts. Using first value only. Delta-C is 0.0014.
Station 025	
120	Salt analysis required 3 attempts. Using first value only. Delta-C is 0.0132.

Station 026

101 Salt analysis required 3 attempts, using first value only. Delta-C at 2189db is 0.0026, Salinity = 34.069.

Station 027

123 Sample Log: "N23 closed in air." Samples were only drawn for Bio-optics.

122 Samples were only drawn for Bio-optics.

120 Samples were only drawn for Bio-optics.

118 Samples were only drawn for Bio-optics.

Station 028

Cast 2 Cast 1 was optics. Some double samples on cast 2. CTD: Edited .bot file and duplicated missing press levels (~15,37,50). These were bottles 18,16,14.

220 Samples were only drawn for Bio-optics.

218 Samples were only drawn for Bio-optics.

216 Samples were only drawn for Bio-optics.

214 Samples were only drawn for Bio-optics.

207 Salt analysis required 4 attempts. Using first salt value only. Delta-C is 0.0015. 000112 SRA

Station 029

107 Sample Log: "On N7 oxy was drawn after ph/alk."

Station 030

124 Sample Log: "N24 leaking. Tripped in air?" Oxygen looks high vs other parameters, CTDO and nearby stations. Delta-C at 3db is 6.7238. Salinity is 34.090. CTS code 4. Bottle salt overlays well with surface value from STA.031 (vs theta).

Station 031

123 Salt analysis required 4 attempts (Delta-C was .0172) Using first value only, Delta-C is 0.006.

102 Salt analysis required 4 attempts. Using first value only. Delta-C at 2119db is 0.0002.

Station 032

123 Delta-C at 22db is -0.0257. Salinity is 34.320. Salt analysis ok. Sample from gradient area.

117 Deleted O2; bad.

110 Delta-C at 1211db is 0.0028. Value high vs other stations.

104 CTD: bottle 4 did not close. Hung on conducting cable at pylon. Sample Log: "Bottle did

not close."

103 CTD: NB3 looks like closed late. Nuts, oxy, salt, freon bad.

Station 033

223 Samples were only drawn for Bio-optics.

222 Delta-C at 28db is -0.0779. Salinity is 34.225. Salt analysis ok. Sample from gradient area.

220 Samples were only drawn for Bio-optics.

218 Sample Log: "Oxy on N18 - flask 1429 added 2ml MnCl2, added NaOH-NaI too late. Probably bad." Oxygen suspicious, could be slightly high.

215 Sample Log: "Oxy flask 1442 was broken. Used flask 1381 for 2nd draw.

201 Delta-C at 2179db is -0.0033. Salinity is 34.065. Salt analysis ok. Value ok vs nearby stations (vs theta).

Station 034

221 Samples were only drawn for Bio-optics.

215 Data sheet: "overtitrate - no end point" - looks OK though

207 Salt analysis required 4 attempts. Using first value only, Delta-C is 0.0011.

Station 035

118 Delta-C at 9db is -0.0273. Salinity is 33.968. Salt analysis ok. Sample from gradient area.

Station 036

101 PO4 higher than other nutrients; peak odd shape.

Station 037

112 Sample Log: "Nuts tube 12 empty." DLOG: nuts on 12 not drawn. Forgot.

Station 038

117 Samples were only drawn for Bio-optics.

116 Delta-C at 12db is -0.0408. Salinity is 34.174. Salt analysis ok.

115 Samples were only drawn for Bio-optics.

111 No nutrient value this level; no notes; NB13 run twice so probably not drawn.

112 Samples were only drawn for Bio-optics.

109 Samples were only drawn for Bio-optics.

106 Samples were only drawn for Bio-optics.

Station 039

115	Delta-C at 11db is 0.0263. Salinity is 34.200. Salt analysis ok. Sample from gradient area.
109	Nutrients higher than adjacent Sta 040 at this level; O2 low.
108	Nutrients same as NB7; other parameters look different. NB7 nutrients look correct; possible dupe draw?
Station 040	
224	Samples were only drawn for Bio-optics. Error was made with nutrient sample numbers. Duplicate samples were drawn from 23, but one was assigned to 24. Nutrient values deleted from NB24
222	Samples were only drawn for Bio-optics.
220	Samples were only drawn for Bio-optics.
212	Sample Log: " air leak on N12."
Station 041	
Cast 1	CTD: drifter 15722 deployed after station. No details in log.
123	Delta-C at 14db is -0.2184. Salinity is 33.984. Salt analysis ok. Sample from gradient area.
121	Delta-C at 50db is -0.027. Salinity is 34.090. Salt analysis ok.
108	Salt analysis required 3 attempts. Using first value only, Delta-C is 0.0007.
Station 042	
123	Delta-C at 23db is 0.0841. Salinity is 34.030. Salt analysis ok. Sample from gradient area.
Station 043	
115	Delta-C at 201db is 0.0206. Salt analysis ok. Sample from gradient area.
110	Salt analysis required 4 attempts. Using first value only, Delta-C is -0.0009.
Station 044	
124	Samples were only drawn for Bio-optics. Error was made with nutrient sample numbers. Duplicate samples were drawn from 23, but one was assigned to 24. Nutrient values deleted from NB24
122	Samples were only drawn for Bio-optics.
120	Samples were only drawn for Bio-optics.
118	Samples were only drawn for Bio-optics.
Station 045	
223	Samples were only drawn for Bio-optics. Error was made with nutrient sample numbers.

	Duplicate samples were drawn from 24, but one was assigned to 23. nutrient values deleted from NB23
220	Samples were only drawn for Bio-optics.
208	Sample Log: "Changed MnCl2 dispenser at N8."
207	Sample Log: "Spigot pushed in on N7."
206	Salt analysis required 3 attempts (Delta-C was 0.0028). Using first value only, Delta-C is 0.0007.
Station 046	
115	Sample Log: "N15 changed interior spigot O-ring after sampling."
111	O2 looks high vs other parameters. Flag oxygen questionable.
Station 048	
122	Delta-C at 19db is -0.0289. Salinity is 34.223. Salt analysis ok. Sample from gradient area.
112	Nutrient sample tube empty. Sample not drawn. Forgot?
106	Salt analysis required 3 attempts. Using first value only, Delta-C is 0.0012.
Station 049	
118	Samples were only drawn for Bio-optics.
119	Samples were only drawn for Bio-optics.
116	Samples were only drawn for Bio-optics.
114	Samples were only drawn for Bio-optics.
112	Samples were only drawn for Bio-optics.
Station 050	
223	Samples were only drawn for Bio-optics. Error was made with nutrient sample numbers. Duplicate samples were drawn from 24, but one was assigned to 23. Nutrient values deleted from NB23
222	Delta-C at 22db is -0.0352. Salinity is 34.310. Salt value overlays well with Sta. 051 vs theta. Salt analysis ok.
220	Samples were only drawn for Bio-optics.
205	Sample Log: "N5 leaking, vent not closed."
202	Delta-C at 1968db is .0031. Salt analysis ok. Salt value overlays well with other deep stations (056,059).
Station 054	
121	Delta-C at 40db is -0.0784. Salinity is 34.004. Salt analysis ok. Sample from gradient area.
Station 055	

123-124	Sample Log: N23 and N24 were not tripped.
Cast 1	CTD: winch stop at 2400m on way up. Console op noticed bottom trip had not confirmed and 1st attempt at trip at 2400m failed confirm. Carl power cycled pylon box and got to confirm at 2400m. CTD: Tripping problem. Two bottom levels did not trip. Fixed in 05501.bot file. Preliminary CTD fit not correct for this station. CTD conductivity is approx. 0.015 low. Bottle salts overlay well with other deep stations.
121	Delta-C at 19db is approx. -0.1. Salt analysis ok. Sample from gradient area.
Station 056	
122	Delta-C at 63db is 0.0252. Salinity is 34.046. Salt analysis ok.
121	Delta-C at 94db is 0.0263. Salinity is 34.059. Salt analysis ok.
118	Oxygen looks high and duplicate of 119 vs other parameters and CTDO; assume dupe draw.
Station 057	
Cast 1	CTD: no confirm at initial attempt to trip bottom bottle. Power cycled Cast 2 was optics. some double samples on cast 1. CTD: Extra bottom levels in 05701.bot removed. Preliminary CTD fit not correct for this station. CTD conductivity is approx. 0.015 to 0.018 low. Bottle salts overlay well with other deep stations.
123	Samples were only drawn for Bio-optics. Error was made with nutrient sample numbers. Duplicate samples were drawn from 24, but one was assigned to 23. Nutrient values deleted from NB23
122	Samples were only drawn for Bio-optics.
Station 058	
Cast 1	CTD: no confirm at bottom bottle; power cycled pylon box, 2nd no confirm on bottom bottle. Confirmation on 4th attempt. Cycled power 3 times. Preliminary CTD fit not correct for this station. CTD conductivity is approx. 0.015 low. Bottle salts overlay well with other deep stations.
Station 059	
123	Delta-C at 14db is 0.0563. Salinity is 33.966. Salt analysis ok. Sample from gradient area.
101	Delta-C at 3211db is -0.0025. Salinity is 34.067. Salt analysis ok. Value overlays well with nearby stations.
Station 060	
123	Delta-C at 18db is -0.0672. Salinity is 33.948. Salt analysis ok. Sample from gradient area.

111	Salt analysis required 3 attempts. Using first value only, Delta-C is 0.0011.
110	Ssalt analysis required 3 attempts. Using first value only, Delta-C is 0.0009.
Station 061	
224	Samples were only drawn for Bio-optics.
222	Samples were only drawn for Bio-optics.
220	Samples were only drawn for Bio-optics.
218	Samples were only drawn for Bio-optics.
205	Salt analysis required 4 attempts, Delta-C at 1513db is 0.0036.
204	Samples were only drawn for Bio-optics.
Station 062	
223	Samples were only drawn for Bio-optics.
220	Samples were only drawn for Bio-optics.
218	Samples were only drawn for Bio-optics.
216	Samples were only drawn for Bio-optics.
213	Delta-C at 121db is -0.0255. Salinity is 34.023. Salt analysis ok.
Station 063	
114	Salt analysis required 4 attempts. Using first value only, Delta-C is 0.0024.
112	Salt analysis required 3 attempts. Using first value only, Delta-C is 0.0017.
Station 064	
Cast 1	NO3 and PO4 look higher than nearby stations (079, 063 & 065); Especially in the deep water; F1s higher this station as well; Could be working standard pipetting error. PO4 had alot of reruns this station, but reruns look OK.
120	Sample Log: "N20 spigot pushed in."
101-124	See Cast 1 nutrient comments; code NO3 questionable. See Cast 1 nutrient comments; code PO4 questionable.
Station 066	
118	oxy in bottle 2 would not titrate. contamination in sample.
Station 067	
Cast 2	CTD: cast 1 was optics. some double samples on cast 2. Sample Log: "Sampling jumped around, not simple 1 -> 24."
223	Samples were only drawn for Bio-optics.
221	Samples were only drawn for Bio-optics.
219	Samples were only drawn for Bio-optics.

217	Samples were only drawn for Bio-optics.
211-207	Sample Log: "N7 through N11 in sunshine."
Station 068	
223	Samples were only drawn for Bio-optics.
224	Delta-C at 3db is 0.0415. Salinity is 33.981. Salt analysis required 3 attempts. Sample from gradient area.
221	Samples were only drawn for Bio-optics.
222	Delta-C at 26db is 0.0321. Salinity is 34.366. Salt analysis ok. Sample from gradient area.
219	Samples were only drawn for Bio-optics.
217	Samples were only drawn for Bio-optics.
212	Sample Log: "N12 leaking. Open vent."
Station 069	
113	Delta-C at 22db is -0.0425. Salinity is 34.267. Salt analysis ok. Sample from gradient area.
107	Delta-C at 98db is 0.0416. Salinity is 34.374. Salt analysis ok. Sample from gradient area.
106	Delta-C at 123db is 0.0298. Salinity is 34.197. Salt analysis ok. Sample from gradient area.
104	Delta-C at 178db is 0.025. Salinity is 34.100. Salt analysis ok.
Station 070	
117	Delta-C at 3db is -0.0881. Salinity is 33.933. Salt analysis ok. Sample from gradient area.
118	Samples were only drawn for Bio-optics.
115	Delta-C at 17db is -0.0733. Salinity is 34.390. Salt analysis ok. Sample from gradient area.
116	Samples were only drawn for Bio-optics.
114	Samples were only drawn for Bio-optics.
112	Samples were only drawn for Bio-optics.
110	Samples were only drawn for Bio-optics.
108	Samples were only drawn for Bio-optics.
102	Samples were only drawn for Bio-optics.
Station 071	
Cast 2	CTD: cast 1 was optics. some double samples on cast 2. Probably touched bottom. Bottom bottle tripped 6m above bottom.
221	Samples were only drawn for Bio-optics.

219	Samples were only drawn for Bio-optics.
218	Delta-C at 21db is -0.0536. Salinity is 34.306. Salt analysis ok. Sample from gradient area.
217	Samples were only drawn for Bio-optics.
215	Samples were only drawn for Bio-optics.
209	Samples were only drawn for Bio-optics.
202	O2 looks high vs other parameters; Check CTDO2 trace.
Station 072	
112	Salt analysis required 5 attempts. Value was too high. Using first salt value only. Delta-C at 606db is .0015.
Station 073	
123	Delta-C at 20db is 0.0866. Salinity is 34.432. Salt analysis ok. Sample from gradient area.
Station 074	
123	Delta-C at 14db is 0.0312. Salinity is 33.942. Salt analysis ok. Sample from gradient area.
121	Delta-C at 94db is -0.0361. Salinity is 34.080. Salt analysis ok. Sample from gradient area.
Station 075	
116	Delta-C at 22db is -0.0526. Salinity is 34.242. Salt analysis ok. Sample from gradient area.
115	Delta-C at 37db is -0.052. Salinity is 34.467. Salt analysis ok. Sample from gradient area.
106	CTD: Bottle 6 did not trip. bottle 6 did confirm. Sample Log: "N6 did not trip."
Station 076	
Cast 1	CTD: cast 2 was optics. some double samples on cast 1. Downcast stopped about 2650m to clear fouled cond sensor. Brought up about 50m then continued down. [LDT - bad data starts @ 2606, reversed up at 2682, back down at 2681]
123	Samples were only drawn for Bio-optics.
122	Samples were only drawn for Bio-optics.
106	CTD Log: "bottle 6 did not trip. bottle 6 did confirm." Sample Log: "N6 came up open."
105	Salt analysis required 3 attempts. Delta-C at 2268db was 0.003. Using first salt value only, Delta-C now 0.0015.
104	Sample Log: "N4 sampled by optics before tritium."

Station 077

223 Delta-C at 29db is 0.0704. Salinity is 34.421. Salt analysis ok. Sample from gradient area.

Station 078

122 Delta-C at 28db is -0.0506. Salinity is 34.108. Salt analysis ok. Sample from gradient area.

Station 079

124 Samples were only drawn for Bio-optics.

122 Samples were only drawn for Bio-optics.

120 Samples were only drawn for Bio-optics.

Station 080

223 Samples were only drawn for Bio-optics.

221 Samples were only drawn for Bio-optics.

222 Delta-C at 23db is 0.0386. Salinity is 34.183. Salt analysis ok. Sample from gradient area.

219 Samples were only drawn for Bio-optics.

218 Delta-C at 98db is 0.025. Salinity is 34.093. Salt analysis ok. Sample from gradient area.

Station 081

102 Oxygen looks high by ~0.03ml/L vs other parameters and CTDO; no analytical notes

Station 082

123 Delta-C at 19db is -0.0372. Salinity is 34.170. Salt analysis ok. Sample from gradient.

122 Delta-C at 44db is -0.0365. Salinity is 34.171. Salt analysis ok. Sample from gradient.

Station 083

117 Delta-C at 197db is -0.0365. Salinity is 34.084.

Station 084

124 Delta-C at 3db is 0.085. Salinity is 32.453. Salt analysis ok. Sample from strong gradient area.

124 CFC-11 at 3 db suspiciously low - check with Min

123 Delta-C at 12db is 0.2508. Salinity is 33.120. Salt analysis ok. Sample from strong gradient area.

122 Delta-C at 27db is -0.0318. Salinity is 33.991. Salt analysis ok. Sample from strong gradient area.

120 Delta-C at 83db is 0.0251. Salinity is

34.165. Salt analysis ok. Sample from strong gradient area.

Station 085

122 Samples were only drawn for Bio-optics.

120 Samples were only drawn for Bio-optics.

CFC-11 at 3 db suspiciously low - check with Min

117 Delta-C at 37db is -0.0373. Salinity is 34.115. Salt analysis ok. Sample from gradient area.

118 Samples were only drawn for Bio-optics.

116 Samples were only drawn for Bio-optics.

112 Samples were only drawn for Bio-optics.

110 Samples were only drawn for Bio-optics.

108 Samples were only drawn for Bio-optics.

106 Samples were only drawn for Bio-optics.

104 Samples were only drawn for Bio-optics.

102 Samples were only drawn for Bio-optics.

Station 086

104 Delta-C at 30db is -0.0377. Salinity is 34.170. Salt analysis ok. Sample from gradient area.

103 Oxygen looks odd vs theta; looks low by ~0.2-0.3 ml/L vs other parameters, adjacent shallow stations, and CTDO; however in shallow water and temperature gradient so could be real; no notes; leave for now.

Station 087

213 Samples were only drawn for Bio-optics.

211 Samples were only drawn for Bio-optics.

209 Samples were only drawn for Bio-optics.

206 Delta-C at 43db is 0.0445. Salinity is 34.205. Salt analysis required 3 attempts. Sample from gradient area.

207 Samples were only drawn for Bio-optics.

205 Samples were only drawn for Bio-optics.

Station 088

107 Delta-C at 23db is -0.062. Salinity is 34.035. Salt analysis ok. Sample from gradient area.

Station 089

107 Delta-C at 17db is 0.045. Salinity is 34.188. Salt analysis ok. Sample from gradient area.

105 Delta-C at 42db is 0.0287. Salinity is 34.317. Salt analysis ok. Sample from gradient area.

Station 092

123	Delta-C at 25db is 0.0299. Salinity is 34.014. Salt analysis ok. Sample from gradient area.

Station 093

124	Samples were only drawn for Bio-optics.
122	Samples were only drawn for Bio-optics.
120-121	Sample Log: "N20 and N21 spigots pushed in on boarding."

Station 094

224	Samples were only drawn for Bio-optics.
222	Delta-C at 21db is 0.0413. Salinity is 33.991. Salt analysis ok. Sample in gradient area.
220-221	Sample Log: "N20 and N21 spigots pushed in on boarding. They were okay before cast. After cast, replaced spigot inner O-rings after sampling.
204	Delta-C at 2931db is -0.0026. Salinity is 34.065. Appears slightly low compared to CTD cond.
202	Sample Log: "Oxy sampling delayed on N2 (due to Helium tube problem)."

Station 095

123	Delta-C at 10db is -0.0639. Salinity is 33.996. Salt analysis ok. Sample from gradient area.
113	Sample Log: "Not enough water in N3 and N13 for tritium sample."
103	Sample Log: "Not enough water in N3 and N13 for tritium sample."

Station 097

123	Delta-C at 17db is -0.0552. Salinity is 34.036. Salt analysis ok. Sample from gradient area.

Station 098

224	Delta-C at 3db is -0.0516. Salinity is 34.021. Salt analysis ok. Sample from gradient area.
223	Samples were only drawn for Bio-optics.
221	Samples were only drawn for Bio-optics.
206	CTD Log: "Bottle 6 did not trip. bottle 6 did confirm." Sample Log: "N6 came up open. Third occurence."

Station 099

224	Samples were only drawn for Bio-optics.
206	Samples were only drawn for Bio-optics.

Station 100

106 Sample Log: "N16 spigot pushed in on boarding."

Station 101

109 SiO3 looks high; peak OK however.

101 PO4 looks high by ~0.04uM but peak OK;

Station 103

114 Salt and nutrients not samples on NB14. No notes.

Station 104

Cast 1 Sample log was not filled in for salinity and nutrients. Not certain what else could have been missed, there were salinities and nutrients drawn.

117 Salt analysis required 5 attempts. Delta-C at 176db is -0.0071.

109-113 Sample Log: "Oxy draw temps unsure (out of order) N9 -> N13."

106 Sample Log: "N6 vent open."

Station 105

124 Samples were only drawn for Bio-optics.

120 Delta-C at 46db is 0.0305. Salinity is 34.142. Salt analysis ok. Sample from gradient area.

121 Samples were only drawn for Bio-optics.

116 Salt analysis required 3 attempts. Using first value only. Delta-C at 263db is 0.0008 (was 0.0027).

114 Salt analysis required 3 attempts. Using first value only. Delta-C at 404db is 0.0030 (was 0.0041).

Station 106

223 Samples were only drawn for Bio-optics.

221 Samples were only drawn for Bio-optics.

Station 107

120 Sample Log: "N20 spigot pushed in on boarding. Replaced spigot collar ater cast, might make it less likely to rotate and open spigot."

104 Delta-C at 2582db is -0.003. Salinity is 34.066. Salt analysis ok. Overlays well with Sta. 108/109

103 Delta-C at 2837db is -0.0037. Salinity is 34.065. Salt analysis ok. Overlays well with Sta. 108/109

102 Delta-C at 3040db is -0.0029. Salinity is 34.066. Salt analysis ok. Overlays well

	with Sta. 108/109
101	Delta-C at 3214db is -0.0034. Salinity is 34.066. Salt analysis ok. Overlays well with Sta. 108/109
Station 108	
123	Delta-C at 31db is 0.0658. Salinity is 34.123. Salt analysis ok. Sample from gradient area.
Station 109	
122	Delta-C at 54db is -0.0375. Salinity is 34.076. Salt analysis ok. Sample from gradient area.
119	Salt analysis required 3 attempts. Using first value only. Delta-C at 246db is 0.0026 (was 0.0037).
Station 110	
224	Samples were only drawn for Bio-optics.
Station 111	
105	Delta-C at 2534db is -0.0027. Salinity is 34.066. Salt analysis ok. Samples overlay well w/ Sta.110/112
103	Delta-C at 3145db is -0.0025. Salinity is 34.067. Salt analysis ok. Samples overlay well w/ Sta.110/112
102	Delta-C at 3451db is -0.003. Salinity is 34.067. Salt analysis ok. Samples overlay well w/ Sta.110/112
101	Delta-C at 3689db is -0.0029. Salinity is 34.067. Salt analysis ok. Samples overlay well w/ Sta.110/112
Station 112	
123	Delta-C at 31db is 0.0356. Salinity is 34.040. Salt analysis ok. Sample from gradient area.
112	O2 low, no obvious reason, possible dupe draw of 111, salt very slight indication of similar problem, nothing in nuts indicating leak or problem.
Station 113	
123	Delta-C at 3db is -0.0684. Salinity is 33.828. Salt analysis ok. Sample from gradient area.
123-115	O2 and Nutrients not drawn. Test cast for new CTD sensor.
124	Samples were only drawn for Freon blanks.
111	Samples were only drawn for Freon blanks.
112	O2 and Nutrients not drawn. Test cast for new CTD sensor.
113	No samples taken.

114	No samples taken.
106	Samples were only drawn for Freon blanks
107	O2 and Nutrients not drawn. Test cast for new CTD sensor.
108	No samples taken.
109	No samples taken.
110	No samples taken.
102	Samples were only drawn for Freon blanks.
103	No samples taken.
104	No samples taken.
101	O2 and Nutrients not drawn. Test cast for new CTD sensor.
105	No samples taken.