Cruise Report ONR Japan/East Sea
Hydrographic survey
R/V Professor Khromov KH36 22 July – 13 August 1999

September 1999, updated April 2006

Contents page

A. Cruise narrative

A.1 Highlights

Expedition: KH36, Legs 1 and 2
Chief Scientists (Head of Expedition):

Vladimir Luchin
Far Eastern Regional Hydrometeorological Research Institute (FERHRI)
Vladivostok, Russia
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Lynne D. Talley, Scripps Institution of Oceanography, UCSD
La Jolla, CA USA
email: ltalley@ucsd.edu

Ship: R/V Professor Khromov, Captain I. Kiselev
Ports of Call:

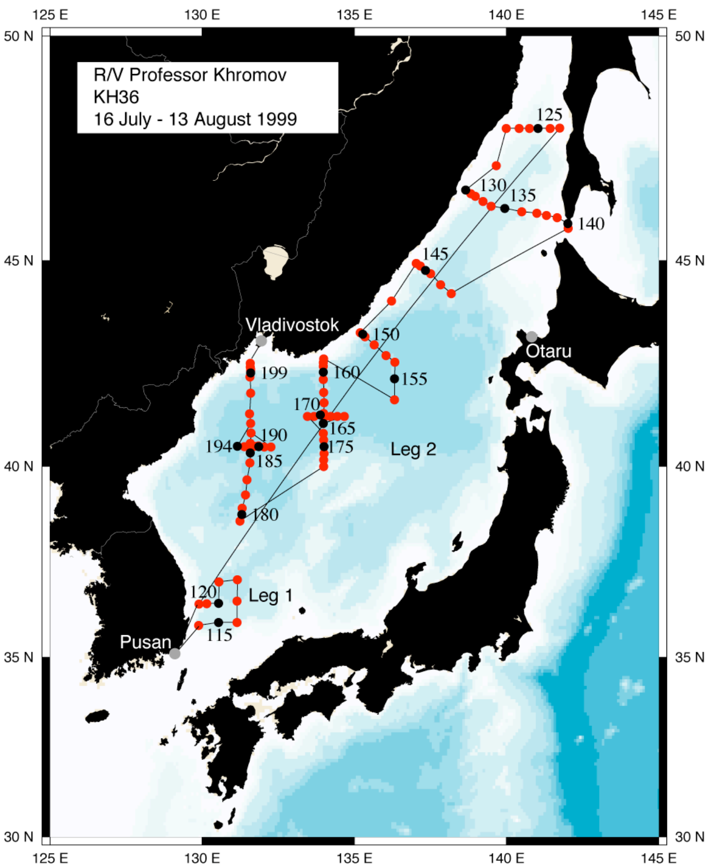
Pusan, Korea
Vladivostok, Russia

Cruise dates:

Leg 1: 22 July 1999 – 25 July 1999
Leg 2: 25 July 1999 - 13 August 1999

A.2 Cruise summary

a. Cruise track (Fig. A.1)



b. Station sampling

90 (Leg 1 – 9; Leg 2 – 81) CTD/24-bottle rosette stations with LADCP; sampling for temperature, salinity, oxygen, nitrate, phosphate, silicate, nitrite, pH, alkalinity, CFCs. (1719 bottles tripped)

36 biooptical profiles

CTD station locations and times (WOCE Hydrographic Programme format)

KH36 Japan Sea Professor Khromov 16 Jul 1999-13 Aug 1999

SHIP/CRS EXPOCODE	STNNBR	CASTNO	UTC DATE	EVENT TIME	POSITION LATITUDE	POSITION LONGITUDE	DEPTH	MAX PRESS	NO. OF BOTTLES	COMMENTS
90CIKH36/1-2	114	2	072299	1039	35 51.20 N	129 53.20 E	1070	1068	22	CTD#5
90CIKH36/1-2	115	1	072299	1618	35 54.20 N	130 33.20 E	1450	1472	19	CTD#5
90CIKH36/1-2	116	1	072399	0534	35 56.90 N	131 8.70 E	1100	1049	24	CTD#3
90CIKH36/1-2	117	1	072399	1044	36 30.00 N	131 8.50 E	2060	2037	24	CTD#3
90CIKH36/1-2	118	1	072399	1539	37 2.80 N	131 8.90 E	2170	2186	22	CTD#5
90CIKH36/1-2	119	1	072399	2212	37 0.90 N	130 33.40 E	2207	2186	24	CTD#5
90CIKH36/1-2	120	1	072499	0440	36 26.80 N	130 33.00 E	1950	1975	24	CTD#5
90CIKH36/1-2	121	1	072499	0838	36 25.10 N	130 9.70 E	1933	1883	24	CTD#5
90CIKH36/1-2	122	1	072499	1212	36 25.30 N	129 53.90 E	480	471	13	CTD#5
90CIKH36/1-2	123	1	072899	1855	48 0.40 N	141 45.00 E	56	52	7	CTD#5
90CIKH36/1-2	124	1	072899	2046	48 0.00 N	141 26.40 E	113	110	14	CTD#5
90CIKH36/1-2	125	1	072899	2256	48 0.10 N	141 2.20 E	852	835	15	CTD#5
90CIKH36/1-2	126	1	072999	0058	48 0.00 N	140 44.90 E	760	761	17	CTD#5
90CIKH36/1-2	127	1	072999	0321	48 0.00 N	140 25.30 E	370	360	18	CTD#5
90CIKH36/1-2	128	1	072999	0546	48 0.00 N	139 59.80 E	118	115	8	CTD#5
90CIKH36/1-2	129	1	072999	1108	47 10.70 N	139 40.00 E	611	598	15	CTD#5
90CIKH36/1-2	130	1	072999	1714	46 37.70 N	138 39.50 E	132	128	8	CTD#5
90CIKH36/1-2	131	1	072999	1851	46 33.00 N	138 50.00 E	412	413	10	CTD#5
90CIKH36/1-2	132	1	072999	2032	46 29.00 N	139 0.00 E	1105	1087	17	CTD#5
90CIKH36/1-2	133	1	072999	2334	46 22.00 N	139 14.80 E	1517	1492	24	CTD#5
90CIKH36/1-2	134	1	073099	0248	46 15.00 N	139 30.10 E	1718	1694	23	CTD#5
90CIKH36/1-2	135	1	073099	0627	46 12.50 N	139 56.50 E	1302	1288	19	CTD#5
90CIKH36/1-2	136	1	073099	1007	46 7.80 N	140 29.70 E	1239	1230	20	CTD#5
90CIKH36/1-2	137	1	073099	1337	46 5.90 N	141 0.20 E	550	562	14	CTD#5
90CIKH36/1-2	138	1	073099	1548	46 2.90 N	141 18.90 E	130	136	7	CTD#5
90CIKH36/1-2	139	1	073099	1831	45 59.70 N	141 39.80 E	76	79	6	CTD#5
90CIKH36/1-2	140	1	073099	2108	45 51.70 N	142 2.00 E	41	39	5	CTD#5
90CIKH36/1-2	141	1	073099	2215	45 45.10 N	142 1.90 E	61	61	11	CTD#5
90CIKH36/1-2	142	1	073199	2105	44 13.00 N	138 10.40 E	1440	1413	24	CTD#5
90CIKH36/1-2	143	1	080199	0122	44 26.00 N	137 50.00 E	2400	2406	24	CTD#5
90CIKH36/1-2	144	1	080199	0523	44 40.30 N	137 29.90 E	1985	1947	22	CTD#5
90CIKH36/1-2	145	1	080199	0831	44 45.90 N	137 19.80 E	1630	1612	24	CTD#5
90CIKH36/1-2	146	1	080199	1105	44 52.80 N	137 10.10 E	1045	1018	21	CTD#5
90CIKH36/1-2	147	1	080199	1256	44 56.50 N	137 2.30 E	235	231	8	CTD#5
90CIKH36/1-2	148	1	080199	2034	44 3.00 N	136 13.40 E	403	405	19	CTD#5
90CIKH36/1-2	149	1	080299	0346	43 17.90 N	135 11.80 E	315	334	19	CTD#5
90CIKH36/1-2	150	1	080299	0507	43 16.00 N	135 16.80 E	1163	1134	20	CTD#5
90CIKH36/1-2	151	1	080299	0718	43 11.90 N	135 21.80 E	3064	3186	24	CTD#5
90CIKH36/1-2	152	1	080299	1124	43 0.20 N	135 39.90 E	3492	3494	24	CTD#5
90CIKH36/1-2	153	1	080299	1629	42 45.20 N	136 2.90 E	3630	3635	24	CTD#5
90CIKH36/1-2	154	1	080299	2102	42 34.90 N	136 19.80 E	2560	2625	24	CTD#5
90CIKH36/1-2	155	1	080399	0136	42 10.00 N	136 20.00 E	3600	3650	24	CTD#5
90CIKH36/1-2	156	1	080399	0843	41 39.90 N	136 19.90 E	3528	3528	24	CTD#5
90CIKH36/1-2	157	1	080399	2340	42 39.90 N	134 0.10 E	287	280	19	CTD#5
90CIKH36/1-2	158	1	080499	0046	42 35.00 N	134 0.00 E	1200	1177	21	CTD#5
90CIKH36/1-2	159	1	080499	0239	42 30.00 N	134 0.00 E	2650	2670	24	CTD#5
90CIKH36/1-2	160	1	080499	0550	42 20.00 N	134 0.00 E	3358	3358	24	CTD#5
90CIKH36/1-2	161	1	080499	1032	42 8.90 N	133 59.80 E	3407	3412	24	CTD#5
90CIKH36/1-2	162	1	080499	1628	41 50.00 N	133 59.90 E	3547	3554	24	CTD#5
90CIKH36/1-2	163	1	080499	2054	41 35.00 N	134 0.00 E	3542	2051	24	CTD#5
90CIKH36/1-2	164	1	080599	0013	41 20.10 N	133 59.70 E	3530	3538	24	CTD#5
90CIKH36/1-2	165	1	080599	0420	41 5.00 N	133 59.90 E	3536	3536	24	CTD#5
90CIKH36/1-2	166	1	080599	1013	41 14.90 N	134 40.00 E	3575	3572	24	CTD#5
90CIKH36/1-2	167	1	080599	1412	41 15.00 N	134 26.40 E	3510	2062	18	CTD#5
90CIKH36/1-2	168	1	080599	1659	41 15.00 N	134 13.50 E	3552	3554	24	CTD#5
90CIKH36/1-2	169	1	080599	2025	41 15.10 N	134 3.10 E	3539	3542	24	CTD#5
90CIKH36/1-2	170	1	080699	0030	41 16.20 N	133 52.90 E	3510	3533	24	CTD#5
90CIKH36/1-2	171	1	080699	0418	41 15.00 N	133 40.40 E	3500	2001	24	CTD#5
90CIKH36/1-2	172	1	080699	0656	41 14.80 N	133 26.70 E	3502	3503	24	CTD#5
90CIKH36/1-2	173	1	080699	1256	40 50.00 N	133 59.90 E	3524	3532	24	CTD#5

90CIKH36/1-2	174	1	080699	1657	40	40.00	N	134	0.10	E	3493	2057	19	CTD#5
90CIKH36/1-2	175	1	080699	1944	40	30.00	N	134	0.00	E	3140	3135	24	CTD#5
90CIKH36/1-2	176	1	080699	2338	40	19.80	N	134	0.40	E	2450	2461	24	CTD#5
90CIKH36/1-2	177	1	080799	0227	40	10.00	N	134	0.00	E	1100	1111	20	CTD#5
90CIKH36/1-2	178	1	080799	0428	40	0.10	N	134	0.00	E	1030	1008	23	CTD#5
90CIKH36/1-2	179	1	080799	1738	38	35.80	N	131	14.80	E	1213	1224	18	CTD#5
90CIKH36/1-2	180	1	080799	1954	38	46.30	N	131	18.20	E	2598	2616	24	CTD#5
90CIKH36/1-2	181	1	080799	2332	38	56.10	N	131	19.00	E	3071	3059	24	CTD#5
90CIKH36/1-2	182	1	080899	0357	39	17.10	N	131	25.20	E	3040	3064	24	CTD#5
90CIKH36/1-2	183	1	080899	0845	39	40.00	N	131	28.90	E	3083	3076	24	CTD#5
90CIKH36/1-2	184	1	080899	1337	40	5.00	N	131	34.90	E	3200	3247	24	CTD#5
90CIKH36/1-2	185	1	080899	1744	40	20.20	N	131	35.20	E	3311	3313	24	CTD#5
90CIKH36/1-2	186	1	080899	2153	40	34.80	N	131	35.30	E	3320	3323	24	CTD#5
90CIKH36/1-2	187	1	080999	0156	40	50.00	N	131	35.10	E	3300	3330	24	CTD#5
90CIKH36/1-2	188	1	080999	0755	40	30.00	N	132	15.50	E	3387	3386	24	CTD#5
90CIKH36/1-2	189	1	080999	1123	40	29.90	N	132	2.60	E	3360	3367	24	CTD#5
90CIKH36/1-2	190	1	080999	1507	40	30.10	N	131	52.00	E	3300	3350	9	CTD#5
90CIKH36/1-2	190	3	080999	1913	40	30.80	N	131	50.80	E	3348	3349	24	CTD#5
90CIKH36/1-2	191	1	080999	2313	40	30.40	N	131	43.00	E	3335	3336	24	CTD#5
90CIKH36/1-2	192	1	081099	0238	40	30.00	N	131	33.10	E	3300	3322	24	CTD#5
90CIKH36/1-2	193	1	081099	0637	40	29.80	N	131	22.60	E	3309	3308	23	CTD#5
90CIKH36/1-2	194	1	081099	1101	40	30.10	N	131	10.10	E	3238	3236	24	CTD#5
90CIKH36/1-2	195	1	081099	1700	41	5.10	N	131	35.10	E	3343	3342	24	CTD#5
90CIKH36/1-2	196	1	081099	2116	41	19.70	N	131	34.80	E	3326	3314	24	CTD#5
											Restart 1.33 hour later			
90CIKH36/1-2	197	1	081199	0332	41	50.00	N	131	35.00	E	3100	3137	24	CTD#5
90CIKH36/1-2	198	1	081199	0855	42	14.10	N	131	34.80	E	2750	2708	22	CTD#5
90CIKH36/1-2	199	1	081199	1211	42	20.40	N	131	35.60	E	2090	2010	21	CTD#5
90CIKH36/1-2	200	1	081199	1448	42	22.80	N	131	35.10	E	900	805	18	CTD#5
90CIKH36/1-2	201	1	081199	1640	42	25.20	N	131	35.30	E	215	204	9	CTD#5
90CIKH36/1-2	202	1	081199	1745	42	28.40	N	131	35.00	E	101	97	7	CTD#5
90CIKH36/1-2	203	1	081199	1853	42	33.30	N	131	35.10	E	68	67	6	CTD#5

c. Underway sampling
pCO2
Surface temperature and salinity
Meteorology

d. Floats
32 profiling ALACE floats ballasted to 800 meters

A.3 Narrative

See Section B.2.1 for a detailed summary of the two legs of the cruise.

Three separately funded sampling programs were aboard: CTD/rosette/chemistry, bio-optical sampling, and meteorology using the WHOI ASIMET system. Two CTD/rosette systems were aboard, both with 24 bottles. The primary sampler carried 24 10-liter bottles, CTD#5, the Lowered Acoustic Doppler Current Profiler (LADCP), and transmissometers. Because of its size, this was deployed from the fantail using the A-frame. The secondary sampler carried 24 1.7-liter bottles and CTD#3, and was deployed from the port side from the normal position for hydrographic casts on the Khromov; it was meant for rough weather. The test cruise consisted of 9 stations in the Ulleung Basin, with the primary purpose of establishing procedures and setup on the Khromov. Because the positions had to be chosen in advance of the R/V Revelle cruises for Korean clearance purposes, they were not at exactly the same locations as the Revelle stations in the Ulleung Basin. The primary cruise leg covered the Russian sector 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 Japanses and Korean sectors were measured in a companion cruise on the R/V Revelle (HNRO7), immediately preceding the Khromov cruise.

CTD/rosette station sampling was to the bottom at most stations, with the exception of several stations in the highly-resolved eddies. Most stations were separated by 10 to 30 nautical miles. The station pattern covered most of the Russian sector. Stations on the northern part of Yamato Rise repeated stations from the Revelle cruise. On most stations, 24 samples were collected from top to bottom. Maximum bottle spacing in the deep waters 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 lowered acoustic doppler current profiler was used on all stations employing the large rosette (CTD#5).

A.4 List of principal investigators

1. Vladimir Luchin (FERHRI) and Lynne Talley (SIO/UCSD): Temperature, salinity, oxygen, nutrients (CTD and rosette)
2. Nikolay Rykov (FERHRI), Lynne Talley (SIO/UCSD) and Peter Hacker (UH): Lowered Acoustic Doppler Current Profiling
3. Pavel Tishchenko (POI): Alkalinity, pH
4. Kyung-Ryul Kim (SNU): Alkalinity, pH, Carbon 14, Delta 18O, Surface pCO2/T/S/chlorophyll
5. William Jenkins (SOC): Delta 18O, Helium-3, tritium, neon, argon, krypton
6. Mark Warner (UW): Chlorofluorocarbons (experimental procedure, not analyzed)
7. Sergei Zakharov (POI) and Greg Mitchell (SIO/UCSD): Water particle size, absorption, pigments, bio-optics
8. Robert Beardsley (WHOI): meteorology
9. Igor Filippov (FERHRI): meteorology

A.5. List of cruise participants

Leg 1 only

1. Lynne Talley (SIO) – Chief scientist
2. David Newton (SIO) - Programmer, LADCP, deck watch
3. Carl Mattson (SIO/ODF) - ODF Tech-in-Charge/Electronics/Deck watch
4. Doug Masten (SIO/ODF) - Nutrient analyst/data processing
5. Ron Patrick (SIO/ODF) - Oxygen/Bottle data
6. Dong-Jin Kang (SNU) - underway chemistry, CO2 (pH by spectro.)
7. Doshik Hahm (SNU) - CO2 (pH by spectro.)
8. Mark Warner (U. Washington) - CFC
9. DongHa Min (SIO) - CFC
10. Clare Postlethwaite (IOS, Southampton) - helium, tritium, neon, argon

Legs 1 and 2

1. Vladimir Luchin (FERHRI) - Chief scientist; CTD/rosette operations, CTD console
2. Alexander Nedashkovskiy (POI) - Nutrients
3. Sergey Sagalaev (POI) - Oxygen
4. Michael Gorelkin (FERHRI) - Salinity
5. Igor Titov (FERHRI) - Electronics, Deck watch
6. Nikolay Rykov (FERHRI) - CTD/rosette operations
7. Vladimir Kraynev (FERHRI) - CTD/rosette operations
8. Igor Zhabin (POI) - CTD/hydrographic data management, software, processing,Deck

9. Vladimir Ponomarev (POI)- CTD/hydrographic data management, software, processing
10. Pavel Tishchenko (POI) - POI chemistry head, CO2 (pH by EMF)
11. Ruslan Chichkin (POI) - CO2 (pH by EMF)
12. Elena Il'ina (POI) - CO2 (Alkalinity)
13. Maria Shvetsova (POI) - CO2 (Alkalinity)
14. Sergei Zakharkov (POI) - Bio-optics
15. Andrey Shcherbina (SIO) LADCP
16. Galina Pavlova (POI) CO2
17. T. Volkova (POI) CO2
18. Olga Shevtsova (POI) CO2
19. Yuri Shulga (POI) CO2
20. A Kalyagin (POI) noble gas
21. O.Vereschagina (POI) CFCs
22. Alexi Sherbinin (FERHRI) Deck
23. Sergey Yaroshev (FERHRI) Deck
24. Mikhail Danchenkov (FERHRI) PALACE
25. Igor Filippov (FERHRI) METEOROLOGY
26. K. Zhevrov (FERHRI) Salinity
27. A Sevastyarov (FERHRI) PLT
28. Anatoly Lemecha (FERHRI) Deck

Institution acronyms

FERHRHI - Far-Eastern Regional Hydrometeorological Research Institute, Vladivostok, Russia

SOC - Southampton Oceanograpy Centre, Southampton, UK

KORDI - Korea Ocean Research and Development Institute, Seoul, Korea

POI - Pacific Oceanological Institute, Far Eastern Branch Russian Academy of Sciences, Vladivostok, Russia

SIO - Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA USA

SIO/ODF - SIO Oceanographic Data Facility

SNU - Seoul National University, Seoul, Republic of Korea

UW - University of Washington, School of Oceanography, Box 357940, Seattle, WA 98195 USA

UH – University of Hawaii, Honolulu, HI USA

WHOI - Woods Hole Oceanographic Institution, Woods Hole, MA USA

B. Description of program and measurement techniques

B.1. Approved program of the expeditionary investigations (Y. Volkov, FERHRI)

FEDERAL SERVICE OF RUSSIA ON HYDROMETEOROLOGY AND ENVIROMENTAL MONITORING (ROSHYDROMET)

Far Eastern Regional Hydrometeorological Research Institute (FERHRI)

PROGRAM
Expedition in the East Sea
Cruise №36 on the R/V "Pr. Khromov"
(July - August 1999)

Vladivostok 1999

1. Registered number of approval to conduct the expedition

The expeditionary investigations in the East Sea in the cruise №36 on the R/V "Pr. Khromov" is being conducted within the frame of program "The Seas of Russia" and International project CREAMS (Circulation Research of the East Asian Marginal Seas) on the basis of agreement being concluded between FERHRI ROSHYDROMET and Washington University (Seattle, USA) of 12. 03. 1999 and approval for the cruise implementation № 009 – 4/384 of 08. 12. 1998.

2. Period of works

The cruise of 26 days duration is to be conducted in the East Sea within the economic zones of Republic of Korea and Russia from July 16 till August 11, 1999.

3. Ports of call

In order to embark/disembark the foreign specialists, to load scientific equipment and to bunker with fresh water, two calls at the port of Pusan (Republic of Korea) have been planned. The foreign specialists will bee disembarked at p. Pusan on the work completion within the economic zone of Korea (21 – 25. 07.), the within the Russian economic zone the observations will be conducted by the Russian specialists.

4. The name of the vessel or any marine craft on which head of expedition will be present

Head of expedition will be on the R/V "Pr. Khromov", displacement 2140 tons, built in 1983 (Finland).

5. Communication

In the cruise the following communication is to be used

- radio/telephone,
- short waves approved for the ship radiostation,
- Ultra Short Waves - international frequencies.

6. Main objectives

The expeditionary investigations are being conducted for the aim of

- determination of the full vertical structure of the main components of the East Sea circulation, including the Liman current, Eastern Korean warm current, Tsushima current, as well as the possible deep-sea west boundary current and other components of the deep-sea circulation that is likely related to the subsurface circulation;
- study of formation conditions and subpolar front development in the central part of East Sea and bottom topography possible influence,
- obtaining of the complete synoptic picture for vertical interstratification structure over the East Sea,
- determination of possibility to use chemical tracers including nutrients, DO and freons so that to reveal the main elements of large-scale circulation and assessment of the North-West and North parts of East Sea in renewal of the intermediate and deep sea waters;
- vertical structure study, at least, of the eddy in the subpolar convection region or subpolar front, and one more in the Eastern-Korean warm current southward the subpolar front.

In order to obtain the above mentioned, the objectives to be solved are as follows:

- to carry out the oceanographic survey in the North-West East Sea making measurements of temperature, salinity and sampling for chemical analysis;
- to conduct a set of hidrometobservation.

7. Types of standard and special observations and works conducting in the cruise to solve the tasks.

7.1. Standard observations:

In the cruise a complex of standard hydrometeorologic, oceanographic and hydrochemical observations are being conducted.

7.2. Special observations

7.2.1. Sampling of sea water to determine the chemical tracer content (C^{14}, O^{18}, freons, He-3, T, Ne, Ar, Kr).

8. Volume of works and observations, addresses and term for information to be transferred, including international exchange.

8.1. Meteorological observations

In the cruise a complex of standard hydrometeorological observations on the program of the vessel station of class 2 as to “Metodical instructions…” GGO, parts I – II, issue 1983 are being produced.

In addition to the complex mentioned the following is being produced

- observation of anomalous events in the atmosphere;
- visual observation of sea water petroleum pollution and oil products.

Information:

1. Transferring of meteorological observationsby KN-01 in the address of “Moscow - Weather”, “Vladivostok - Weather”, “Vladivostok – 213421-Thunderstorm HMC and foreign RMC on the vessel way for 4 basic terms.
2. Transferring of storm warning and data on hazard events is being produced by the open text in address of “Vladivostok - Weather”, “Moscow – Weather”.

8.2. Oceanographic observations

8.2.1. Oceanographic stations on the sections are being carried out through out the bottom.

8.2.2. Observations at the stations

- t °C and salinity measurements by CTD probe throughout the depth of each station probing;
- sea water sampling for hydrochemical analysis at the level of 10, 20, 30, 50, 75, 100, 125, 150, 200, 250, 300, 400, 500, 600, 700, 800, 1000, 1200, 1500, 2000, 2500, 3000 at the each station;
- sea water color and transparence determination on the light time of a day.

Information:

Transferring of data on sea t °C and salinity at the levels by KN-05, KN-06 in the address of “Moscow – Weather”, “Vladivostok – Weather”, “Vladivostok – 213421 – thunderstorm HMC”.

9. Devices and equipment used, including additional ones.

- standard hydrometeorological devices;
- air probing station “Vaisala”;
- hydroprobing “SBE 911 plus CTD” with 24, 10L water sample bottle;
- salinometer “Autosal 8400A”;
- installation “Biamperometric DO Titrator” to determine dissolved O_2 and total alkalinity;
- automatic analyzer “Technicon” to determine nutrients;
- analyzers to determine content of CO_2 and freons;
- PC.

10. Procedure of obtained results processing

Data on CTD measurements obtained in the cruise are being processed on the vessel in operative regime.

Hydrochemical analysis of the water samples are being carried out partially on board and partially at the coastal laboratories.

On processing all results obtained are being recorded in the special formats and carriers.

11. Terms of copies on observations for environmental parameters transfer at Russian State fund of data on environment

11.1. On the date of the vessel arrival the cruise report (3 copies) is being presented at the Marine Department and Base of Fleet by Master and Head of expedition. The cruise report after its control by Departments mentioned above is being sent at **ROSHYDROMET**.

11.2. Scientific report including analysis of the work carried out and assessment of the data quality (2 copies, including original) is being given in library of FERHRI.

Data on observations after analysis at the coastal laboratories are being presented at Regional Oceanographic data Center.

Terms of information providing is determined by agreement of the parties for the data exchange.

12. Information on RF representative authorized by Ministry of Science RF

The representative participation in the cruise is not considered.

13. Information on hydrometeorological observations and environment pollution

13.1. The operative information processing and propagation is being produced during the cruise under the requirements existing and transferred in the addresses painted out after each type of observations within the present program.

13.2. Tables of the results of sea water pollution with oil products are being sent to Monitoring Department FERHRI.

14. Participants of the expedition

To solve the tasks of the program the following specialists will take part in the cruise FERHRI - 10 persons, PIO - 14, USA - 9, Republic of Korea - 2.

Director of FERHRI Yu. Volkov

B.2. Report of head of expedition (V. Luchin, FERHRI)

B.2.1 Progress and details of the cruise implementation

Expedition cruise № 36 on the R/V "Professor Khromov" was being conducted on the program of the seventh joint Russian – Korean expedition within the frame of international project creams under the plans of operative and productive works and international scientific cooperation of ROSHYDROMET on the basis of agreement between FERHRI and University of Washington and Scripps Institution of Oceanography California University USA of 12. 03. 1999 and approval for the cruise N OC9 – 4/162 of 23. 04. 1999.

Expedition investigations have been conducted so that to obtain the natural data for

- determination of full vertical structure of the main circulation components in the East Sea, including the Liman current, Eastern – Korean warm current, Tsushima current, as will as the deep boundary current and other deep circulation components;
- study of formation conditions and subpolar front development in the central part of East Sea and bottom topography possible influence;
- obtaining of the complete synoptic picture for vertical interstratification structure over the East Sea
- determination of possibility to use chemical tracers including nutrients, dissolved oxygen, freons so that to reveal the main elements of large – scale circulation and assessment of North-West and North parts of East Sea in renewal of the intermediate and deep sea waters;
- vertical eddy structure study in subpolar convective region and subpolar front.

In order to obtain the above mentioned the objective to be solved are as follows

- to carry out the oceanographic survey of deep sea regions in South –West, central and northern part of East Sea with making measurements of t ^{o}C and salinity by CTD – probe and sampling of water for the chemical analysis;
- to conduct a set of standard hydrometeorological on the program of the vessel station of class II, as well as additional observations on the anomalous events in the atmosphere and sea water oil and oil products pollution;
- to process and record on the carries all kinds of observations;
- to prepare the scientific report including all types of studies.

The R/V "Professor Khromov" went into the cruise № 36 on July 16, 99 and proceeded to the port Pusan to embark the researchers and to load the scientific devices.

On July 22 loading on board the expedition equipment and embarking the specialists from USA and Republic Korea the vessel left Pusan and proceeded in the region of work in South–West East Sea (Uleung Basin).

In the region mentioned from July 22 till July 24 there were carried out 9 oceanographic stations. Further the vessel went to Pusan to disembark the foreign participants of the cruise on leaving Pusan the following works were produced

-25-29.07 - transition to the Tatar Strait;
-29.07 - section across $48^0 00^{'}$ N, from $141^0 45^{'}$ to $140^0 00^{'}$ E;
-29-30.07 - transition to position $46^0 38^{'}$ N, $138^0 40^{'}$ E;
-30-31.07 - section from position $46^0 38^{'}$ N, $138^0 40^{'}$ E to $46^0 00^{'}$ N $141^0 40^{'}$ E;

-31.07 - section in the Laperuz Strait;
-31.07-01.08 - transition to position $44^{0}13^{'}$ N, $138^{0}10^{'}$ E;
-01-02.08 - section from position $44^{0}13^{'}$ N, $138^{0}10^{'}$ E to $44^{0}57^{'}$ N $137^{0}03^{'}$ E;
-02.08 - transition to position $43^{0}18^{'}$ N, $135^{0}12^{'}$ E;
-02-03.08 - section from position $43^{0}18^{'}$ N, $135^{0}12^{'}$ E to $41^{0}40^{'}$ N $136^{0}20^{'}$ E;
-03-04.08 - transition to position $42^{0}40^{'}$ N, $134^{0}00^{'}$ E:
-04-07.08 - section across $134^{0}00^{'}$ E from $42^{0}40^{'}$ to $40^{0}00^{'}$ N, including section through the eddy across $41^{0}15^{'}$ N from $134^{0}40^{'}$ to $133^{0}27^{'}$ E:
-07-08.08 - transition to position $38^{0}36^{'}$ N, $131^{0}15^{'}$ E;
-08-09.08 - section from position $38^{0}36^{'}$ N, $131^{0}15^{'}$ E to $40^{0}05^{'}$ N $131^{0}35^{'}$ E;
-09-12.08 - section across $131^{0}35^{'}$ E from $40^{0}05^{'}$ to $42^{0}33^{'}$ N, including section through the eddy across $40^{0}30^{'}$ N from $132^{0}15^{'}$ to $131^{0}10^{'}$ E;
-12.08 - analysis completion and information processing;
-13.08 - arrival at Vladivostok.

The weather conditions during the first twenty days, mainly, are not favorable for the work planned to be performed. The persistent wind was from 10 to 15 m/s, the sea waves made difficulties in producing of the oceanographic stations because of the heavy rolling and pitching.

The weather conditions of the last cruise week were favorable for o work.

Program of work has been made completely, excluding 3 missed oceanographic stations that were in the territorial waters of Japan. In the cruise the content of carbon dioxide was being measured continuously in the sea surface layer. The sea water sampled from the engine pipeline and with the help of thermoisolated hose it reached the hydrology laboratory where the measurement of the carbon dioxide, chlorofile, $t^{0}C$ and salinity were done.

Hydrometeorological observations have been performed 4 per a day at 00, 06, 12, and 18 hours GMT.

In the cruise № 36 2 Korean, 24 Russian and 9 specialist of USA took part.

Scientific equipment

- standard hydrometeorological equipment;
- probing station of the atmosphere "Vaisala";
- hydroprobe "SBE 911 plus CTD" with 24 10L bottles
- salinometer "Autosal 8400A";
- "Biamperometric D.O. Titrator" to determine the dissolved oxygen and the total alkalinity;
- automatic analyzer "Technicon" to determine the nutrients;
- analyzers to determine CO_2, freons;
- computers

B.2.2 Volume of work, actual cruise program implementation

Approved program has been made completely taking into account some amendments produced by the proposal of POI and Scripps Institution regarding the order of the route going in the area of eddy polygons.

Figures A.1 and B.2.1 and accompanying station list of the present report show the route of the vessel going and station positions.

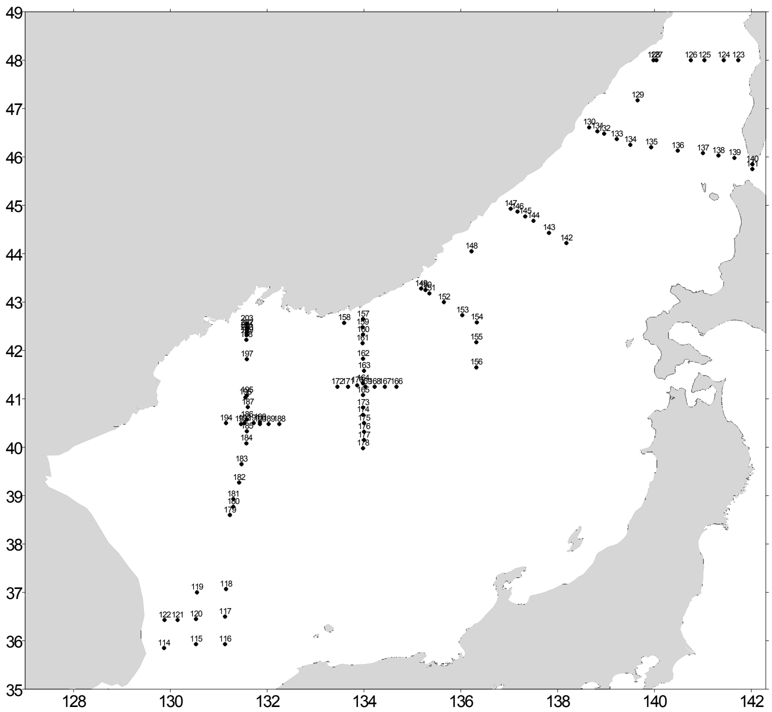


Figure B.2.1 Cruise track of the R/V Professor Khromov, KH36 (16 July – 13 August 1999).

In the cruise the following type and number of observations have been carried out

---

Oceanographic stations including t^0C and salinity measurements by CTD probe from surface to the bottom - 90;

Sea water samples to determine

-salinity	-	90 station, 1719 samples;
-dissolved oxygen	-	90 st., 1719 s.;
-pH	-	88 st., 1200 s.;
-total alkalinity	-	88 st., 1200 s.;
-silicate	-	90 st., 1719 s.;
-phosphate	-	90 st., 1719 s.;
-nitrate	-	90 st., 1719 s.;
-nitrite	-	90 st., 1719 s.;
-freons	-	51 st., 681 s.;
-helium	-	37 st., 325 s.;
-tritium	-	34 st., 278 s.;
-O^{18}	-	40 st., 325 s.;
-C^{14}	-	5 st., 54 s.;
-chlorophile	-	89 s.;

Biooptical observations

-spectrum suspension absorption	-	36 st., 192 s.;
-spectrum of dissolved substance	-	8 st., 44 s.;
-content of chlorophile “a”	-	36 st., 188 s.;
-content of suspended organic matter	-	33 st., 141 s.;
-sea water transparence within the red and blue spectrum field	-	90 st.;
-sea water transparence on Sekki’s disk	-	28 st.;
-urgent hydrometeorological observations	-	86;
-storm warning	-	3.

On the cruise completion and under agreement between parties participants in the expedition, the Russian and American Parties have been presented the data of CTD probe “SBE 911 plus CTD” measurements altogether with information of hydrometeorological observations.

Data on the current measurements using LADCP, sea water hydrochemical analyses and continuous measurements of CO_2 content will be transferred to the Russian Party on processing completion in the coastal laboratories of Seoul National University and Scripps Institution of Oceanography California University USA.

The cruise program is fully completed. Data have been recorded on the carriers and transferred in Regional Center of Oceanography data and library of FERHRI.

B.2.3 Description of scientific and technical group work and crew in the expedition regarding the cruise program implementation.

Well coordinated work and full understanding of all scientific groups and the ship departments allowed to solve all tasks in due time.

B.2.4 The most important results obtained

The basic result of the cruise is the comprehensive oceanographic data massive obtaining (hydrophysical, hydrochemical, biooptical, current speed, inert gas content and so on) on the up-to-date level.

For the first time in the North and North-West part of the East Sea detailed instrumental current measurements and other oceanographic features measurements from the sea surface to the bottom have been performed. Measurements and sea water sampling at the near bottom levels have been produced by 4-8 meter over the bottom.

High accuracy measurement data of hydrophysical and hydrochemical parameters allow to clarify essentially the spatial structure of water masses. They will be very useful as standard data on choosing criteria to estimate the massive quality of historic oceanographic information. The results obtained will be used to solve the problem of intermediate deep water formation in the East Sea.

The preliminary analysis of the data obtained in the cruise showed that the Tsusima current effect is not limited by the sea part southward of the subpolar front. This water effect is being marked along all the East Sea water area. In the layer of 1000–2000 meter there are fixed the
waters of the lower salinity estimations (less than 34,066 $^0/_{00}$). It is likely due to the convective processes in the fall winter period and further water transformation in accordance with their migration within the limits.

The current measurements obtained allow to clarify and add information available on the elements of total sea water circulation and more detail investigate the dynamic processes taking place in synoptic eddies the obtained preliminary results are an evidence that the anticyclone current system in the eddies studied propagates to the near bottom levels (about 3000-3200 m.).

Biooptic data allow to establish the models describing the level of the primary organic matter producing in the East Sea.

At some oceanographic stations in the region studied with the depths to 3000 m and lower there has been registered not high but analytical essential silicate decreasing at the near bottom levels.

Nitrite content in the sea, excluding the layer of 100-200 m is to analytical zero. At the same time at some stations in the near bottom layer (at the level of 1000-2000 m) there has been recorded the persistent nitrite presence.

B.2.5 Recommendations on improvement of the expedition arrangement and the vessel equipment

The experience of expeditionary works, carried out in the cruise, shows that under favourable weather conditions the vessel is enough suitable to produce oceanographic observations on planning the cruise it is necessary to consider more time to produce deep sea oceanographic stations and storm weather conditions.

B.3. Master's Report: I. Kiselev

B.3.1. Cruise navigation peculiarities.

The vessel route of the cruise № 36 took place in the central part of the East Sea, well studied regarding the navigation problems. Fig. 2.1 & tabl. 2.1 show the actual vessel route & positions of oceanographic stations taking into account some amendments made by the Japan party regurst.

The weather conditions in the cruise, mainly, didn't hinder to conduct the studies planned.

In the cruise the synoptic data have been received regularly. Navigation charts & manuals for sailing have been corrected by requirements IM, PRIP, NAVIP, NAVAREA. The requirements of good marine practice have been user. The control on the vessel hull non water permeability & stability has been produced continuously.

On July 18 at 10-40 o'clock the vessel arrived at the pilot anchorage of the p.Pusan & at 11-50 o'clock was put along Yong-Ho berth near by the r/v “Roger Revelle” USA.

On July 22 at 14-00 after taking on board the Russian specialists {14 persons}, the American & Korean specialists {10 persons}, two Navy observers of R.Korea as well as expeditional equipment ship left the p.Pusan & proceeded in the region of the work in the Korean economic zone.

On July 25 at 09-00 on the joint expeditional stage completion, the vessel came back to Pusan to disembark the foreigner participants of expedition & at 10-10 it was put along the passenger berth № 1.

On July 25 at 19-00 after bunkering with the fresh water, the vessel left Pusan & proceeded in the Tatar Strait.

On August 13 at 08-00 on the oceanographic survey completion on the sections in the North & central parts of East Sea & eddy polygons the vessel arrived at the inner road of the port Vladivostok.

B.3.2. Methods & accuracy of the vessel position determination

To determine the vessel position the following technical devices have been use:

- HCC ”NAVSTAR XR-4”, {Gold Star, R. Korea};
- Radar “OKEAN”, 3 sm {Russia};
- Radar “OKEAN”, 10 sm {Russia};
- Radar “FURUNO”, 3 sm {Japan};
- Giro compass “VEGA-2” {Russia};

- Doppler lag “FURUNO” {Japan};
- Echo sounder “NAL-M-3B”, 500 m depth {RUSSIA};
- Echo sounder “ELAK ENIF”, 15000 m depth {Germany}.

Within radiolocation visibility of the coastal things the position determination has been produced by radar. Off shore the main device to fix the place was HCC “NAVSTAR XR-4”.

All available on board navigation equipment was reliable operation in the cruise & ensured accuracy of the place position & depth required to sample the sea water.

B.3.3. Peculiarities in the expedition work

Having strong wind more than 10 m/s, decreasing the angle of wire cable declination & ensuring the water samples of great volume, in addition, avoiding damage of equipment & devices having heavy rolling, few oceanographic stations have been carried out with the help of the main engine, keeping the vessel by the bow against the wind & wave.

The weather conditions during the first twenty days of the cruise, mainly, were not favourable for the work implementation. When strong wind being {more than 10 m/s}, because of heavy rolling & pitching implementation of the oceanographic stations by CTD probe of a great volume using stern P- frame was very difficult to be executed.

B.4. Meteorological observations (I. Filippov)

B.4.1 Program of work

Program of the cruise 36 has been planned to execute a number of hydrometeorological observations on the program of the vessel station class II under “Methodical instructions to produce meteorological and actinometry observations on the research vessels“ part I,II.,1983, as well as the observations on the anomalous events in the atmosphere and visual monitoring on the sea surface pollution of oil and oil products.

Meteorological data are being transferred by code KN-01 for 4 main intervals in the address of Moscow- Weather, Vladivostok-Weather and foreign centers, storm warnings are transmitted by open text in the address of Moscow- Weather and Vladivostok-Weather.

B.4.2 Characteristic of the work to be executed

Meteorological observations were produced in the cruise from July 16 till August 13, 1999, excluding the vessel staying at Pusan, at the main synoptic period 00, 06, 12 and 18 hours GMT.

Urgent hydrometeorological observations have been carried out in total - 86 and sent the same quantity in the addresses corresponding. 3 storm warnings have been sent, as well.

All information has been controlled and recorded in tables (THM-15).

B.4.3 Equipment, devices, characteristic of work, position and change in the cruise.

When meteorological observations producing, standard Russian meteodevices and automatic meteostation “Midas 321” (Finland) developed under requirements of World Meteorological Organization (WMO) have been applied.

The atmospheric pressure was measured by aneroid barometer M-67 fixed in meteorological laboratory at the altitude 5 meter over the sea level.

Baric tendency feature was determined by week barograph M-22H fixed nearly aneroid barometer .

The air temperature was measured by aspiration psychrometer MB-4M fixed on the turn arms at the distance of 3 m from the vessel side at the altitude 12 m over the sea level.

The wind speed and direction were measured by sensors of automatic station “MIDAS-321” fixed on the fork mast at the altitude of 18 m over the sea level.

The sea surface layer was measured by mercury thermometer TM-10 being put in standard safeguard covering in the vessel bow part on the windy leeward side.

The atmospheric precipitation quantity was determined by automatic weather station “MIDAS-321”.

Observations on clouds, visibility, atmospheric events, wave direction and period were produced by visual from the upper bridge. The wave altitude was determined from the stern duck.

Hydrometeorological information was processed by IBM PC/AT using program METEO-SW.

B.4.4 Evidence on control and devices calibration

Table 4.1 gives dates of control on the meteorological devices used in the cruise

Table 4.1

Name of device	Type	Factory number	Date of control
Barometer-aneroid	M-67	1057	January 1999
Week barograph	M-22H	19036	January 1999
Psychrometer aspiration	MB-4M	6269	January 1999
Anemograph	M63M-1	40	February 1999
Anemometer (manual)	MC-13	6796	January 1999
Mercury thermometer	TM-10	7573	January 1999

The automatic meteorological station “MIDAS-321” readings were regularly controlled by standard meteorological devices in the cruise

B.4.5 Methods of observations and processing

Meteorological observations and obtained data processing have been conducted under the Russian methodical instructions as to WMO standards.

B.4.6 Data on hazard and especially hazard hydrometeorological events

In the cruise the hazard events were observed as follows

23.05.1999 in the position $40^{0} 12^{'}$ N, $134^{0} 37^{'}$ E - fog, visibility - 400 m,
26.05.1999 in the position $41^{0} 15^{'}$ N, $134^{0} 06^{'}$ E - fog, visibility - 400 m,

27.05.1999 in the position $41^{0}16'$N, $134^{0}31'$E - fog, visibility - 400 m.

B.5. Report of oceanographic group (CTD, salinity, oxygen)

B.5.1. CTD, rosette, salinity, oxygen data on Legs 1 and 2 (V. Luchin)

B.5.1.1 Program of work

In the cruise the oceanographic observations have been carried out under the approved program taking into account a few amendments of CTD stations position & the order proceeding along the route. Figure 1 & accompanying table show the scheme of route & station positions.

The oceanographic work consisted of:

- sea water temperature & salinity measurements by CTD probe "SBE 911 plus CTD" from the sea surface to the bottom making sea water samples at the given levels {not always standard} by twenty four 10 l bottles for the hydrochemical analyses;
- sea water salinity determination in the laboratories by salinometer "Autosal 8400";
- current measurements at oceanographic stations {while up & down the probe} by special acoustic equipment {LADCP}.

B.5.1.2. Characteristic of the work carried out {CTD measurements, water sampling& current measurements at the stations}.

In order to make measurements of the temperature, salinity and seawater pressure at the stations from the sea surface throughout the bottom CTD probe NBIS of model MK III as well as rosette to the probe "SBE 911 plus CTD" were used. The water samplers for hydrochemical analyses were fulfilled at the chosen levels by twenty four 10 l bottles. In the laboratory the sea water salinity was determined by salinometer "Autosal 8400".

The current measurements at the stations {while up &down the probe } were fulfilled by LADCP.

CTD data, salinity & current measurements were produced by using software developed in Scripps Oceanographic Institute of UCSD. The data processing were performed by IBM PC. All data were recorded on the carriers as well as CDROMs & Zip disks. The CTD data were recorded on VCR cassettes.

In the cruise there were fulfilled 90 oceanographic stations in total with temperature, pressure measurements {depth of the devices submerging} & salinity {conductivity} by CTD probe from the surface throughout the bottom. At all oceanographic stations {irrespectively from the depth of position } the last level of observations was at the distance of 4-10 m from the bottom.

B.5.1.3 Hydrochemical observations

B.5.1.3.1. Devices

Salinity was determined both by CTD detector {continuous profile throughout the depth } & by salinometer at each station {control determination}.

In the cruise two salinometers “Autosal 8400 A” company “Guildline Instruments LTD” {Canada} № 53-503 &№48-263 were used. Instrumental accuracy of this type salinometers is not worse than $-^{+}$ 0.001 $^{0}/_{00}$ while making a set of sample standardizing at each station & not worse than $^{+}-$ 0.003 $^{0}/_{00}$ for 24 hours of work not including restandardizing.

High accuracy & persistence in data obtaining by the salinometer was achieved by the presence of two pain of platinum-radium electrodes in the measurements chamber & built-in high frequency thermostat {volume of water tank – 18 l} having the range of given temperature 18-33^{0}C with the interval in 3^{0}C, accuracy 0.02^{0}C. Moreover, double meanings of relative conductivity of standard & samplers are used that increases the resolution device ability.

Salinometer №53-503 is connected with PC through builtin interface RS232. The data putting from salinometer display №48-263 to the computer is produced by hand.

B.5.1.3.2. Methods of determination & salinity data processing

The control salinity samplers were chosen at each stations at all levels of the bottles working {maximal number – 24}.

Levels of sample taken were defined by an operator of CTD probe, taking into account the element profile depth change, determined by the probe detector {temperature, salinity, dissolved oxygen & fluorimeter.

Samples were thermostatted in the laboratory not less than 8 hours before determination beginning. The experiment demonstrated that having instable temperature in the laboratory such thermostating is not sufficient, the speed of sample going through salinometer should be decreased, as a result, the time spent for the sample analysis abruptly increases, & the data stability decreases. Therefore, on the r/v “Pr. Khromov” the sample water thermostatting was additionally applied, directly before the temper. determination approximately by 1°C lower the temperature marked in salinometer thermostatt.

Before & on completing of each set of samples, the salinometer was calibrated as to the normal water of IAPSO standard, series P134 {USA}. It was produced a few readings of each sample, assuming differences in readings are as follows: 000003 for normal water & 0.00005 for the sample of double conductivity. The sample salinity estimations were obtained not accounting the device heated itself.
The intermediate data were processed under the program – salinity was obtained in consideration of self-heating, as well as the estimation difference between the salinity estimations by a salinometer & CTD detector that could be used on further calculation after a critical control.

In the cruise at 90 stations there were analysed in total 1719 samples.

B.5.2 CTD, rosette, salinity, oxygen data on Leg 1 (C. Mattson, SIO/ODF)

This is a continuation of cruise HNRO7. Refer to the HNRO7 Prelim Cruise Report for preexisting conditions.

B.5.2.1 CTD data and rosette

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

CTD instrument numbers:

NBIS Model MKIII ODF CTD#3 sta 116,117
NBIS Model MKIII ODF CTD#5 sta 114,115,118-122

Large rosette:
The large rosette was used for Stations 114-115, 118-122 and consisted of:
NBIS MKIIIB CTD s/n 01-1070 (ODF ctd#5)
Sensormedics Oxygen Sensor s/n 6-02-08
STS 24 bottle rosette frame
24pl Seabird pylon model SBE32 s/n 3212613-0164
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
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 for onboard CTD and Bottle data reports.
Cond#1 sensor has a pressure effect on deep case 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.
Oxygen:
Oxygen data interfaced with the CTD and incorporated into the CTD data stream.
Sensormedics Oxygen Sensor s/n 6-02-08
Transmissometer:
Wetlabs Cstar 25cm (Blue) Transmissometer c/n CST-244DB
Wetlabs Cstar 25cm (RED) Transmissometer c/n CST-245DB
LADCP:
RDI LADCP CS-150KHZ s/n 1546

Small Rosette. The small rosette was used on sta 116, 117 and consisted of:
NBIS MKIIIB CTD s/n 01-1095 (ODF ctd#3)
Sensormedics Oxygen Sensor s/n 90222-01 sta 116
Sensormedics Oxygen Sensor s/n 6-02-07 sta 117
FSI OTM s/n 1322
STS small 24 bottle rosette frame
36pl Seabird pylon model SBE32 s/n 3216715-0187
Seabird Temperature Sensor SBE35 s/n 3516590-0011
24 SIO made bullister style 2.7 liter bottles
Benthos Altimeter model 2110 s/n 156
CTD#3:
New Conductivity sensor s/n P51 was installed at beginning of trip.
Conductivity sensor cleaned prior to sta 117
PRT#1 has what appears to be a long response time of about 1 second or more.
CTD sensors soaked in distilled water betweem all casts.
Bottles:
2.7L Bullister style SIO manufactured.
Bottles serial numbered 1-24 were tripped in sequence.

The pylon was a SBE32 36 place model so certain pylon positions were skipped. This was done automatically by the acquisition program and tripped in the following order:

01 02 04 05 06 08 10 11 13 14
16 17 19 20 22 23 25 26 28 29
31 32 34 35

Oxygen:

Oxygen data interfaced with the CTD and incorporated into the CTD data stream.
Sensormedics Oxygen Sensor s/n 90222-01 sta 116
Sensormedics Oxygen Sensor s/n 6-02-07 sta 117

Thermometers:

No DSRT's

Transmissometer:

No Transmissometer

LADCP:

No LADCP

Winches: The CTD winch had a 9mm single conductor EM cable with approx 4700M of wire.

B.5.2.2 Salinity

Salinometer types	Serial numbers
Guidline 8400A Autosal	55-503
Guidline 8400A Autosal	48-263

Standard seawater: Batch P-134

Autosals were configured for computer-aided measurement. The data was acquired on a PC. #48-263 had an intermittent display problem that was repaired after box #116. The serial interface then stopped working. The Autosal operation was then switched to #55-503.

#48-263 stations 114-117 27 deg bath temp
#55-503 stations 118-122 27 deg bath temp

B.5.2.3 Oxygen

Oxygens were run all stations using a Dosimat UV-endpoint detection automatic titration system. There were no major 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.5.3 CTD final calibration comments (M. Johnson, SIO/ODF)

General comments: As of 2 November 2004, these KH36 CTD data (90 stations) 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 of the first 9 casts have been interpolated; all interpolated/extrapolated data are quality-coded 6. The software problem that omitted this data was fixed prior to the start of the cruise. 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: upcasts were offset from 0 to -0.004 PSU vs downcasts below the thermocline on this cruise. The calibrated downcast CTD salinity data were fairly consistent. The bottle salinity data had numerous standardization issues. An attempt was made to weed out the standardization problems, which seemed to be worse during the first 20 casts of the cruise. The remaining salinity data were used to determine final calibrations for the CTD data.

CTD-3, with yet another new conductivity sensor, was used for stations 116 and 117; otherwise, CTD-5 (with dual T/C sensors) was used. The new CTD-3 C sensor had a + drift with time, both down and up casts, but less than the previous new sensor used for only station 113 on HNRO7. An extra S(P**1) correction was applied to the downcast salinity, based on comparison of "final" corrected salinity to the upcast bottle data. Stations 116 and 117 had different corrections applied, because the sensor was "cleaned" between the casts in an attempt to stop the drift. The deep data are consistent with nearby casts.

Detailed calibration comments:

```
KH36 CTD Configurations:

   NBIS MKIIIB CTD: s/n 01-1095 (ODF CTD#3) sta 116,117
      Pressure s/n 77011
      T1 s/n 15778 (T1 apparently has a long response time of 1+ seconds)
      T2 FSI OTM s/n 1322
      C1 s/n P62 (new/installed at beginning of cruise; cleaned between
116/117)
      C2 N/A

   NBIS MKIIIB CTD: s/n 01-1070 (ODF CTD#5) sta 114,115,118-203
      Pressure s/n 77017
      Dual T/C Sensors mounted on twin turrets:
      T1 s/n 15407 (hnro7/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 90222-01 sta 116
      O2 s/n 6-02-07 sta 117
      O2 s/n 6-02-08 on stas 114,115,118-142 (did not work during 142)
      O2 s/n UNKNOWN on stas 143-203

   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 P62 (GO):  stations 116+117
    Calibrated to bottle salts taken during cruise.
    This sensor had a noticeable + Conductivity drift with time
        during station 116, but drifted significantly less than
        the sensor used on HNRO7 station 113.  The sensor was
        "cleaned" before station 117, resulting in a much smaller
        station 117 drift.  Down and up casts needed separate
        corrections, and each station needed a different
        correction due to the sensor cleaning.
    1. A second-order dC(C**2) slope based on bottle-CTD (up cast)
        differences from both casts was determined. The same
        slope was applied to both stations, to down and up casts.
    2. Residual bottle-CTD (down cast) Salinity differences were
        visually grabbed from a theta-salinity plot.  A first-
        order pressure-dependent fit (dS(P)) was generated and
        applied separately for down and up casts (sta 116) and
        for the down cast only (sta 117).  These fits were applied
        IN ADDITION TO the dC(C) slope determined in step 1.
    3. Station 116 deep bottles seemed to have standardization
        issues and could not be trusted.  The dS(P) fits for
        sta 116 (described in step 2) were redetermined/reapplied
        using sta 117 bottle data.
    4. Deep Theta-Salinity overlays of stations 114-122 were checked
        for consistency.  Station 116 was at the southeast corner
        of the "box" of stations, and station 117 was the center
        of 3 casts along the eastern border of the "box".

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.6. Report on LADCP observation (N. Rykov and A. Shcherbina)

B.6.1. Objectives

The aim of observatons is to obtain a set of the current vertical profiles from the sea surface throughout the boltom for furher estimation of the dynamic processes in the economic zone Russian Federation of the Japan Sea.

Objectives:

- to make instrumental current measurements by LADCP as to the instructions received;
- to fulfill a preliminary data processing by methods and sofware of University of Hawaii (USA);
- to obtain the electronic copies of the observed data, current vertical profile components and another characteristics, current vectors at the given levels.

B.6.2. Characteristic of measurement equipment, methods of observations and processing

In order to make measurements of the current velocity and a number of associated characteristics, LADCP has been used (Lowered Acoustic Doppler Current Profiler).Manual « DR/SC-BBADCP TECHNICAL MANUAL-AUGUST 1995 (CHANGE1)» has in it content the technical device specification, description of control orders and parameters, list of output data format, the basic calculation formulae mentioned in it.

The principle of various modification LADCP operation is in a difference of frequencies for sending and reflecting sound signal within the source and moving water mass. Measured relative current velocity is determined by the term:

$$V = Fd \bullet C \bullet 1000 / 2Fs,$$

where C is a sound velocity in the sea water;

Fd - shear of Doppler's frequency;

Fs - transmited source frequency. For the device used Fs = 153.6 kHz.

So that to obtain the horizontal and vertical vector components of the current there are used four sources sending signals at different angle regarding each other.

The technical characteristics of the meter take into consideration a possibility of 128 water layers echo ranging simultanuasly, each layer having thickness from 0.05 to 32 m. Given accuracy of the current speed measurement is usually 1 sm/s. Actual accuracy depends on an accuracy of the sound velocity determination and the time positions. In accordance with this the final data processing requires CTD-data of very high quality as well as the sound signal source position determination of high discretness and accuracy in time and geographical positions.

To countrol LADCP operation the system of commands and given parameters are used (see below).

Specifications commands and LADCP operation parameters.

```
Broadband ADCP Version 5.52
RD Instruments (c) 1991-96
All rights reserved.
>CY
>RA
RA = 000 ----------------- Number of Deployments Recorded
>
>CR1
[Parameters set to FACTORY defaults]
>PS0
    Frequency:  153600 HZ
Configuration:  4 BEAM, JANUS
  Match Layer:  10
   Beam Angle:  30 DEGREES
 Beam Pattern:  CONVEX
  Orientation:  DOWN
 Xducer Ser #:  02612
    Sensor(s):  HEADING  TILT 1  TILT 2  TEMPERATURE
 XDC Firmware:   1.16
 CPU Firmware:   5.52
 DEMOD #1 Ver:  ad46, Type:   3
 DEMOD #2 Ver:  ad46, Type:   3
 PWRTIMG  Ver:  c5d3, Type:   4
 REC Firmware:   4.05
>WV300
>WN16
```

```
>EZ0011101
>EC1500
>EX11101
>WP1
>WF1600
>WS1600
>WM1
>WB1
>WE0150
>WC056
>BP0
>CP255
>CL0
>TP 00:00:00
>TE 00:00:01.00
>TB 00:00:02.60
>TC 2
>CF11101
>CK
[Parameters saved as USER defaults]
>B?
BA = 030 ----------------- Evaluation Amplitude Min (1-255)
BB = 0000 ---------------- Blanking (cm) (0-9999)
BC = 220 ----------------- Correlation Magnitude Min (0-255)
BD = 000 ----------------- Delay Re-Acquire (# Ensembles)
BE = 1000 ---------------- Max Error Velocity (mm/s)
BF = 00000 --------------- Depth Guess (0=Auto, 1-65535 = dm)
BG = 80,30,00030 --------- N/A Shal Xmt (%), Deep Xmt (%), Deep (dm)
BH = 190,010,004,040 ----- N/A Thresh(cnt), S Amb(cm/s), L Amb(cm/s), MinAmb
BK = 0 ------------------- Layer Mode (0-Off, 1-On, 2-Lost, 3-No BT)
BL = 320,0640,0960 ------- Layer:  Min Size (dm), Near (dm), Far (dm)
BM = 5 ------------------- Mode (4 = Default - Coherent, 5 = Default)
BP = 000 ----------------- Pings per Ensemble
BR = 0 ------------------- Range Resolution (0 = 4%, 1 = 2%, 2 = 1%)
BS ----------------------- Clear Distance Traveled
BX = 5000 ---------------- Maximum Depth (80-9999 dm)
BZ = 005 ----------------- Coherent Ambiguity Velocity (cm/s radial)
>C?
CB = 411 ----------------- Serial Port Control (Baud; Par; Stop)
CF = 11101 --------------- Flow Ctrl (EnsCyc;PngCyc;Binry;Ser;Rec)
CG = 0 ------------------- Ping Mode (0=Std, 1=Timed Data Out)
CK ----------------------- Keep Parameters as USER Defaults
CL = 0 ------------------- Battery Saver Mode (0=OFF, 1=ON)
CP = 255 ----------------- Xmt Power (0=min, 255=max)
CQ = 008 ----------------- Xmt Delay Select (0-127)
CR # --------------------- Retrieve Parameters (0 = USER, 1 = FACTORY)
CS ----------------------- Go (Start Pinging)
CT = 00 ------------------ Turnkey Mode (0=OFF,1=TURNKEY)
CX = 0 ------------------- Triggered Xmt (0=OFF,1=LH,2=HL,3=LH/HL,4=L,5=H)
CY = 00000000 ------------ Clear BIT Log
```

```
CZ ----------------------- Power Down BBADCP
>E?
EA = +00000 -------------- Heading Alignment (1/100 deg)
EB = +00000 -------------- Heading Bias (1/100 deg)
EC = 1500 ---------------- Speed Of Sound (m/s)
ED = 00000 --------------- Transducer Depth (0 - 65535 dm)
EH = 00000 --------------- Heading (1/100 deg)
EP = +0000 --------------- Tilt 1 Sensor (1/100 deg)
ER = +0000 --------------- Tilt 2 Sensor (1/100 deg)
ES = 35 ------------------ Salinity (0-40 pp thousand)
ET = +2500 --------------- Temperature (1/100 deg Celsius)
EX = 11101 --------------- Coord Transform (Xform:Type; Tilts; 3Bm; Map)
EZ = 0011101 ------------- Sensor Source (C;D;H;P;R;S;T)
>P?
PA ----------------------- Pre-Deployment Tests
PC ### ------------------- Built In Tests, PC 0 = Help
PD = 00 ------------------ Data Stream Select (0-7)
PI = 011111 -------------- Built in Tests (Rpt;CPU;Clk;TC;DSP;Loop)
PM ----------------------- Distance Measure Facility
PS # --------------------- Show Sys Parms (0=Xdcr,1=FLdr,2=VLdr,3=Mat,4=Seq)
PT ### ------------------- Built In Tests, PT 0 = Help
>T?
TB = 00:00:02.60 --------- Time per Burst (hrs:min:sec.sec/100)
TC = 00002 --------------- Ensembles Per Burst (0-65535)
TE = 00:00:01.00 --------- Time per Ensemble (hrs:min:sec.sec/100)
TF = **/**/**,**:**:** --- Time of First Ping (yr/mon/day,hour:min:sec)
TP = 00:00.00 ------------ Time per Ping (min:sec.sec/100)
TS = 99/07/07,19:59:03 --- Time Set (yr/mon/day,hour:min:sec)
>W?
WA = 255 ----------------- False Target Threshold (Max) (0-255 counts)
WB = 1 ------------------- Mode 1 Bandwidth Control (0=Wid,1=Med,2=Nar)
WC = 056 ----------------- Low Correlation Threshold (0-255)
WD = 111 100 000 --------- Data Out (V;C;A  PG;St;Vsum  Vsum^2;#G;P0)
WE = 0150 ---------------- Error Velocity Threshold (0-5000 mm/s)
WF = 1600 ---------------- Blank After Transmit (cm)
WG = 000 ----------------- Percent Good Minimum (0-100%)
WH = 111 100 000 --------- Bm 5 Data Out (V;C;A  PG;St;Vsum  Vsum^2;#G;P0)
WI = 0 ------------------- Clip Data Past Bottom (0=OFF,1=ON)
WJ = 1 ------------------- Rcvr Gain Select (0=Low,1=High)
WL = 000,005 ------------- Water Reference Layer:  Begin Cell (0=OFF), End Cell
WM = 1 ------------------- Profiling Mode (1-8)
WN = 016 ----------------- Number of depth cells (1-128)
WP = 00001 --------------- Pings per Ensemble (0-16384)
WQ = 0 ------------------- Sample Ambient Sound (0=OFF,1=ON)
WS = 1600 ---------------- Depth Cell Size (cm)
WT = 0000 ---------------- Transmit Length (cm) [0 = Bin Length]
WV = 300 ----------------- Mode 1 Ambiguity Velocity (cm/s radial)
WW = 004 ----------------- Mode 1 Pings before Mode 4 Re-acquire
WX = 999 ----------------- Mode 4 Ambiguity Velocity (cm/s radial)
WZ = 010 ----------------- Modes 5 and 8 Ambiguity Velocity (cm/s radial)
```

```
>R?
RA = 000 ----------------- Number of Deployments Recorded
RB ### ------------------- Blank Check 1 MB of Recorder Memory (0 = ALL)
RD = 000 ----------------- Current Deployment Selected (0 = NONE)
RE ErAsE ----------------- Erase Recorder
RJ +##### ---------------- Number of Ensembles to Jump (+/- 99999)
RP = 0000 ---------------- Recorder Parameters (-;-;-;No Buffer)
RS = 000,020 ------------- Rec Space Used (MB), Free (MB), (999 = Erasing)
RT ----------------------- Recorder BIT
RY ### ------------------- Start YModem (Batch) Xfer Deployment # (0=All)
>
```

Parameters and commands can be used both for initial meter loading and by an operator of LADCP. At the last case recorrection of commands and parameters may require the software amendments.

The main given parameters:

- maximal velocity;
- a number of ensembles of records;
- a number of signal in ensembles;
- time for ensemble;
- a number of signal averaged by ensemble;
- sound velocity;
- type of coordinates;
- size of memory required;
- time of the first signal sending;
- time interval between signals;
- size of scanning layers;
- a number of scanning layers;
- accuracy of velocity measurement (root-mean-square deviation).

The main output data:

- reference sign indication part;
- current velocity (each layer for each source);
- correlation value (each layer for each source);
- echo signal intersity (each layer for each source);
- interest content of high quality data (aech layer for each source);
- characteristics of the near bottom layer.

LADCP has been built in CTD basket. Accumulator block also fixed in CTD basket and gives feeding to the meter. Boost charge of the battery is produced from the vessel source of 58 V on the vessel moving. The measured data record is performed on the autonomic information storage being located on the device case. The obtained information is rewritten on the vessel computer of Notebook type. The computer is controled by LADCP operator. The connected cable is used both for the commands information transmision and as the feeding line. For the data processing PC of Pentium class is used.

Under the instruction an operator fulfills the actions ensuring LADCP operation in the regime of recording, making copies of the observed data from LADCP storage on a hard disk PC, fills in the report of observations.

The software for LADCP data processing has been developed in Unviersity of Hawaii (USA). It has been prepared to use in UNIX media with a wide applying of the languages C and Perl and MatLab packet. The output data presented to be processed are in a binary form. To produce the calculations by self programm products there is a convertor to transfer them in ASCII format.

Under the vessel conditions the preliminary data processing has been done. It main task is to give an assessment of the data obtained and their suitability for future comprehensive processing. In the preliminary the sound velocity was assumed to be constant, and the vessel drift in the observation time was to be linear and uniform. In no way the current meter location regarding the vessel position meter was considered. Having the great cable angle declination under the heavy vessel drift, it could be made errors in the current calculations, especially essential at the shallow water station, where CTD and LADCP measurements require reletavely not much time. At the shallow water stations, in addition, the essential errors in the current calculations can appear because of the low vessel accuracy of GPS. The final data processing will have been produced, using CTD and navigational data during the year at University of Hawaii.

B.6.3. Actual program implementation; characteristic of the obtained results

The current measurements were fulfilled at each CTD probing. There were no any damage in the equipment operation. The program has been carried out completely. As a result the follouing data were obtained:

- data of observation;
- reports of LADCP probing;
- GPS files (seft of satellite navigational vessel positions determination with a discretness 3 sec);
- plots of vertical profiles of the current components in the electronic form;
- mapped current vectors at the levels of 60, 100 and 500 m in electronic and hard copies.

Because of the meter constructive peculiarities and due to priviously given parameters there were not obtained the current records at the stations of the depth less than 150 m (NN 123, 124, 128, 130, 138-141, 202, 203). In probing at ststions 131 and 132 GPS was not working, so the measuremant positions of starting and completion are unknown, as s result, the currents at the stations were not determined. Because of the weather conditions the data from the stations 115-116 have very poor quality.

<u>The vertical current structure</u> of the Japan Sea region studied looks very complex and ambiguous (Fig.6.1-6.4). As a rule, the maximal velocities were being observed in the surface and subsurface layers preserving their direction with in the limits of one square. Further with the depth in the sea different positions by individual examples there were observed the relatively homogeneous one layer current struture, but zonal and meridional components oftener changed their sing many times. The minimal velocities closing to zero ones were observed in the intermediate, deep sea or near bottom layers. In some cases the current intensification near bottom were observed (for example, sta. 159, 163, 165, 170, 183 and so on). It is very important that the stations mentioned above were placed in the deep sea basin. The last feature, if it finds the confirmation on the final data processing, will require a special analysis and explanation.

In the <u>horizontal current structure</u> there can be determined a number of the circulation elements (Fig.6.5-6.7).

1. The westbern stream of the Tsushima current propagates north-eastward to the region of 40-40.5° N, 134° E, where happens the strengthen of it eastern component. At the depth of 60-100 m the current velocity in the stream is to be 20-30 sm/sec. On the southern side of the subpolar front there was observed the current intensification. At the depth of 500

m the refurn/restore current of south-easternward with the velocities of 5-10 sm/sec is dominant.

2. In the northen part of the region studied in the upper layer there is observed the Japan Sea water transport in the direction of the Laperous Strait.

3. Along the coast from 141° to 134° E the current directed south-westward the Primorye Current is marked. It is weak nearly the shores (3-5 sm/sec) and becomes more strong on the off shore side, where the streams of 15-20 sm/sec branch out from it south-eastern direction.

4. In the current field two anticyclonic eddies (A1 and A2) with the water rotation clockwise are vividly revealed. A1 eddy center is located nearly the position 41°15 N and 134° E. Near the central position the currents are weak and instable, however, they gain in strength up to 20-25 sm/sec at the distance of 10 miles from the center and preserve their essential ability (8-10 sm/sec) throughout the bottom (Fig. 6.8, 6.9). Moreover, their intensification to 15-20 sm/sec is observed near bottom. All water thickness being inrolved in the circulation by the eddy from the sea surface throughout the bottom a new and important factor in dynamics of the long living eddies subject to confirmation of the event by the final result processing. On the eddy periphery the current velocity abruptly reduces the dynamic structure of A2-eddy (center about 40°30 N, 131° E) is more complicated if compared to A1 (Fig.6.10, 6.11). It is assymetric regarding the central axis. Nearly the center the velocity meridional components at the intermidiate depths decreases to zero or changes it sign to opposite one. In the upper layer the velocities excess 30-40 sm/sec and at the depths from 1500 m throughout the bottom are 10-15 sm/sec, i.e. as in the previous case the eddy rotary motions cover all the water thickness.

B.6.4. Conclusion and summary

For the first time the widescale survey of the Japan Sea, covering the basic current systems with instrumental current measurement of high discretness from the sea surface throughout the bottom on the R/V «R/Revelle» and «Prof. Khromov» has been conducted. The data obtained for the Japan Sea are unique. The preliminary processing results and obtained data analysis give an evidence that they can be used for the investigations of various dynamic processes and events.

The main conclusions can be done as follows:

- meter of LADCP type is an effective mean for the water circulation and dynamics studies. To improve its efficienty the up to data navigational vessel systems should be fixed installed so that to ensure the conditions of probing with the minimal deviation from the vertical;
- program-technology scheme of the data processing is acceptable for an operator having experience do of PC operation, though is not quite suitable for a user of Russian Federation. It is produced to work in UNIX media, applying languages Perl and MatLab are little known in Russia. The output data are presented in a binary form that doesn't allow to make their estimations by the user. The results of preliminary processing have been presented in a graph form but not in a table one that doesn't allow to store them in the archive file, so that the data to be processed and analyses further. The operator can't change the current measurement parameters due to a danger not to read the data obtained and to process them. Due to the full software absence and instruction for user it is impossible to process data in final so that to oftain not only the graph picture but as well as the results in a table form;
- measured and then processed the current vector estimations are likely to be actual both on the velocity and direction. They indicate to the current intensification along zones of

frontal divisions, along coast of the Primorie Current 48° and 43°20 N, the water fall in the direction of the Laperouz Strait, anticyclonic eddies at 134° and 131°30 E. Of the most important fearture regarding the eddies mentioned above is the participant in a circular movement not only the baroclinic layer but as well as all water thickness from the surface throughout the bottom.

B.7. Report of hydrochemical group: P. Tishchenko

B.7.1 Objectives

The hydrochemical group's main task is to obtain new data on the carbonate system parameter distribution (pH and total alkalinity), dissolved oxygen and nutrients (nitrite, nitrate, nonorganic phosphor and silicate) in the North-West part of the Japan Sea. In addition, there were sampled the sea samples for dissolved calcium, inert gases (helium, neon, argon, xenon, radon) freons and isotopes (tritium , C14 , O18). The analysis of the samples will be carried out in the coastal laboratories.

Besides the methodical work on pH measurements in the sea water has been conducted. pH measurements were produced by now general accepted spectrophotometric method (equipment has been provided by Seoul National University) and recently worked out by POI the potentiometric method in a cell of liquid lack unit.

The new data have been obtained at up-to-date level so that to study the Japan water mass hydrochemical structure in the summer season.

B.7.2 Staff of the group and their duties.

1. Dr. P.Tishchenko, head of group - potentiometric pH measurement, sampling (to determine pH , alkalinity, result processing, data file formation (pH, alkalinity), report compiling.
2. R.Chichkin, researcher - potantiometric pH measurement, sampling (to determine pH , alkalinity), equipment preparation to measure pH.
3. J.Pavlova – chief researcher- spectrophotometric pH measurement, sampling (to determine pH), data file formation (pH).
4. Yu.Shulga, engineer - spectrophotometric pH measurement, sampling (to determine pH).
5. T.Volkova, researcher – determination of alkalinity, equipment preparation for alkalinity measurement.
6. E.Il'ina, researcher – alkalinity determination.
7. Dr. A.Nedashkovsky, leading researcher - biogenic element determination, obtained results processing , file data formation (biogenic elements).
8. M.Shevtzova, engineer – biogenic element determination
9. S. Sagalaev, researcher- dissolved oxygen determination, sampling for oxygen, data file formation (oxygen).
10. O.Shevtsova, researcher - dissolved oxygen determination, sampling for oxygen.
11. A.Kalyagin, leading researcher - sampling for helium, tritium, isotop O18.
12. O.Vereschagina, chief engineer - sampling for freons, ampule soldering.

B.7.3 Methods of hydrochemical parameters determination.

B.7.3.1 pH – measurements

B.7.3.1.1 pH-potentiometric determination

pH-potentiometric measurements were being conducted just after sampling at 25°C by the method of direct potentiometry in the close running water cells of lack liquid unit

СЭ-Na^+	studied section standard section	H^+-СЭ	(A)

by glass pH – electrode (Ross-TM Orion Co.) and Na+ - glass electrode (ESL–051-G). As a low ohm electrode there was used chlorsilver electrode with double liquid unit (outer unit of the type "Smoothing", model 900200, Orion Co.). EMF was recorded by digital pH meter (model EL-940, Orion Co.) with a sensibility of 0.1 mv. Electrode pair has been standardized by SWS scale, using buffer TRIS as a standard (DelValls, Dickson, 1998) and pH was calculated by the formula:

$$pH = 8.0936 + \frac{(E_S - E_X)}{59.16} + \log\left[\frac{(m_{Na})_S}{(m_{Na})_X}\right] + \log\left[\frac{(\gamma_{Na})_S}{(\gamma_{Na})_X}\right]$$

where Ex ,Es – the cell EMF (A) in the studied standard solutions . Na molality $(m_{Na})_x$ was calculated by the data of salinity (S), using terms (Clegg and Whitfield, 1991),

$$(m_{Na})_X = 0.013872 \cdot S / (1 - 0.001005 \cdot S)$$

The rates of $(\gamma_{Na})_x$, activity were calculated by the equation (Tishchenko and Pavlova, 1999)

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

where I –ionic force determined by the equation (Clegg and Whitfield, 1991)

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

The rate of sodium activity and molality in a standard buffer solution were $(m_{Na})_s = 0.44618$, $(\gamma_{Na})_s = 0.6412$, respectively.

We made estimation of the pH measurement error by this method and it is equal to ±0.0044 units pH (Tishchenko at el., 1998). It total, pH was measured in 1200 samples.

B.7.3.1.2 Spectrophotometric pH determination

In the cruise the Seoul National University suggested the equipment and reagents required for spectrophotometric pH determination. For this method m – cresol purple-indicator was used, constant of which depends on salinity and absolute temperature (T) in accordance with the equation (Clayton and Byrn, 1993)

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

The sea light absorption was measured by an indicator with the wave length of 434, 578 and 738 by means of Spectrophotometer Ultraspec 2000. pH estimations were calculate by formula

$$pH = pK_2 + \log\left(\frac{(A_{578} - A_{730}) / (A_{434} - A_{730}) - \varepsilon_1^I / \varepsilon_2^I}{\varepsilon_1^{II} / \varepsilon_2^I - (A_{578} - A_{730}) / (A_{434} - A_{730}) \cdot \varepsilon_2^{II} / \varepsilon_2^I}\right)$$

where A - absorption at associated wave length, ratio of function coefficients for m-cresol purple indicators are to be $\varepsilon_1^I / \varepsilon_2^I = 0.0069$, $\varepsilon_1^{II} / \varepsilon_2^I = 2.222$, $\varepsilon_2^{II} / \varepsilon_2^I = 0.133$.

Dong-Jin Kang (SNU) stated that the method reproductively was equal to 0.006 units pH . pH were measured in 1150 samples by spectrophotometric method.

B.7.3.2 Alkalinity determination

Alkalinity has been analyzed just on sampling by a direct titration in the open cell by Bruevich' method (1944): 25 ml of sea water was titrated by 0.02 n of hydrochloric acid with the mixed indicators (methyl red and methylene blue). In the titration process the water samples were blown through by the air free from carbon dioxide and ammonia. The point of equivalence (pH about 5.4-5.5) was determined by visual to transition of the light green color into light rose one. The titr HCl was installed daily in accordance with a standard soda solution prepared by the weigh method taking into consideration the vacuum amendment as to Dickson's CRM. Titration was produced by a burette of Brinkman/Dosimate –665. Reproduction of sample obtained at one level was ±0.0027 mg-equ/l.

B.7.3.3 Determination of biogenic elements

Out of the biognic elements NO2 and NO3 nonorganic phosphor and silicon solved in the water were determined. The samples were analyses by standard spectrophotometric method. In the analysis there was used autoanalizator "Technicon", provided by SIO. The method accuracy is 1%. At 85 station 1500 sea water samples were measured.

B.7.3.4 Oxygen determination

Dissolved oxygen determination was produced by the volume Vinkler's method, modificated by Carpenter (1965). The essence of modification is in the fact that the end point of titration was determined by photocolourimetry (350-365 nm) with further processing by a computer, i.e. the titration process happened without a man activity that allowed to increase the method accuracy and its reproduction. Usage of precession weighers also promoted to increasing of the accuracy method. The authors of the method state that the dissolved oxygen in the water is determined with the accuracy of ±0,005 ml/l.

The equipment used was from (Scripps Institute of Oceanography), and consisted of microburettes Brikman/Dosimate-665, photocolourimeter and PC286/20/40M. The injectors of 1 ml were used in the burettes for oxygen titration and by 10 ml for calibration of thiosulphate solution. The burette control for titration taking photocolourimeter records as well as burette and temperature detectors (temperature Na2S2O3 and KIO3) were carried out by computer through multichannel chart I/O (PCL-812) and the readable terminal. The software for work of SIO installation was written on Beisik (qb45). The oxygen bottles used of standard SiO, also calibrated there. The reagents and standards provided by SIO were used for the work.

B.7.3.5 Calcium determination

Calcium will be analyses by a complexonometric titration EGTA (Tsunogai S., et al., 1968). The essence of the method is as follows: 10 g of the sea water is transferred into 100 ml conic flask there EGTA solution of 7.5 mm volume was added that made titration of 95% for initial calcium quantity. After mixing by magnetic mixed device in the flask was introduced 2 ml of 0.05% GHA [glyoxal-bis (2-hydroxy-anil)] and 2 ml of borate buffer solution. The obtained solution were mixed during 3 minutes and 4 ml n-butanole was added that extragated in red calcium GHA complex in a thin organic layer. Further calcium titration is being produce by the intensive mixing to colour an organic layer colour transition from red to colourless . The standard solution is being prepared from calcium oxide sample preliminary calcinated at 950°C , soluted in the hydrochloric acid. Correction factor considering strontium presence is equal to 0.9946 (Tsunogai S., et al., 1968). Applying of Brikman/Dosimat-665 burette with 0.001 ml scale division provided the analysis accuracy of ±0.1%.

B.7.3.6 Dissolved gases

The dissolved gases – freon, helium and the other noble gases (neon, argon, xenon, radon) serve as indicators of the water mass age. The samples to analyze freons were taken at 43 stations (601 samples) and will be transferred in Washington University (Seattle, USA). The samples on helium and other inert gases (37 stations, 325 samples) as well as on isotopes O18 (40 stations, 325 samples), tritium (34 stations, 278 samples) were taken for transferring them to be analyzed in Kyung-Ryul Kim's laboratories (Seoul University) and Bill Jenkins (Institute of Oceanographic Sciences, Southampton, England).

B.7.4 Work carried out and form of the results to be presented

In the cruise pH and alkalinity were measured at 100 stations, oxygen and biogenic elements were determined at 102 stations. For the surface level at 100 stations there were obtained the samples with the solved calcium content, in addition, the samples were taken at a few deep-sea stations.

The measurements were fulfilled in the cruise are as follows :

pH pot	1200
pH spec	1200
Alkalinity	1200
Oxygen	1650
Nitrite	1650
Nitrate	1650
Nonorganic phosphor	1650
Nonorganic silicon	1650
Calcium	300

pH estimations were measured within SWS scale and presented in total file KH36.sea . Determination results of oxygen, alkalinity, biogenic elements are also given in this file.

B.7.5 Preliminary scientific results

B.7.5.1 Comparison of potentiometric and spectrophotometric methods of pH measurements in the sea water

At the initial test cruise stage we used the methodical variant of spectrophotometric pH measurement suggested by SNU. It included the sea water passing transport through the running that was destined to determine the accurate volume of the sample introduced in the optical cell. In this case the sea water sample was being mixed with the indicator by means of the air bubble being in the cell. Fig. 7.1a shows the result difference between potentiometric and spectrophotometric measurements this difference is to be – 0.025 units pH. In a few case it reaches – 0.1 units pH. We suggest that this difference should be due to the carbon acid lost in the process of the sea water sample going from a bottle in to the spectrophotometric cell. To make spectrophotometric pH measurements is not required the accurate ration between the indicator and sample. In order to reduce the sample way passing, a pipette was removed. Actually the agreement of the methods were improved, but general picture staged similar (Fig. 7.1.b). We explain this by a degazation in the mixing process of the indicator and sea water by means of the air bubble. To avoid this effect all gas bubbles were removed from the spectrophotometric cell. As a mixer of the sample and indicator a piece of ftoropeast was used. It was a case of maximal agreement between 2 methods (Fig. 7.1c). However as before the systematic difference (-0.15 units pH) is presence between 2 methods. Perhaps it is due to different standards used by two methods. (The potentiometric method was used TRIS buffer and spectrophotometric one was used the constants of indicator). However, we think that in the spectrophotomentric method we were not able to exclude the degazation process, therefore the results of the potentiometric method are considered to be move correct. So in further work only these results will be used by us.

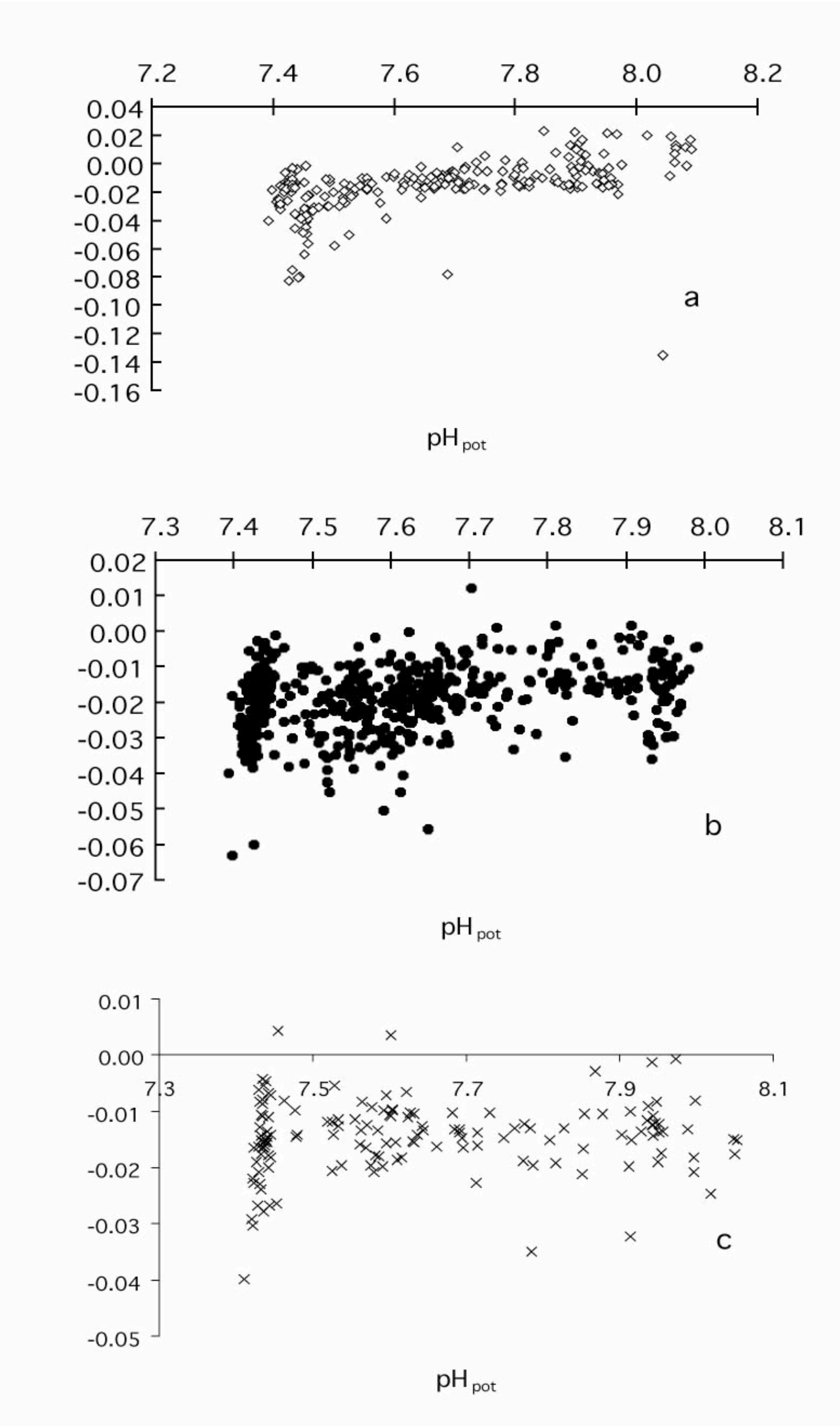


Fig.7.1. Difference of potentiometric and spectrophotometric methods for pH measurement; a - running pipette is used for spectrophotometric method; b - pHspec were obtained not using the running pipette; c –indicator and sample were mixed without air bubbles.

B.7.5.2. Carbonate system and oxygen

Generally known, that the surface water, as s rule, is close by its saturation to the gases as oxygen and carbon dioxide. These gases distribution is close related between them through the organic matter, that is form and broken down in the sea. If assumed Redfild' stoichiometry for the organic matter, them the relation between the important gases will be written by the below equation

$$(CH_2O)_{106}(NH_3)_{16}H_3PO_4+138O_2=106CO_2+122H_2O+16HNO_3+H_3PO_4$$

In this case when the reaction goes from the right to the left (photosynthesis) the surface water can be under saturation by the carbonic and over saturation in relation to oxygen. However, this process may be only in the field of photical layer. This layer below, the process of the organic matter oxygenation only occur (reaction is from the left to right). As a result, the deep sea waters are always under saturated by oxygen and over saturated by the carbonic acid. Due to these reactions and gas exchange on the boundary – sea water/atmosphere, the sea water is essentially stratified with the depth regarding concentration of oxygen and carbonic dioxide. In this case, if the rapid dynamic processes (for example eddies) lead to the water mass vertical transport, then the oxygen and carbonic dioxide content may serve as the indicator of the processes mentioned.

pH was measured in the cruise. This value, above all, depends on the carbonic acid concentration. Total alkalinity was also analyzed by us. The estimation of two parameters of carbonic system will allow us to calculate the other ones, including the carbonic acid concentration. However, here we'll only consider quality and character of distribution for the directly measured data.

Fig. 7.2. shows oxygen and pH distribution. The figure demonstrates that in pH and oxygen distribution is observed a slightly expressed minimum at the depths of 1500 – 2000 m. The position scattering on the profile vividly increases the analytical errors for the levels upper 1500 m. Distribution becomes more homogeneous at the deeper levels. In this case oxygen changes within the limits 210 – 212 mcmol/kg, leaving an average value 211 mcmol/kg. pH estimations are within the limits 7.41 – 7.44, an average value is equal to 7.425 that is lower to some extent for the average meanings (7.446) at the deep sea levels obtained in the winter period (Tishchenko and et al, 1998b).

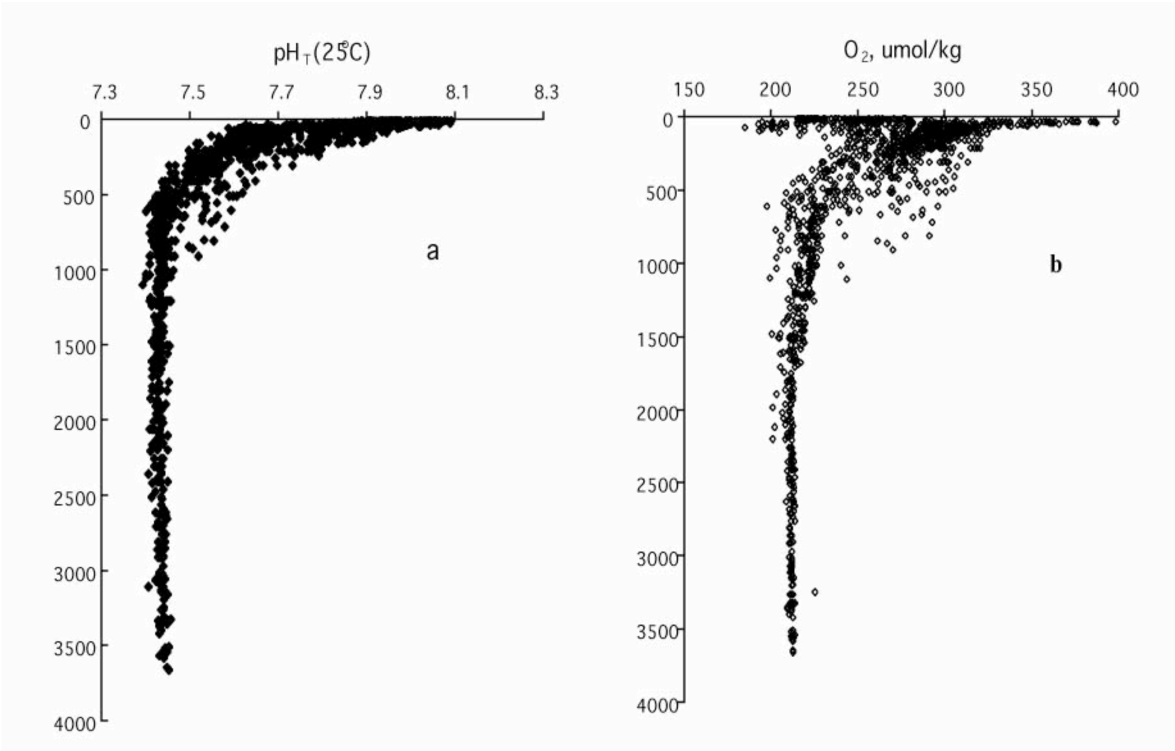


Fig.7.2. Profiles of pH **(a)** and oxygen **(b)**.

The figure shows the close character of pH and oxygen distribution that indicates to their internal relation. As already told pH is to an essential degree, determined by the carbonic acid concentration and the latter is related to oxygen through the reaction above mentioned. Fig.7.3 shows directly correlation relation between pH and oxygen. In spite of the evident dependence (nearly to linear one) of these parameters, there exist the ejection areas in the pH increasing . We consider these injection are chemical processes but not analytical measurement errors that should be carefully studies and guessed. Fig. 7.4 gives the results of alkalinity measurements.

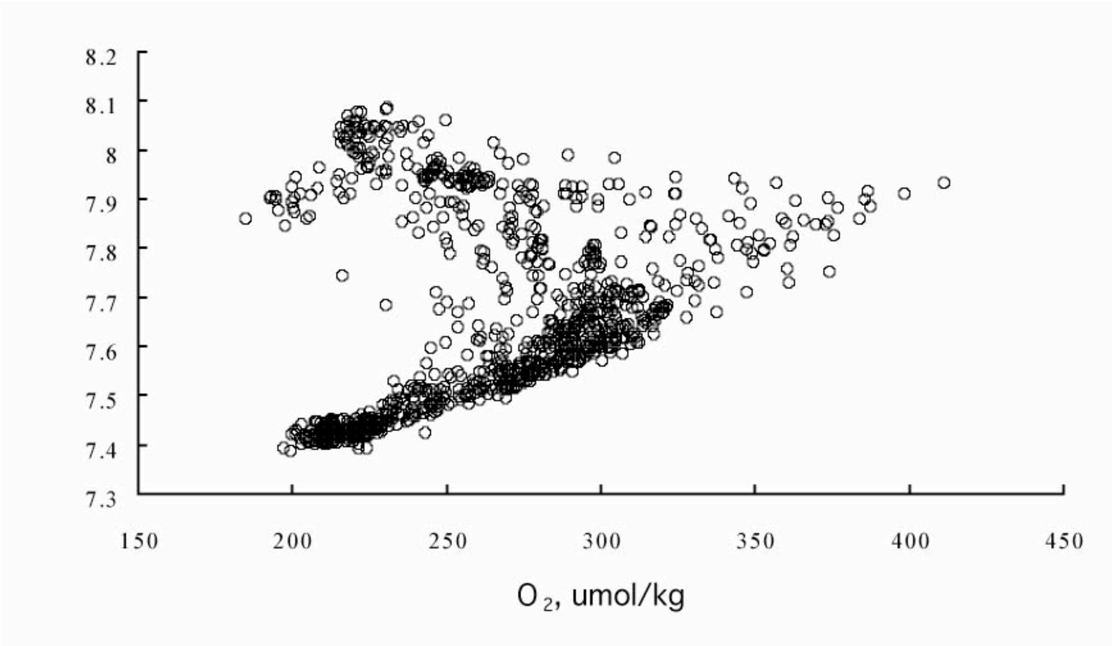


Fig. 7.3. Correlation field of pH-oxygen.

The surface levels are as a rule characterized by the lower estimations of alkalinity (Fig. 7.4a). This factor is due to an effect of dilution, i.e. by lower salinity. By normalization of alkalinity to 35o/oo salinity the effect of dilution is removal (Fig. 7.4b). Minimum of alkalinity normalized at the depth of 200 – 300 m seems to be explained by zooplankton consumption of carbonate calcium. The normalized alkalinity is little changed with the depth. Its average value is 2.350 mg-equ/kg lower 2000 m that is well associated to the value 2.355 mg-equ/kg prior obtained by us (Tishchenko at et., 1988b).

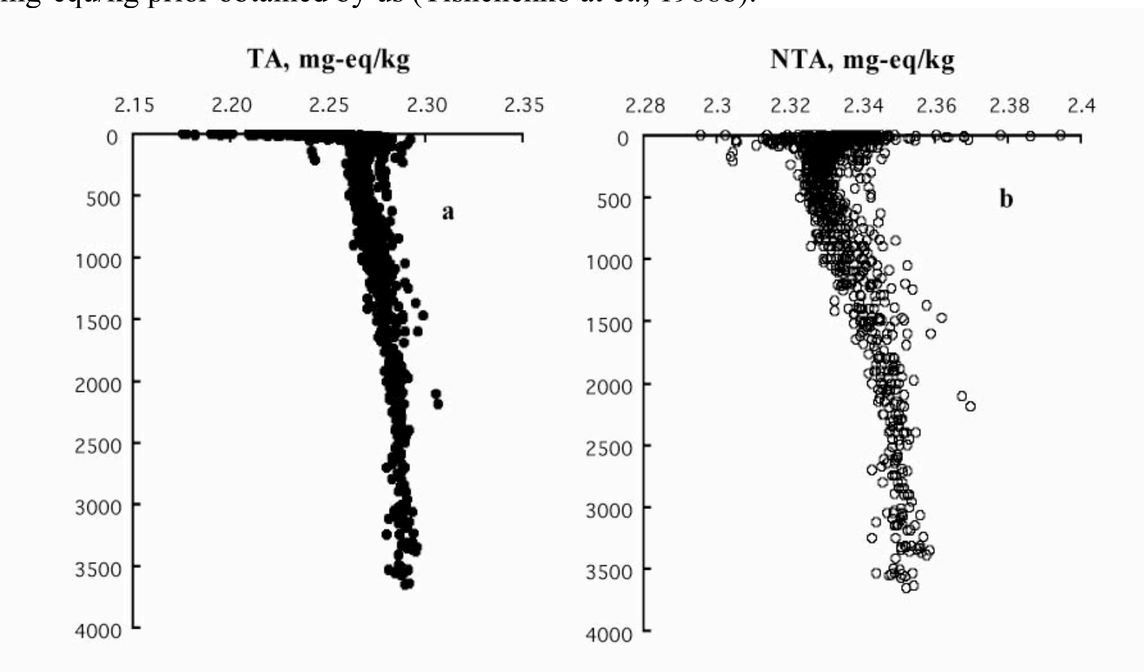


Fig.7.4. Profile of alkalinity distribution **(a)** and normalized alkalinity **(b)**.

B.7.6 Biogenic element variability at the deep-sea stations

Fig. 7.5 gives the general character of vertical silicate and phosphate variability. The vertical nitrate variability is similar to phosphate one that is confirmed by Fig. 7.6 where nitrate – phosphate correlation fields are shown.

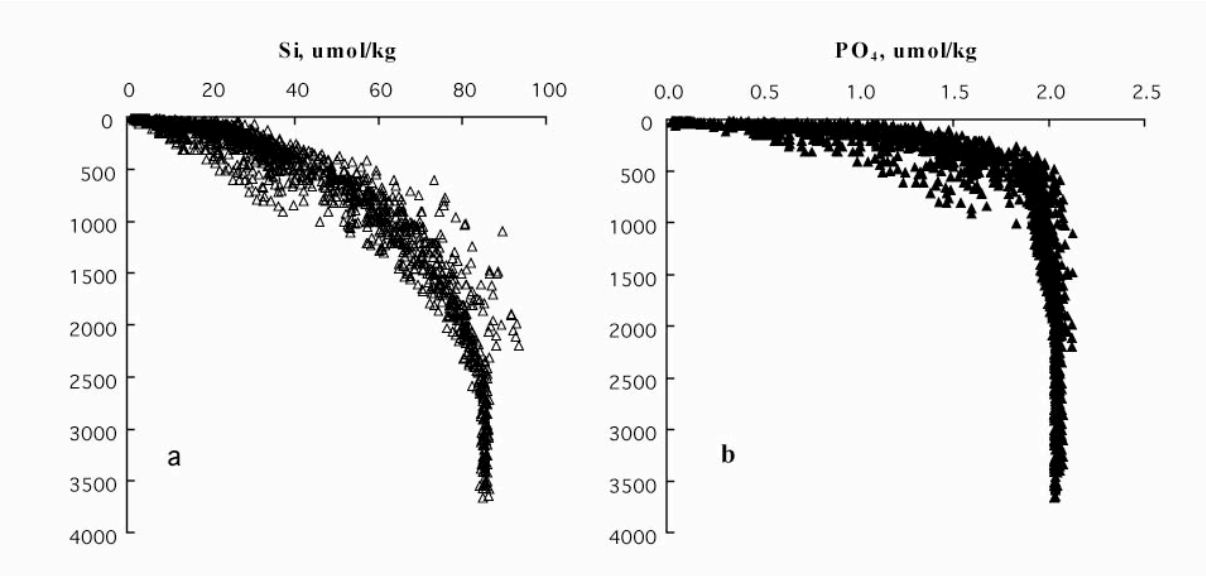


Fig. 7.5. Correlation fields silicates-depth (a) and phosphates-depth (b)

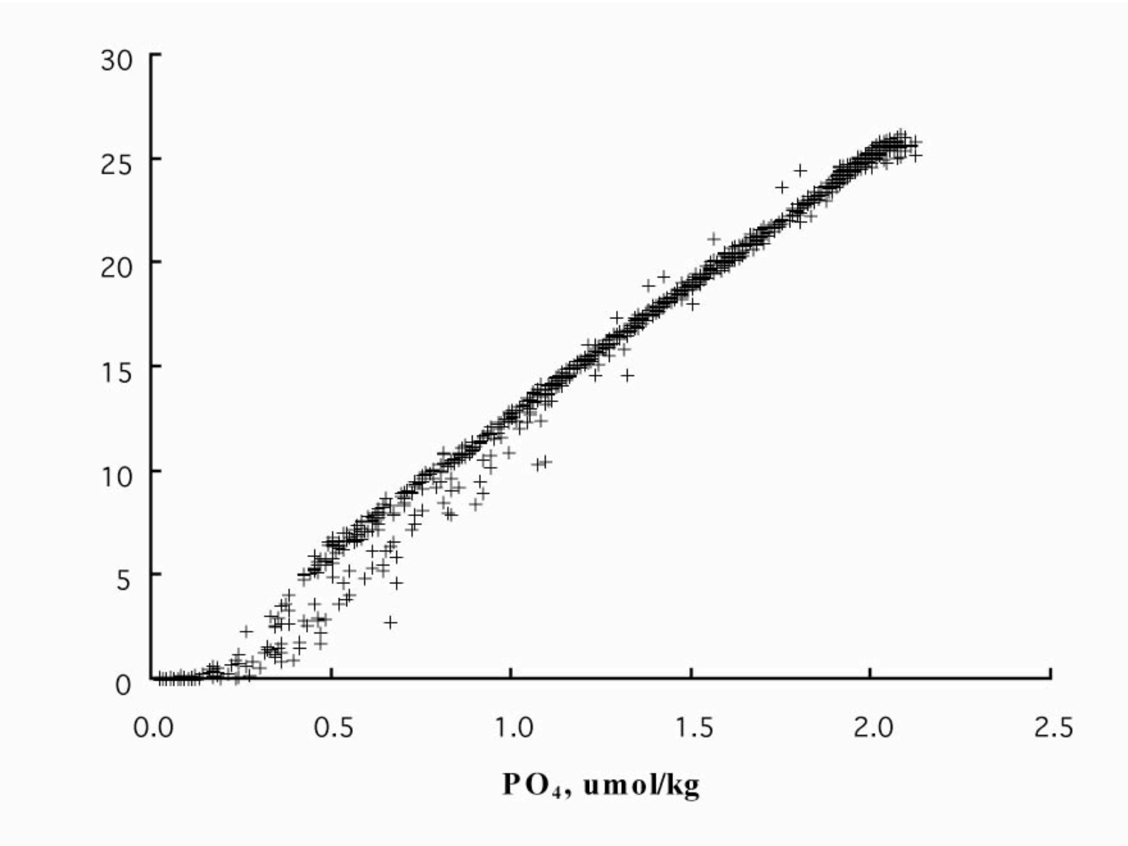


Fig. 7.6. Correlation field nitrates-phosphates ($\Delta N/\Delta P = 13.1$, $r = 0.995$)

The obtained data show that at the deep sea stations the vertical biogenic element distribution can be characterized by the three layer structure :a) homogeneous deep sea layer (from 2000 m to the bottom), b) intermediate layer(100-500),c) surface layer.

B.7.7 References

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B.8. Report of bioptical group: S. Zakharkov

B.8.1. Basic scientific positions

The main investigations have been carried out by Dr. S. Zakharkov (POI) with a help of Dr. G. Mitchell (Scripps Institute of Oceanography).

Spectors of the surface water reflection and direct sunlight were measured by a and radiometer SIMBAD. The above water measurements were supported by the water samples to determine chlorophile "a", HPLC-pigments, absorption particles and dissolved matters, particles of organic carbon and nonorganic material.

The samples were taken in euphotic zone defined by the depth of Secchi disk. The particle matter was divided into phytoplankton and detrit components using methanol extraction and differential spectroscopy. The summary particle absorption and water solution can be used to model the coefficients of spector rejection weaken in the euphotic zone.

The rejection light coefficients and CTD data will be used to determine the water mass structure and circulation. Meters of the red and blue spector rejection were built in CTD system of SIO. The water samples throughout the depth were taken at individual stations for the analyses mentioned above to be done. The coefficients of rejection will be related to the vertical hydrological and hydrochemical structure parameters, including oxygen, biogenic elements, salinity and temperature.

B.8.2. Equipment, provisions and reagents used

Under water trausparence meter (in red spector field).
Under water transparence meter (in blue spector field).
Spectrophotometer Cary 1E UV/Visible (190-900 nm).
Universal small oceanic meter light reflector SIMBAD.
PC ATC 386.
PC HTI P-90 MHz.
Colour monitor SVGA Shamrock 15.

Dewar flask of 5 l liquid nitrogen Taylor Wraton.
Dewar flask of 35 l liquid nitrogen Taylor Wraton.
Vacuum filtration equipment including 2 vacuum pumps, filtration reservoir, orgglass installation for the sample filtration, filtering funnels, forceps and so on.

So that the above described work to be carried out on board the "Pr. Khromov" were delivered 8 l of methanol (for pigment extraction), 100 ml of 25% glutaric dialdehyde, 4 l of ethanol (to wash glasses and optical windows), 1 l of concentrated hydrochlorid acid (to wash the flasks for samples). The liquid nitrogen (35 l) was received in Pusan.

B.8.3.The group staff

The group consisted of Dr. S.Zakharkov (POI)

B.8.4. Methods

B.8.4.1. Typical plan of station

Above water reflection was measured by SIMBAD in the day light of CTD stations. The water samples from CTD-ROSET system were taken from the surface and at the chosen depths, day stations to provide SeaWiFS and SIMBAD with the data. The analysis of one sample part for absorption was done on the vessel the other samples are kept in liquid nitrogen so that further to be analysed in SIO, in case of nitrogen is not much the samples will be put in the scientific freezer. The samples for mineral optics were fixed by the glutaric dialdehyde on the glass flasks and sent to SIO.

B.8.4.2. Water sampling

At two stations in day time from the sea surface will be sampled 10-15 l of water for detailed analysis. At the other depths taking into account the works to be fulfilled and the particle concentration in the water there will be sampled 5-10 l of water. To carry out this work it may take two bottles as a maximum.

Table shows a maximal number of the levels where the couple water sample to the samples to be taken.

Stations of depth less	Maximal number of the levels
than 500 m	6
500-1500	4
1500-2000	3
2000-2500	2
more than 2500	1

The sample bottle water for hydrooptical studies were chosen on all other hydrological and hydrochemical samples completion.

B.8.5. Results

The light rejection paramerters in the Japan Sea were studied including the specific chlorophil absorption. The coefficients of chlorophile including the specific absorption. The coefficients of chlorophile specific absorption can be used to establish the photosynthetic models of the studied region productivity. To obtain the aim the water samples taken on the euphotic zone to be measured. Besides, the samples to analyse the other phytoplankton components to be chosen.

In a total to be sampled

a) 192 samples to analyse the particle and detritus absorption spectors at 36 stations; 44 out of the samples being analysed in the cruise, the other ones to be sent for the analysis in SIO;

b) 44 samples to analyse the dissolved matter absorption spector. All were analysed on board the vessel in the cruise;

c) 141 samples at 33 stations to analyse the organic carbon particles;

d) 92 samples to analyse phicoeritrine at 27 stations;

e) 118 samples to analyse phytoplankton pigments by the method of a high efficiency of liquid chromatography at 27 stations;

f) 80 samples to analyse aminoacids of micospirine types (photoprotectors of phytoplankton) by the method of liquid chromatography high efficienly at 27 stations;

g) 191 samples at 36 stations to determine chlorophile "a" concentration by the fluorescentic method;

h) 48 samples to analyse mineral optics at 8 stations.

The water transparence is also measured by Secchi disk at 29 stations and reflected light polarization spector measurement by hand Simbad at 31 stations were produced.

B.8.6 Conclusions

1) For the first time the large scale survy of the Japan Sea studied to be carried out by the up-to-date methods. On further result processing in the coastal laboratories the models describing the level of the initial organic production in the Japan Sea will be constructed.

2) The investigations carried out, will be used for SeaWeaFS data calibration.

3) During the studies conducted in all the regions there were observed the summer minimum in phytoplankton evolution that was due to high transparence by Sekki disk and low phytoplankton pigment concentration.

B.9. Synoptic eddies study over the North-West part of the Japan Sea: V. Ponomarev

B.9.1 Experiment aim

The aim of this expedition program is to determine the anticyclonic eddy structure over the NW part of the Japan Sea on the background of large scale oceanographic survey being produced within the basic program. It’s supposed to make assessment of the eddy effect on the hydrological and hydrochemical feature distribution in the intermediate, deep-sea and near bottom sea layers. In future, the obtained data can be used to make assessment of the vertical transport and heat, salt and chemical makers inflow in the deep sea layers.

B.9.2 Hypothesis being put in the background of experiment

In the cruise on the R/V «P.Gordienko» in April 1999 firstly there were obtained the hydrological and chemical feature distribution in three anticyclonic eddies over the Japan trough northward the subarctic (Polar) front. It was demonstrated that:

- the horizontal dimensions of these eddies decrease with the basic pycnocline thickness under the theoretic estimations,
- the vertical anticyclonic eddy scale is essentially more than the main pycnocline thickness and the eddy effect propagates to the depths of 2000-2500 m,
- in the anticyclonic eddies core of the NW part of the Japan Sea, the most warm and the freshest waters are located in compare to the surrounding ones corresponding to the vertical salinity and temperature stratification in the given sea part,
- the anticyclonic eddies located southward the subarctic front have waters of increase salinity and temperature estimations in a core as to the subtropical vertical water structure in this part of the sea.

By the virtue of the essential number and long evolution of anticyclonic eddy formation their effect on the vertical transport of heat, salt, dissolved oxygen and nutrients of the Japan Sea can be essentially great.

Estimations of climatic changes in the Japan Sea fulfilled by PIO (Ponomarev, Salyuk, Bychkov 1996, Ponomarev, Salyuk 1997), Hokkaido University (Minobe 1996, 1997), Washington University (Riser 1997) and Seoul National University (Kim K.-R., Kim K. 1998) showed that on recently 20-30 years the Japan Sea deep layer winter ventilation decreased essentially. With this factor, the deep sea water temperature and their content of silicates increase and salinity and dissolved oxygen content decrease. In the upper layers of the Japan Sea proper waters (250-1000 m) the potential temperature more increases with time if compared to the lower waters. The vertical density stratification and thickness of the main pycnocline therefore also increases and the barocline effects, on the whole, for all over the sea strengthen.

On our opinion, when there lacks the deep water exchange through the Straits that is a character of the Japan Sea, the eddies of synoptic scale are one of the important physical mechanism causing the vertical heat flowing in the deep sea layers. If a number of the cold winters decreases as well as the deep water cooling due to the convective processes, including the slope convection and convection in eddies, the positive heat flowing seem to be dominated, caused by synoptic eddy dynamics, and potential proper sea water temperature increases from year to year. The hypothesis mentioned is the basis of the experiment planned to study the synoptic eddies.

B.9.3 Preconditions to choose the region of studies

Elements of the synoptic scale dynamics over the Japan Sea (anticyclonic and cyclonic eddies, warm and cold stream intrusions (streamers), meanders, rings, boundary currents, and upwelling structures) are well presented in the satellite pictures of high resolution within the infrared and radiolocational ranges. The most long living and stable elements of the synoptic dynamics are the anticyclonic eddies having here less spatial scales if compared to the ocean - 30-80 km. These eddies are well seen in the satellite pictures in the cold half of year due to temperature contrast. Therefore, their dimension, velocity of moving can be estimated, the individual eddy transport trajectory can be observed.

In April 1999, the joint cruise with POI and FERHRI on the R/V «P.Gordienko» was carried out, so that to define the peculiarities of the hydrological conditions in the South-West part of the Japan trough in the spring season. The task has been set, in addition, to determine the thermohaline characteristics of three anticyclonic eddies observed in the satellite pictures of the region studied.

In the cruise on the R/V «Prof.Khromov» in the second time the hydrometeorological sections were produced across of two eddies with a resolution to 7 miles. Taking into consideration the fact that the sections through eddies are directly connected with the large scale sections carried out by the main program of the Japan Sea survey.

B.9.4 The main objectives of the experiment

- to determine a distribution of hydrological (temperature, salinity, density, current velocities) and hydrochemical (content of oxygen, nutrients, pH and so on) features in two typical anticyclonic eddies of the North-West part of the Japan Sea in the middle of the summer season,
- to reveal the eddy structure variability occurred from April till August 1999
-

B.9.5 Expected methods of antyciclonic eddies studied

It's suggested to fulfill the oceanographic sections with horizontal resolution of 7-10 miles , that are to cross two antyciclonic eddies in zonal and meridional directions. The eddy positions are preliminary defined by satellite pictures available and clarified in process of section producing. At each station of the meridional section crossing the eddy, there is a depth of specific isotherms location (5°, 2°, 1°, 0.75°, 0.5°) by the distribution of which the most probable eddy center position is determined, as well as latitude of the further zonal section across the eddy. Respectively, the oceanographic stations location on zonal section also clarified. The levels, where samples are taken, are chosen as CTD-probing happens. Sea water sampling is produced in a specific points of the temperature, salinity and oxygen content profiles by CTD-probing. Sampling vertical resolution from the upper layers to the lower ones decreases.

The additional observations and data taken in investigation results to be analysed:
1). The vessel meteorological observations on the vessel way and at oceanographic stations with a help of MIDAS are produced. In the period of the section fulfillment crossing the eddies, the meteorological observations are made at the interval of 2 minutes. Recording of meteorological data on magnetic carriers, the slip averaging at 10 minute window is carried out.
2). Standard visual observations on the cloudiness, sea surface state in the vessel meteorological terms are made. Besides, availability of the slick bands on sea surface and their orientation to the vessel running in area of anticyclonic eddies are fulfilled in a visual way.

In perspective it's supposed to carry out detailed analysis of the data observed in anticyclonic eddies using temperature, salinity (CTD), current velocities (ADCP), content of oxygen and nutrients.

B.9.6 Preliminary scientific results

By satellite pictures and CTD probing the anticyclonic eddies on the investigation migrated (from April till August 1999) by 15-20 miles, mainly, eastward. Along with, center of the first east eddy has the northward shifting, but center of the second west eddy has the southward one. The eddy center positions changes marked, are in correspondence with their general migration over the Japan basin slopes against the clockwise that has prior shown in Lobanov, Danchenkov, Nikitin, 1998.

Figures 9.1-9.10 show sistribution of temperature, salinity, density and oxygen on individual sections crossing the anticyclonic eddies. These distributions demonstrate the preliminary research results that are formulated as the following conclusions and summary.

The thermohaline structure changes of two studied anticyclonic eddies occurred during four months (April-August 1999) are essential, mainly, in the upper layer with thickness of 100 m in accordance with annual variation of hydrological conditions.

In the cold period the minimal vertical temperature, salinity and density gradients were marked in the central eddy part in near surface layer with a thickness of 100-150 m.

In the warm period the minimal vertical gradients of the features marked are observed below the seasonal pycnocline having the curvature of opposite sign as compared to the curvature of the main pycnocline. The eddy core has a form of the infrathermocline lens where are involved in the less salinity surface waters from the eddy periphery (fig. 9.5) in a form of stream intrusion from the north-west. On the core periphery in the main pycnocline as on the sea surface there are observed stream intrusion of the salt subtropical waters from the south (fig. 9.2).

The evident changes in thermohaline eddy structure below the levels of 170-200 m were not discovered. Differences of the north-east (eddy 1) and south-west (eddy 2) eddies are almost the same as were observed in April 1999.

The south-west eddy has more horizontal (to 120 km) and vertical (to 2000-2500 m) scales if compared to the north-east eddy (fig. 9.1-9.6). It's characterized by more contrasts in salinity distribution of the main pycnocline, has more fresh and warm waters in core, more asymmetry and axis inclination than the north-east eddy.

On the whole, by the preliminary estimations of the horizontal gradients for the potential temperature and salinity in the lower deep sea and near bottom Japan basin layer (deeper 2000 m) the effect, at the least, of the south-west eddy to the temperature and salinity distribution has place almost to the basin bottom. The temperature, salinity (CTD), current velocities (ADCP) data showed that the anticyclonic eddy dynamics is interrelated to the large and synoptic scale circulation being under influence of the bottom topography in the deep sea and near bottom Japan basin layers.

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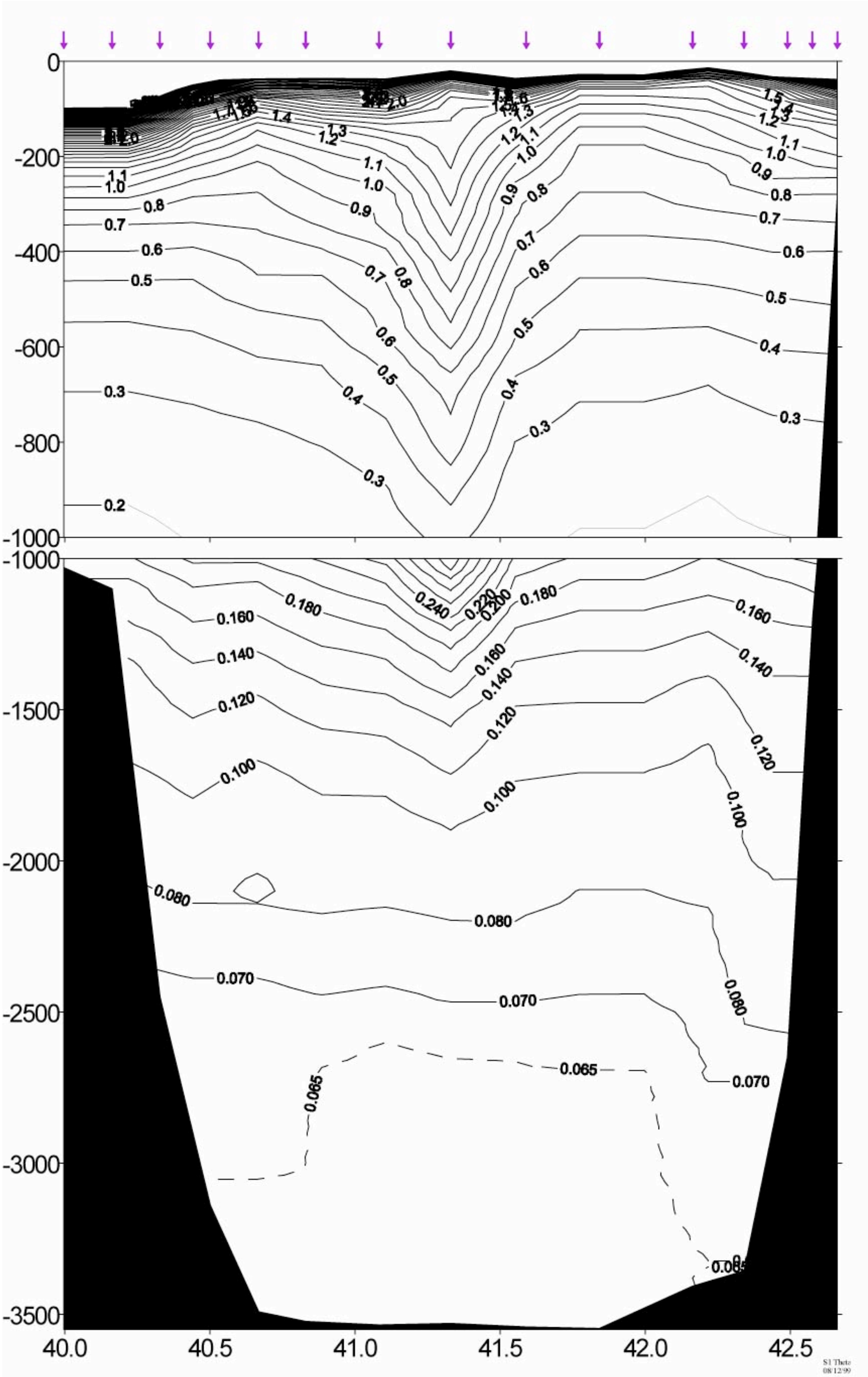

Fig. 9.1. Distribution of potential temperature on the section along 134°E, crossing the anticyclonic eddy 1, stations 157-178.

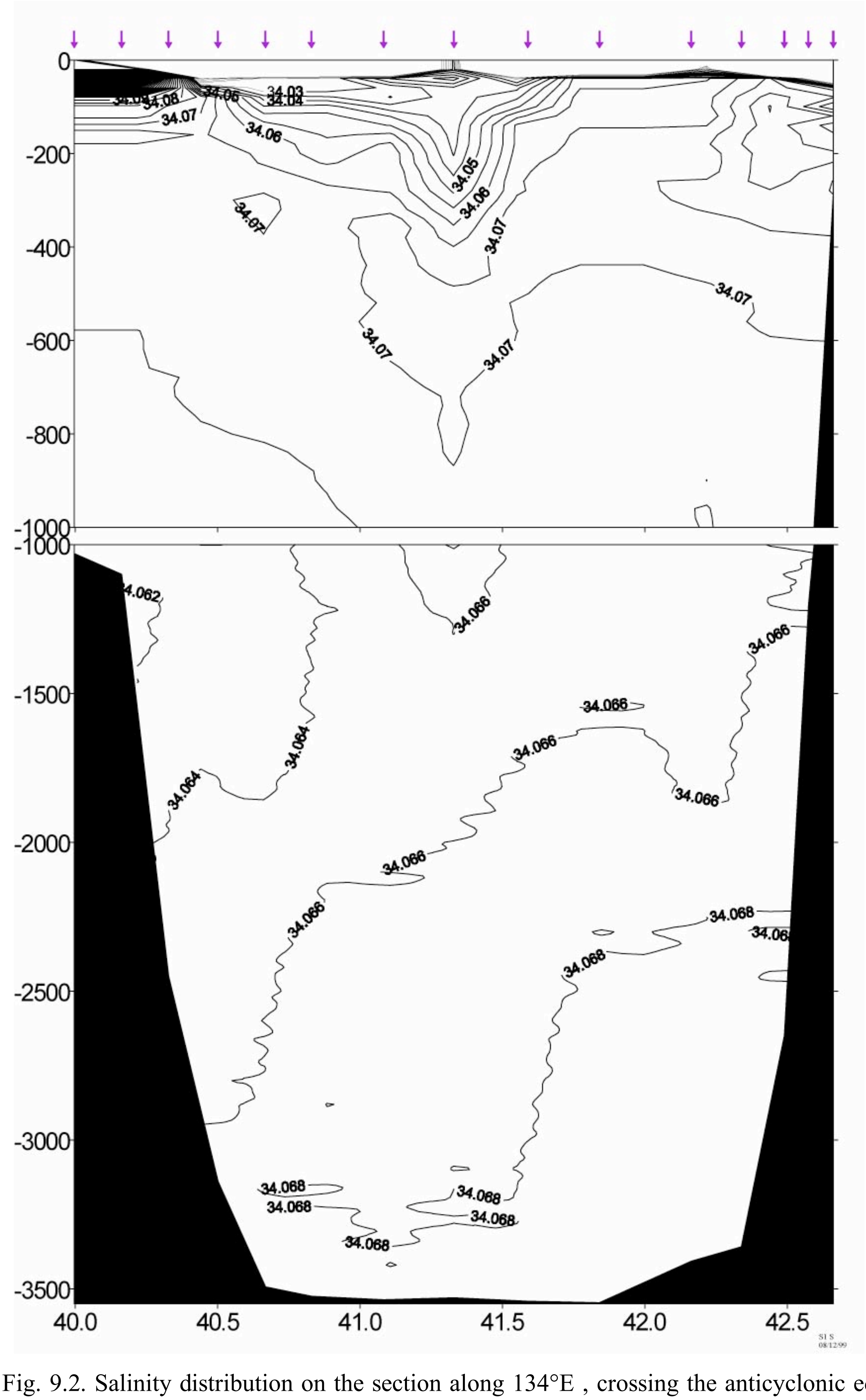

Fig. 9.2. Salinity distribution on the section along 134°E , crossing the anticyclonic eddy 1, stations 157-178.

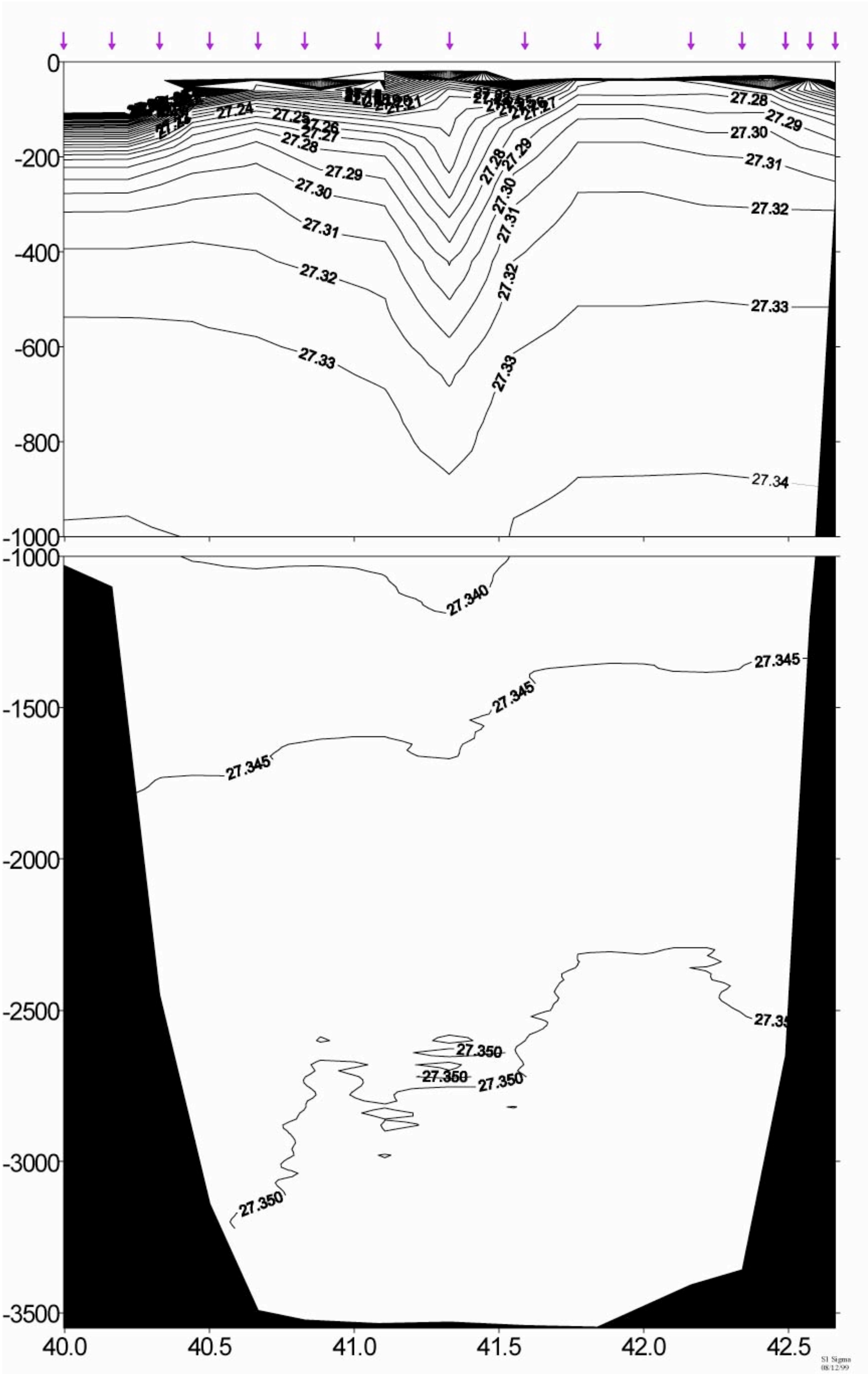

Fig. 9.3. Distribution of potential density on the section along 134°E, crossing the anticyclonic eddy 1, stations 157-178.

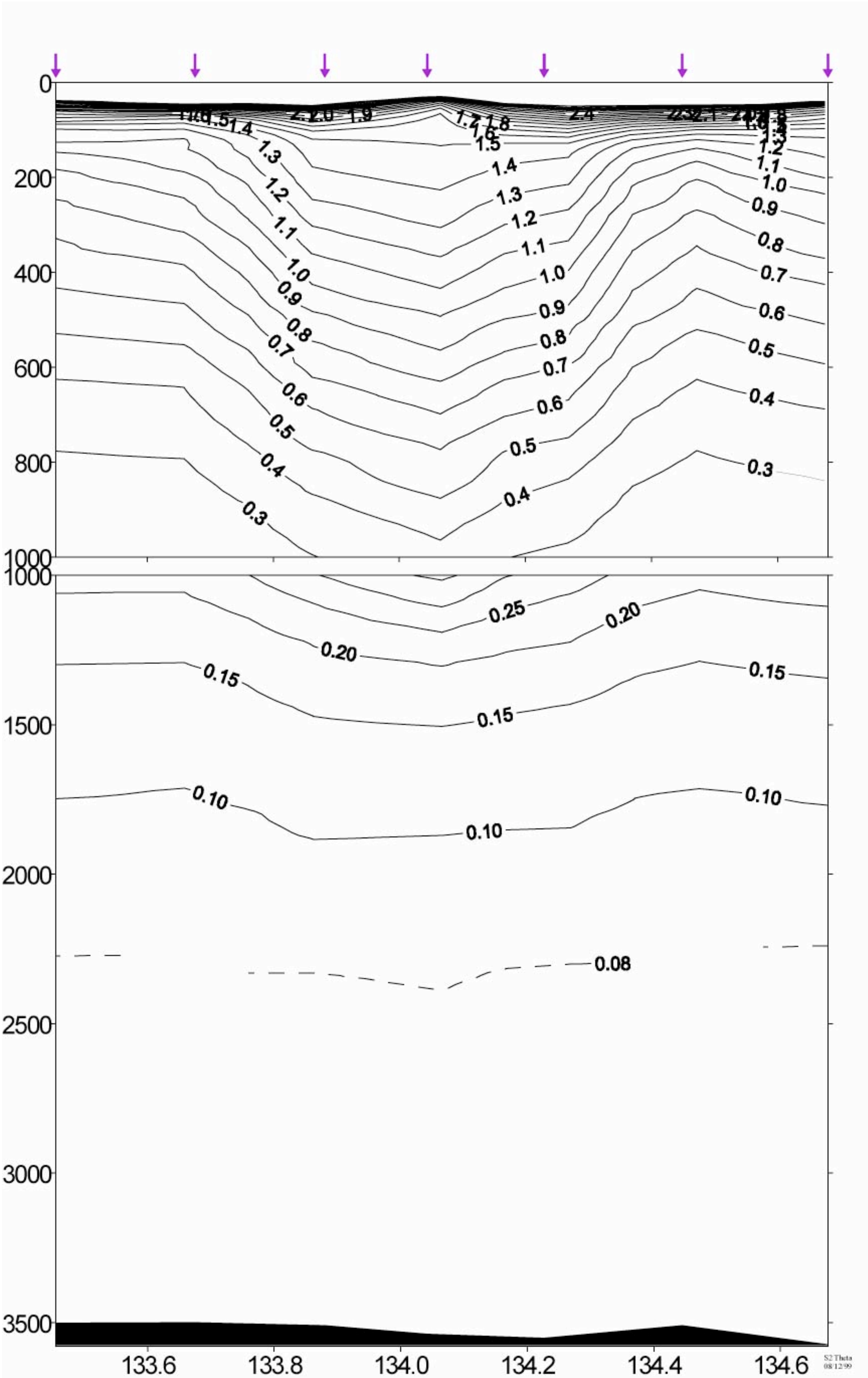

Fig. 9.4. Distribution of potential temperature on the section along 41°15'N, crossing the anticyclonic eddy 1, stations 166-172.

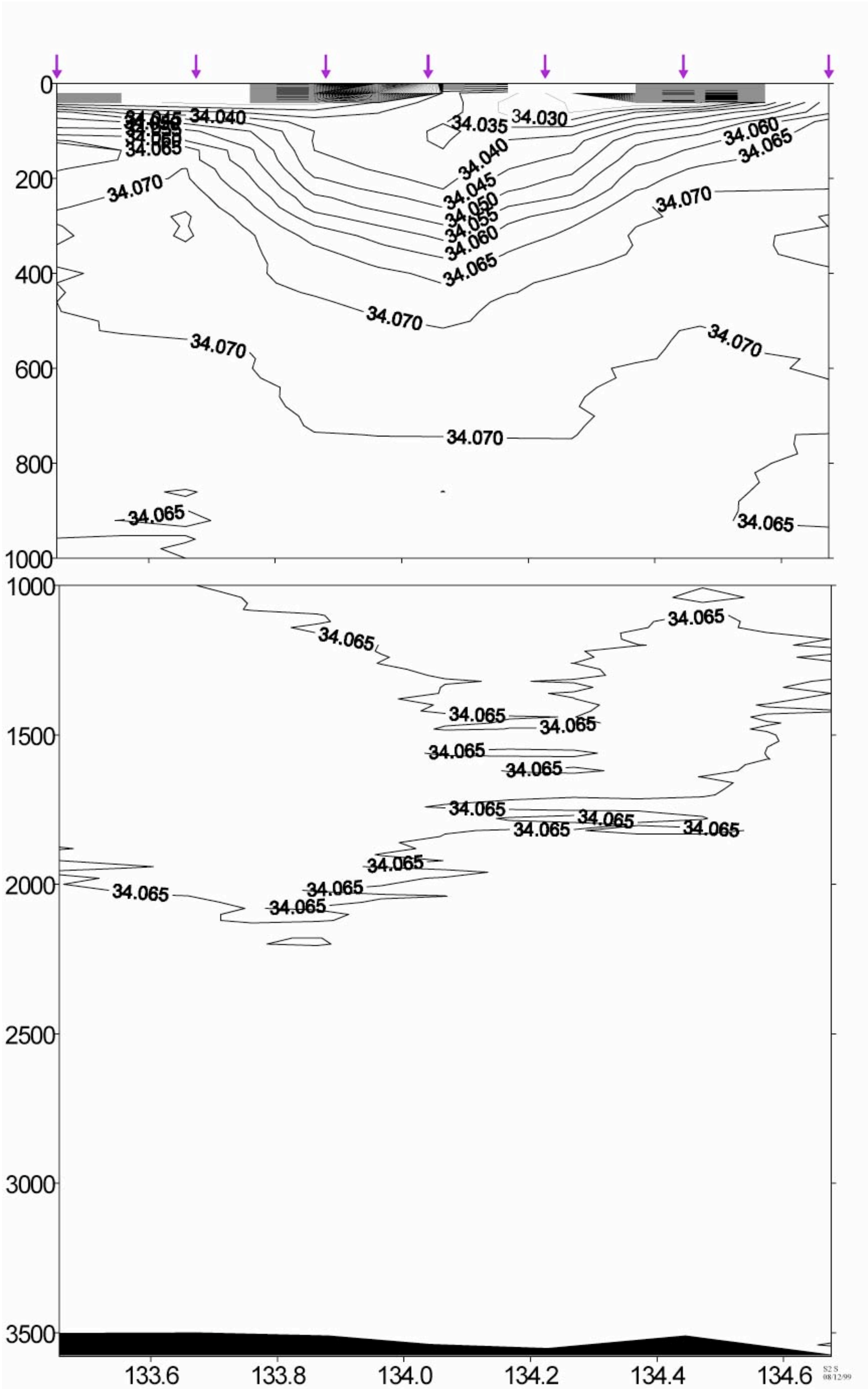

Fig. 9.5. Salinity distribution on the section along 41°15'N, crossing the anticyclonic eddy 1, stations 166-172.

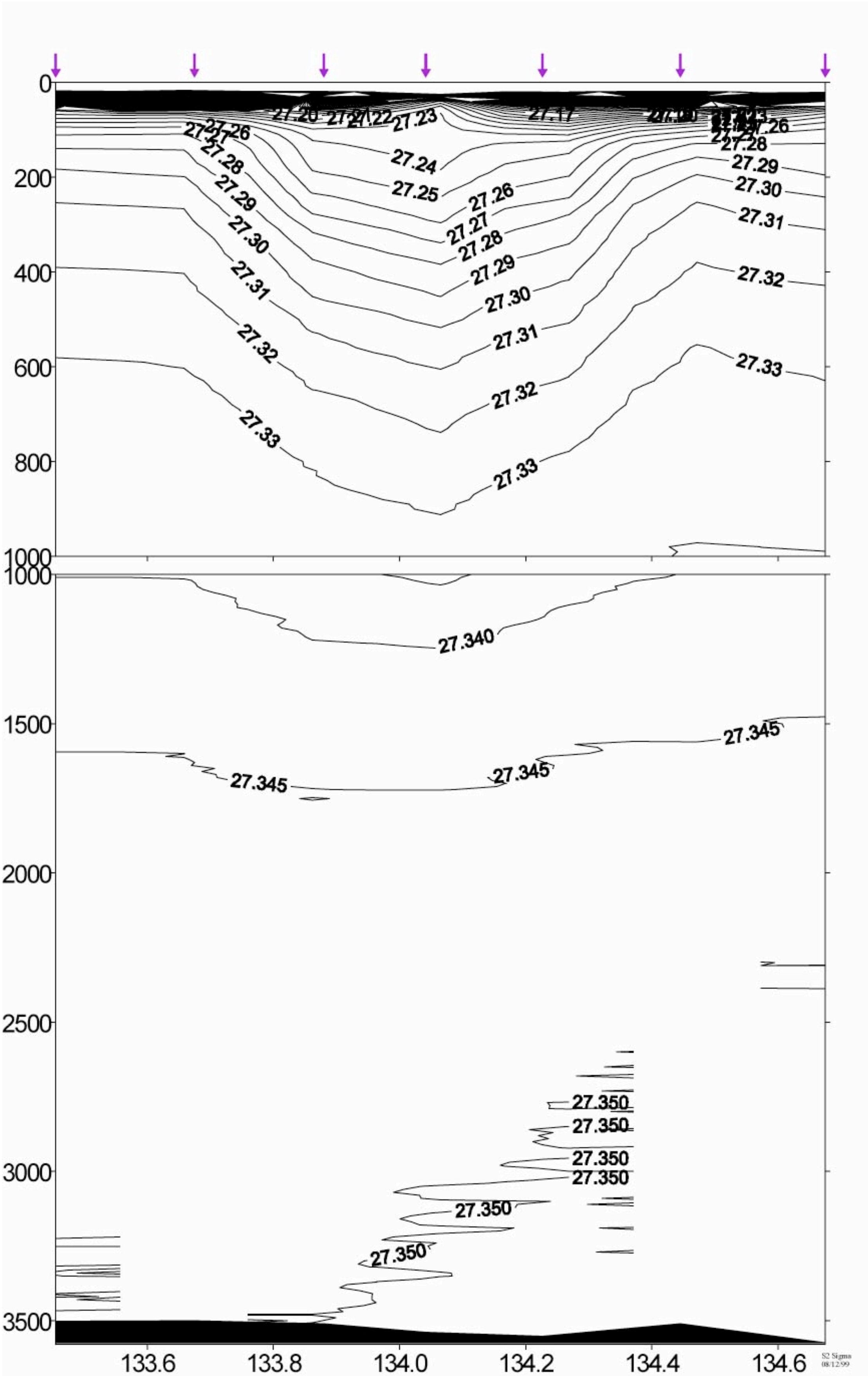

Fig. 9.6. Distribution of potential density on the section along 41°15'N, crossing the anticyclonic eddy 1, stations 166-172.

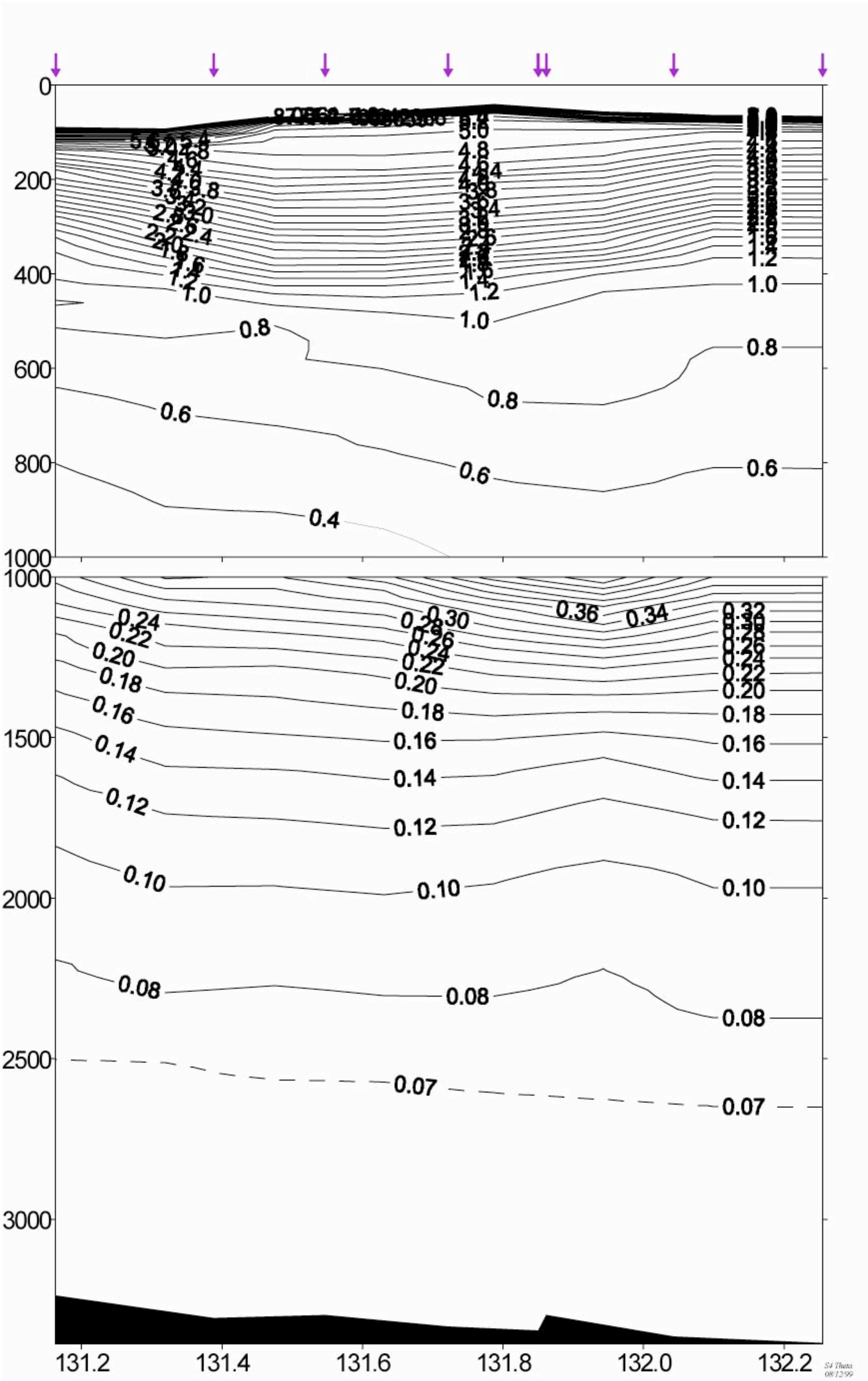

Fig. 9.7. Distribution of potential temperature on the section along 40°45'N, crossing the anticyclonic eddy 2, stations 188-194.

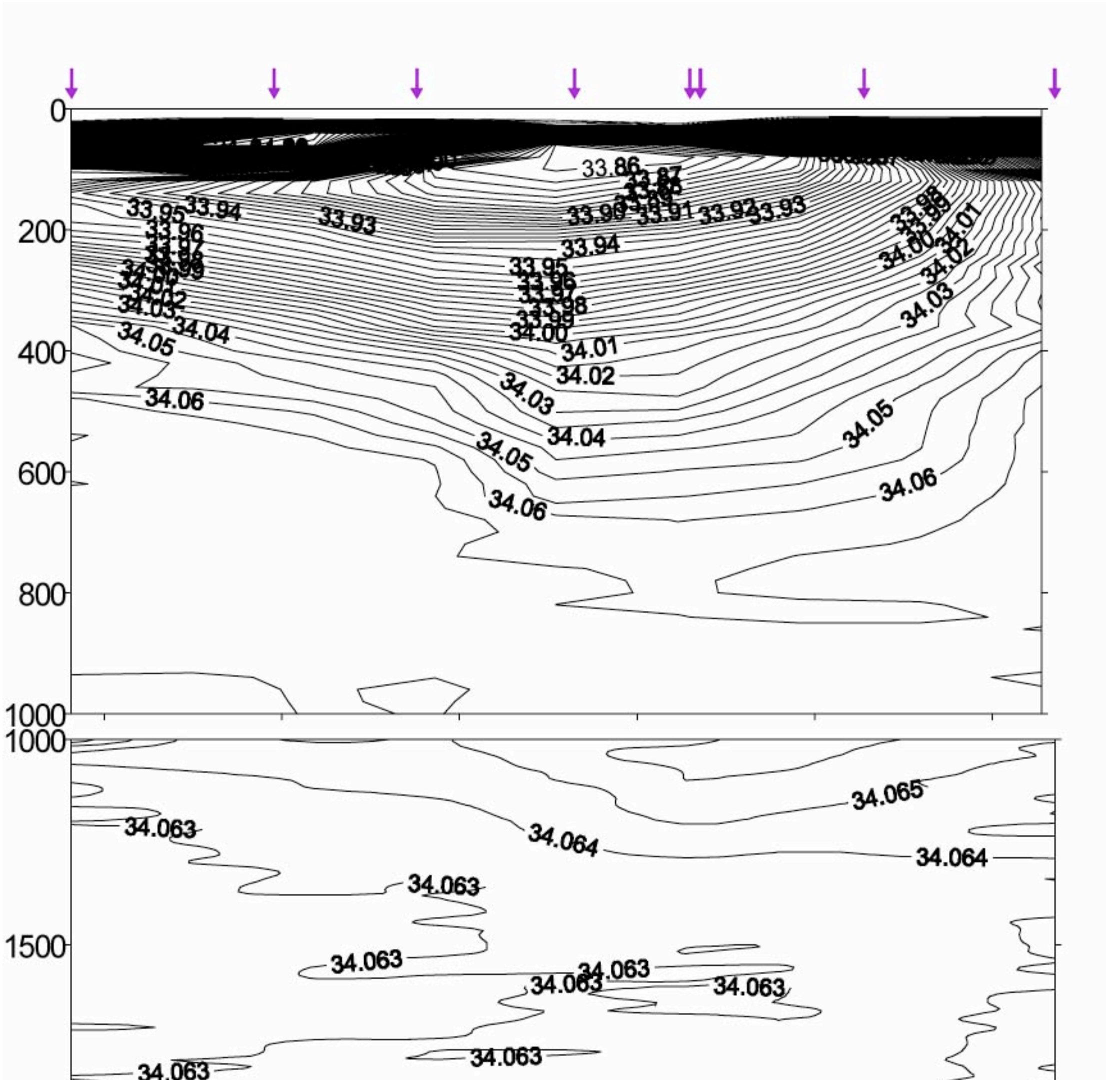

Fig. 9.8. Salinity distribution on the section along 40°45'N, crossing the anticyclonic eddy 2, stations 188-194.

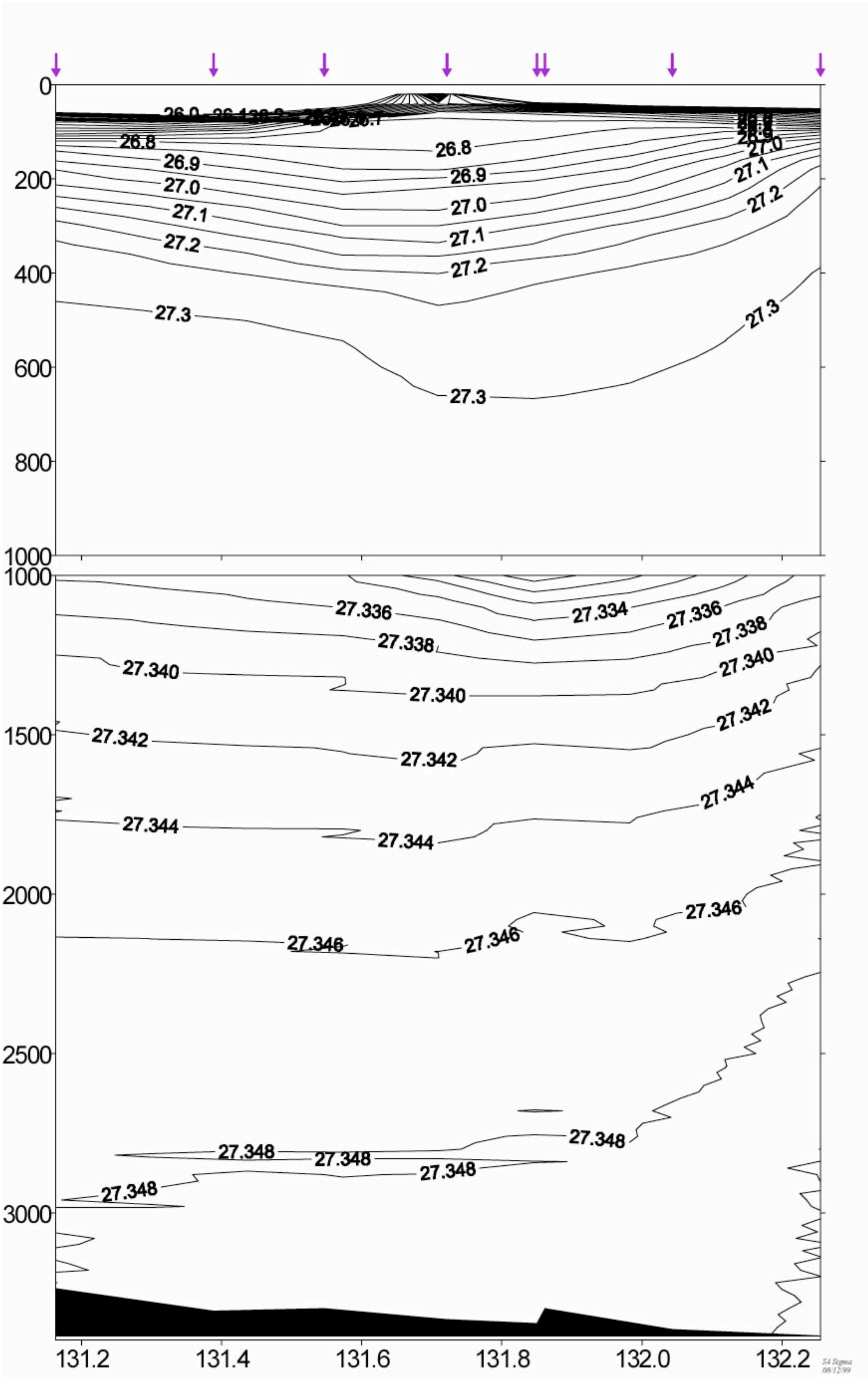

Fig. 9.9. Distribution of potential density on the section along 40°45'N, crossing the anticyclonic eddy 2, stations 188-194.

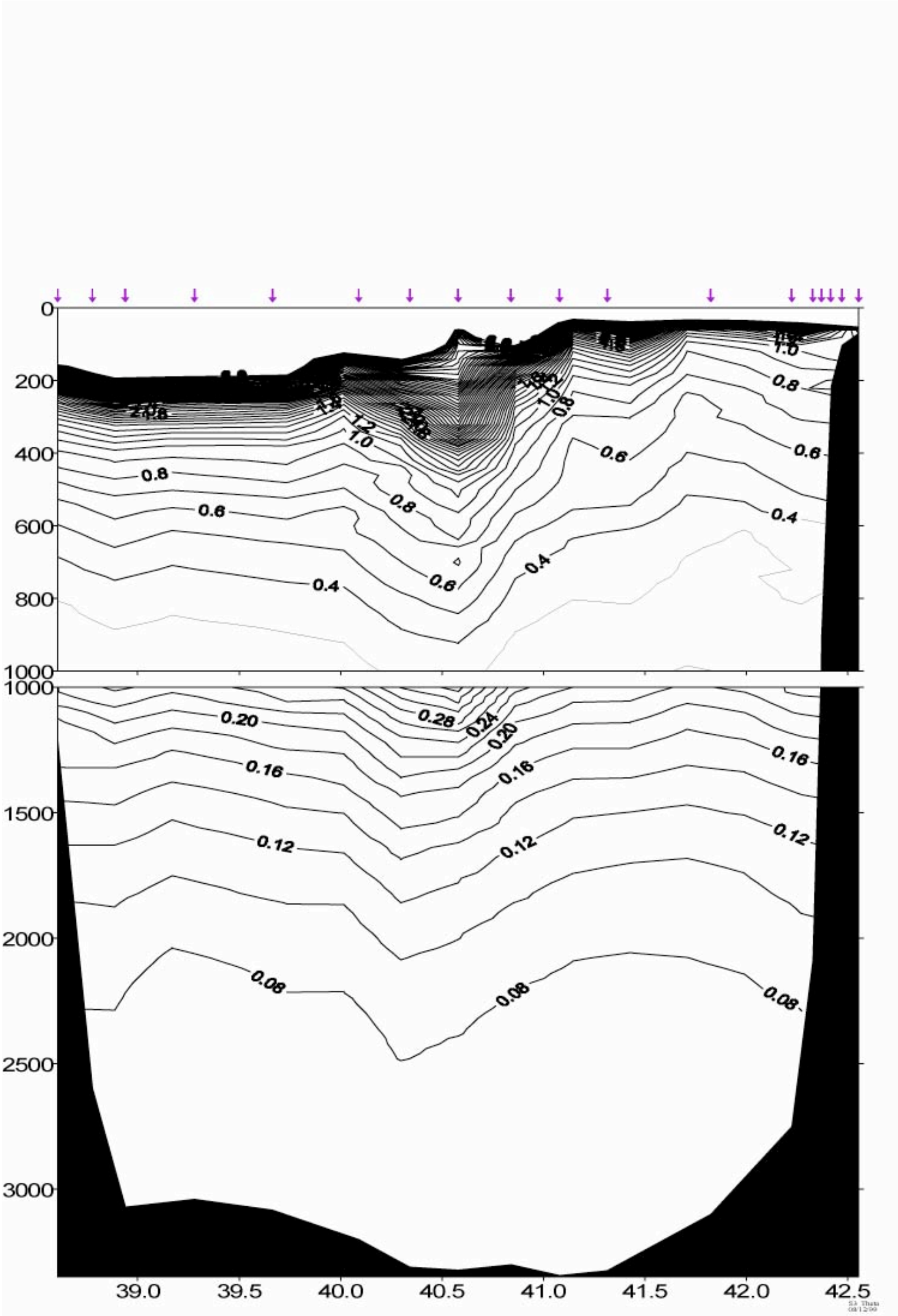

Fig. 9.10. Distribution of potential temperature on the section along 131°30'E, crossing eddy 2, stations179-203.

Appendix A: CTD data quality comments (M. Johnson, SIO/ODF)

```
## KH36 notes:

162/01  hit bottom; truncated pseq data before hit
175/01  hit bottom; truncated pseq data before hit
176/01      digitized data start in-water, +1db added to pressure values
for entire
        cast (compared raw pressure/temperature values at surface to nearby
casts)

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

 116/01    0,30,34 db
 117/01    0 db
 118/01    34 db
 120/01    18-20 db
 145/01    540 db*
  91 casts/8 levels interpolated

*145/01 cast restarted shipboard; 464-638db data are missing in
      shipboard-digitized raw CTD data file.  Recovered most
      by redigitizing missing area from vhs tape and cleaning
      up extremely high noise levels.


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

114/02      1.5 mins. at 42 - 52 db       ## maxp 1068
120/01      1.5 mins. at 1936 - 1942 db   ## maxp 1976
151/01      3 mins. at 1960 - 1964 db     ## maxp 3186
155/01      4 mins. at 722 - 728 db       ## maxp 3652
161/01      43 mins. at 1860 - 1864 db    ## maxp 3414
        also, 14 db yoyo here (1862 back to 1848 db down)
172/01      11 mins. at 3366 - 3372 db    ## maxp 3504


## Conductivity offsets:  OC = Offset Conductivity   OS = Offset Salinity
      (all these casts are deeper than 3000db)

153/01  788-822 db    #OS/+0.145 to +0.215 PSU
154/01  558-564 db    #OS/+0.26 to +0.44 PSU
166/01  720-914 db    #OC +0.003 mS/cm
183/01 1428-1442 db   #OS/+0.013 to +0.086 PSU
184/01 1116-1128 db   #OC +0.004 mS/cm
190/03 1226-1230 db   #OC +0.001 mS/cm
190/03 1228-1300 db   #OC +0.005 mS/cm
```

Appendix B: Bottle data quality comments

```
Bottle data quality comments
Japan East Sea
Summer 1999
Khromov  KH36
Contact:  Lynne D. Talley ltalley@ucsd.edu


6/24/02
For salinity: batch P134 was used on kh36, kh38 and xp00
----
kh36 quality comments - console log sheets, sample log sheets,
bottle sample log book, salt, oxigen, nutrients analysis logs.
Codes:
qflg = 4  bad value
```

```
qflg = 3  suspicious value
qflg = 2  good value

Leg 1 (test cruise):

Station 114 02
CTD 5, big Rosette
Cast 01 - winch stop on way down. Wire problem.
Cast 02 - some double samples for optics. Duplicates delete
          from H00. Save in H00.svd.
DLOG - 205 SiO3 too low (qflg = 3)
       207 sal - low (qflg = 3)

Station 115 01
CTD 5, big Rosette, bad weather, rolling, deck overflow during station.
SLOG - Bottle 15 - stopcock pushed hardly.
DLOG - 101 PO4 high, probably OK (qflg = 2)

Station 116 01
Too rough for work with big Rosette. Wind 15 m/c.
CTD 3, small Rosette.
Some double samples for optics. Duplicates delete
from H00. Save in H00.svd.
CTD salinity spikes in strong T gradient.
SLOG - Bottle N9 broke spigot boarding, no samples.
       Station N 116 01 used twice in computer.
       Bottles NN 2, 14, 9 - leak prior to venting
       (when stopcock pushed in and vent closed).
DLOG - 101 not enough water for salt, nuts.
       102 not enough water for oxy. Salt missing.
       109 not enough water for salt, nuts, oxy.
       114 not enough water for salt, nuts, oxy.
       102 bad salt, nuts.
       104 bad all salt, nuts, oxy (qflg = 4)
Edited H00 file - bottle 4 delete. Save values in H00.svd
                  bottle 2 deleted. Save values in H00.svd.
Station 117 01
CTD 3, small Rosette.
CTD salinity spikes in strong T gradient.
SLOG - Bottles NN 4,5,11,14 - leak prior to venting.
DLOG - 111 no sample for oxy.
       102 SiO3 hight (qflg = 3).
       101 -salt too hight. No flush between std and sample 1 (qflg = 4).
       Change value on -9.0 in H00. Save value in H00.svd.
       Autosal - check end worm std. Use 1.99984 for end worm.

Station 118 01
CTD 5, big Rosette.
Bottle N15 - stopcock difficult to close.
DLOG - autosal - 109 salt too hight (qflg = 4). Large difference between
       bath temp. and sample temp. Salt drift due to evaporation?
       107 - salt too hight (qflg = 3)
       102 - salt too hight (qflg = 4)

Station 119 01
CTD 5, big Rosette.
Some double samples for optics. Duplicates delete from H00. Save in H00.svd.
DLOG - autosal - 106 salt too hight (qflg = 4). Large difference between
       bath temp. Salt drift due to evaporation?

Station 120 01
CTD 5, big Rosette.
Surface - double sample for optics. Duplicate delete from H00.
Save in H00.svd.
DLOG - 105 SiO3 hight (qflg = 3).

Station 121 01
CTD 5, big Rosette.
CTD - no comment.
DLOG - 102 oxy hight (qflg = 3).

Station 122 01
CTD 5, big Rosette.
CTD - no comment.

Leg 2, northern Japan Sea

Station 123 01
CTD 5, big Rosette.
```

No record on the VCR.
DLOG - 105 - salt. Diff C and S hight. Hight temp. grad.
Probably OK (qflg = 2).

Station 124 01
CTD 5, big Rosette.
Some double samples for optics. Duplicates delete from H00. Save in H00.svd.
DLOG - AUTOSAL - shange bottles number in rs\12301 and rs\12301.lst.
save wrong value in rs\12301.svd and rs\12301d.lst.

Station 125 01
CTD 5, big Rosette.
SLOG - Bottle N5 - vent did not closed

Station 126 01
CTD 5, big Rosette.
SLOG - Bottle N10 - stopcock broken during recovery, samples taken.
DLOG - AUTOSAL files - change station number from 127 to 126 (126 - correct).

Station 127 01
CTD 5, big Rosette.
Some double samples for optics. Duplicates delete from H00. Save in H00.svd.
DLOG -AUTOSAL - Bad salt. End worm std = 2.00580. Too hight to standardize.

Station 128 01
CTD 5, big Rosette.
DLOG -AUTOSAL - Bad salt. End worm std = 2.00580. Too hight to standardize.
Change AUTOSAL N 503 on AUTOSAL N 268.

Station 129 01
CTD 5, big Rosette.
No comment

Station 130 01
CTD 5, big Rosette.
No comment

Station 131 01
CTD 5, big Rosette.
No comment

Station 132 01
CTD 5, big Rosette.
No comment.

Station 133 01
CTD 5, big Rosette.
Some double samples for optics. Duplicates delete from H00. Save in H00.svd.
DLOG - 104 - salt hight (qflg = 3).

Station 134 01
CTD 5, big Rosette.
DLOG - AUTOSAL - two end worm value.

Station 135 01
CTD 5, big Rosette.
DLOG - 112 - salt too hight (qflg = 4). In file H00 shange on -9.0000. Save
in H00.svd

Station 136 01
CTD 5, big Rosette.

Station 137 01
CTD 5, big Rosette.
DLOG -AUTOSAL - Bad salt. End worm std = 2.00469 too hight to standardize.
Edit files RS\13701 and 13701.lst for checking salinity.
Original files saved as RS\13701.svd and 13701d.list.

Station 138 01
CTD 5, big Rosette.
DLOG -AUTOSAL - Bad salt. End worm std = 2.00469 too hight to standardize.
Edit files RS\13701 and 13701.lst for checking salinity.
Original files saved as RS\13701.svd and 13701d.list.

Station 139 01
CTD 5, big Rosette.

Station 140 01
CTD 5, big Rosette.

Station 141 01
CTD 5, big Rosette.
Some double samples for optics. Duplicates delete from H00. Save in H00.svd.
DLOG - change bottle number in rs\13901 according Small Sample Log

Station 142 01
CTD 5, big Rosette.
One stick of hook lost during recovery CTD.
Some double samples for optics. Duplicates delete from H00. Save in H00.svd.
CTD oxygen bad.
DLOG - AUTOSAL - wrong samples number from 010 to end. Change according
       Sample Log in rs\14701 and 14701.list files. Save old as 14701.svd and
       14701d.list.

Station 143 01
CTD 5, big Rosette.
New CTD oxygen sensor installed before station.

Station 144 01
CTD 5, big Rosette.
DLOG - 103 - low salinity (qflg = 3)
       101 - salinity too hight (qflg=4)

Station 145 01
CTD 5, big Rosette.
Some double samples for optics. Duplicates delete from H00. Save in H00.svd.
CTD acquisition computer error on downcast. Computer restarted as cast 2.
Record in two files - 14501.raw and 14502. raw. Continous record on VCR.
File 14503.raw - rewrite from VCR.
DLOG - Files 14501.bot and 14502.bot save in 14501d.bot and 14502d.bot.
       14502.bot renamed in 14501.bot. New 14501.bot used in H00 file.

Station 146 01
CTD 5, big Rosette.
DLOG - 119 - NO2 too hight (qflg=3).
       120 - diff C and S too hight. Strong grad. Probably OK (qflg=2)

Station 147 01
CTD 5, big Rosette.
DLOG - 108 -no oxygen, bad titration.

Station 148 01
CTD 5, big Rosette.
Some double samples for optics. Duplicates delete from H00. Save in H00.svd.
DLOG - AUTOSAL - ship electricity system break during measurements.
       No end worm std.
       RS\files - 14801 -added worm end std R1=1.99979 R2=199979.
       Save original as 14801.svd

Station 149 01
CTD 5, big Rosette.
Some double samples for optics. Duplicates delete from H00. Save in H00.svd.
DLOG - AUTOSAL - ship electricity system break during measurements.
       No end worm std.
       New worm std after bottle 107.
       RS\files - 14901.svd and 14901d.lst - part down to 0107
       typed handly from 14801 and 14801.lst.
       Files 14901 and 14901.lst after edition. Added real worm 0100
       std R1=1.99979 and R2=199979. Deleted typed lines. From 0108 -
       real salt data.
       14901.bot only 18 trips (19 OK). Duplicated 016 trip values
       for 017 in H00 file.

Station 150 01
CTD 5, big Rosette.
Rosette catch fisherman wire during recovery.
DLOG - 107 - no oxy due to bad titration.

Station 151 01
CTD 5, big Rosette.
DLOG - 121 - no oxy due to wrong titration.

Station 152 01
CTD 5, big Rosette.
DLOG - autosal files RS\15201 and 15201.lst after edition. Deleted
       wrong lines. Save original as 15201d.lst and 15201.svd.

Station 153 01
CTD 5, big Rosette.
DLOG - autosal - files 15301 and 15301.lst - deleted first 0102 line
       (typed wrong value) and first end worm value. Save in 15301.svd
       and 15301d.lst.

Station 154 01
CTD 5, big Rosette.

Station 155 01
CTD 5, big Rosette.
DLOG - autosal - 0115- deleted first 0115 line with wrong salt.
                 Operator's mistake-first 0115=0116. Save in rs\15501.svd

Station 156 01
CTD 5, big Rosette.

Station 157 01
CTD 5, big Rosette.
Some double samples for optics. Duplicates delete from H00. Save in H00.svd.

Station 158 01
CTD 5, big Rosette.
DLOG - autosal - two 0115 lines. Operator's mistakes.
       First is wrong, deleted. Save in RS\15801.svd

Station 159 01
CTD 5, big Rosette.
Double sample for optics near surface. Duplicate delete from H00. Save in H00.svd.

Station 160 01
CTD 5, big Rosette.
SLOG - Bottle 24 close in air
       Wire damaged, cut dangerous part.
       Records on VCR stop during station.
DLOG - salt sample bottles N 7, 17 brouken.

Station 161 01
CTD 5, big Rosette.

Station 162 01
CTD 5, big Rosette.
SLOG - altimetr did not work.
DLOG - 102 - salt hight (qflg=3)
       112 - salt hight (qflg=3)
       116 - salt low (qflg=3)

Station 163 01
CTD 5, big Rosette.
Some double samples for optics. Duplicates delete from H00. Save in H00.svd.
(ldt 10/10/99: DAB in sum file must be wrong - says close to
bottom but station ends at about 2000)

Station 164 01
CTD 5, big Rosette.

Station 165 01
CTD 5, big Rosette.
DLOG - Autosal - St. 165 processed as 164. Rename files rs\
       16401 in 16501. Change number of station and box number.
       Save in rs\16501.svd and 16501d. lst.

Station 166 01
CTD 5, big Rosette.
DLOG - Autosal - Operator's mistake. Change box number from 003 on 004
       according Sample Log Sheet.
       bottle 12 - SiO3 low (qflg = 3).

Station 167 01
CTD 5, big Rosette.

Station 168 01
CTD 5, big Rosette.

Station 169 01
CTD 5, big Rosette.

Station 170 01
CTD 5, big Rosette.

```
DLOG - 105 NO3 low. Local oxy max. Probably OK (qflg=2)

Station 171 01
CTD 5, big Rosette.
Some double samples for optics. Duplicates delete from H00. Save in H00.svd.

Station 172 01
CTD 5, big Rosette.
DLOG - salt 108 - lid broken (qflg=4).
            104 - salt hight (qflg=3)

Station 173 01
CTD 5, big Rosette.
SLOG - bottle N 18 -no sample for nutrients.

07 08 1999 - Computer virus "monkey" find on OXY f-disk.
             Cheking all f-disks and this computer.
             No virus.

Station 174 01
CTD 5, big Rosette.

Station 175 01
CTD 5, big Rosette.
SLOG - altimetr did not work.

Station 176 01
CTD 5, big Rosette.
Some double samples for optics. Duplicates delete from H00. Save in H00.svd.
DLOG 114 -no oxy.
(note that DAB in sum file is wrong - station does not go to bottom
10/9/99 ldt)

Station 177 01
CTD 5, big Rosette.
Some double samples for optics. Duplicates delete from H00. Save in H00.svd.

Station 178 01
CTD 5, big Rosette.
Some double samples for optics. Duplicates delete from H00. Save in H00.svd.
SLOG - freons -bottle N6 -lid broken
       salinity - two end worm std. First deleted, save in rs\17801.svd.

Station 179 01
CTD 5, big Rosette.
DLOG - 102 -oxy hight (qflg=4)

Station 180 01
CTD 5, big Rosette.
SLOG - Noble G from bottle N5 -tube broken. Samples from bottle N6.
Some double samples for optics. Duplicates delete from H00. Save in H00.svd.

Station 181 01
CTD 5, big Rosette.

Station 182 01
CTD 5, big Rosette.
Surface double sample for optics. Duplicates delete from H00. Save in H00.svd.
SLOG - Before St. 182 change position  of bottles N 1 and 2 on Rosette.
       Bottle N 1 replace on place N 2, bottle N2 on N 1. Change bottles mark.

Station 183 01
CTD 5, big Rosette.

Station 184 01
CTD 5, big Rosette.

Station 185 01
CTD 5, big Rosette.
SLOG - Bottle N 10 air leak prior to venting.

Station 186 01
CTD 5, big Rosette.

Station 187 01
CTD 5, big Rosette.

Station 188 01
CTD 5, big Rosette.
```

Station 189 01
CTD 5, big Rosette.

Station 190 01
CTD 5, big Rosette.
CTD only.
(WHY??? any log book notes? ldt 9/10/99)
Use this cast since cast 3 has bad offsets

Station 190 02
CTD 5, big Rosette.
Only CTD - Upcast from 1850 m. No confirm after bottle N 7.
No sampling, station repited as cast 3.

Station 190 03
CTD 5, big Rosette.
CTD conductivity offset downcast.
(NOTE LDT 9/10/99: offset is 1090-1136 and 1232-1304 - Use CAST 1!
Looks like slime.)

Station 191 01
CTD 5, big Rosette.
Surface double samples for optics. Duplicates delete from H00. Save in H00.svd.

Station 192 01
CTD 5, big Rosette.
CTD - winch stop upcast
Surface double samples for optics. Duplicates delete from H00. Save in H00.svd.

Station 193 01
CTD 5, big Rosette.
Surface double sample for optics. Duplicates delete from H00. Save in H00.svd.
SLOG - Bottle N15 -no confirmation at 400 db? (did not push fair button ?).
Bottle N 15 close at 300 db.
CTD - winch stop upcast

Station 194 01
CTD 5, big Rosette.
SLOG - vent of bottle N 2 did not close strongly, leak slightly.
DLOG - oxy bottle N 1 hight (qflg=4).

Station 195 01
CTD 5, big Rosette.

Station 196 01
CTD 5, big Rosette.
CTD - Bottle N 1 and 2 - no confirmations on SBE deck unit. Change SBE unit.
Open upcast file 19602.

Station 196 02
CTD 5, big Rosette.
Surface double sample for optics. Duplicates delete from H00. Save in H00.svd.
SLOG - CTD upcast. Bottle 1 - no comfirmation.
DLOG - salt, oxygen, nutrients processed as ...19601... Change
files name and cast number in files.
DLOG - Bottles N 1,2,3 -same depth, oxy diffrent.

Station 197 01
CTD 5, big Rosette.
Surface double sample for optics. Duplicates delete from H00. Save in H00.svd.

Station 198 01
CTD 5, big Rosette.

Station 199 01
CTD 5, big Rosette.

Station 200 01
CTD 5, big Rosette.
SLOG - N 2,4,6 - double samples for oxygen.

Station 201 01
CTD 5, big Rosette.

Station 202 01
CTD 5, big Rosette.

Station 203 01

CTD 5, big Rosette.