Cruise Report

Compiled by: Thomas J. Müller

F.S. Poseidon

Cruise No.: 261

Dates of Cruise: 27.06. - 14.07.2000

Areas of Research: Physical oceanography; chemical oceanography

Port Calls: Reykjavik, 14.07.-19.07. 2000

Institute: Institut für Meereskunde, Kiel, Germany

Chief Scientist: Dr. Thomas J. Müller

Number of Scientists: 7

Projects: Special research programme 'Thermohaline Circulation Variability in the North Atlantic' (Thermohaline Zirkulationsschwankungen im Nordatlantik), Sonderforschungsbereich 460, Universität Kiel, TP A3

This cruise report consists of 9 pages, 2 appendices and 5 figures

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1. Scientific crew

P261: 27.06.-14.07.2000, Cork - Reykjavik

<table>
<thead>
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<td>Müller, Dr. Thomas J.</td>
<td>IFMK</td>
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Institutions
IFMK       Institut für Meereskunde an der Universität Kiel, Kiel, Germany
Geomar    Geomar, Kiel, Germany

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2. Research programme

The special research programme 'Variability of the Thermohaline Circulation in the North Atlantic' has been set up in Germany four years ago, with major contributions from the Institut für Meereskunde, Kiel. One of its projects aims at a better understanding of the entrance of Labrador Sea Water (LSW) and the overflow from the Iceland Scotland Ridge (ISOW) into the Iceland Basin, which are major components that form the North Atlantic Deep Water and that undergo intensive mixing. The project's observational part uses current measurements, both by moored and drifting instruments, and shipborne instrumentation to identify water masses, to estimate transport rates and mixing, and to support the calibration of high resolution regional circulation and process models.

The main objectives of POSEIDON cruise 261 (Fig. 1) were to
- recover a set of four moorings east of the Charly Gibbs Fracture Zone (CGFZ) after one year recording time to estimate the transport of ISOW into the CGFZ
- deploy a set of four of moorings south of Iceland to monitor the ISOW for one year at its entrance into the Iceland Basin
- launch a series of RAFOS floats to track paths of LSW
- take stations and sections with CTD and a shipborne Acoustic Doppler Current Profiler (vmADCP) in order to get references for changes in water masses and estimates of transport.

An additional programme conducted by Geomar, is looking for Methane (CH4) balances in the North Atlantic, in particular near the Mid Atlantic Ridge (MAR).
3. Narrative of cruise with technical details
The scientific crew embarked late evening of the 25 June in Cork. On 26 June, the scientific equipment was set up in port.

The vessel sailed on schedule on 27 June at 09:00 from Cork. While heading towards the West (Fig. 1), the 200 nm EEZ of Ireland was reached on 28 June where routine logging of underway measurements began:

- precise navigational information from an Ashtech GG24 system
- heading, pitch and roll information from a 3-dimensional Ashtech ADU2 system
- sea surface temperature and salinity using a thermosalinograph
- standard meteorological parameters (note: starboard sensors only)
- profiles of ocean currents down to ca. 300 m using a 150 kHz RDI ADCP system

The first of six CTD stations (#166 to #171, Fig. 1; App. 1) on a quasi-zonal section through the WestEuropean Basin towards the CGFZ were taken to check for changes in water masses. Four RAFOS floats were launched on this section with 1500 m mission depth within the core of the LSW. On 02 July in the morning, we reached the first of the four moorings at the eastern entrance to the CGFZ (Fig. 2). All four moorings with a total of 17 current meters were recovered between 02 July and 04 July. Also, CTD stations in the rift valley south of the CGFZ (#171, #176, and #173 at mooring site Z; Fig. 2) were taken to look for positive CH4 anomalies. Launching a park of four double relase and one free floating RAFOS floats (FP in Fig. 2) near the entrance to the CGFZ completed the work in this area.

Proceeding northwestwards, we took 5 CTD stations (#182 to #186; App. 1; Fig. 1) on the eastern flank of the Reykjanaes Ridge where in 1997/1998 3 moorings had been in site to measure the southward transport of ISOW. We then followed approximately the 2800 m depth contour northwards (#187 to # 190; App. 1; Fig. 1) before we reached the site for the first of four mooring sites. From 07 July to 10 July, the four current meter moorings V420/W, V419/O, V418/S and V417/I were deployed. In between, we had a station on the site of Geosecs Station 23 (60°N30', 18°W00', #194) to obtain a profile for analysing CO2 relevant parameters. Also, a box of CTD profiles was begun that was finished on 13 July (Fig. 1).

On the way to Reykjavik, the en-route measurements were switched off outside the 12 nm zone of Iceland. POSEIDON called in to Reykjavik where cruise P261 finished on 14 July at 08:00 UTC.

4. Scientific report and first results
Charlie Gibbs Fracture Zone CGFZ is expected to be the pathway for the Iceland Scotland Overflow Water (ISOW) into the western North Atlantic’s basins. Saunders (2001) from own measurements speculates that part of the overflow enters CGFZ and leaves it in the west at salinities higher than 34.98. Less saline waters in CGFZ at levels deeper 3500 m are of western origin; they enter CGFZ from the west, perhaps being correlated with a northward shift of the North Atlantic Current.

Mooring array CGFZ was arranged cross channel at the eastern entrance to CGFZ. The cross channel temperature and salinity distributions (Fig. 3 a, b) show mooring C in overflow salinity maximum while current meters of sites G, F, and Z at the deeper levels might be within western waters. Note also, that the core of the low-saline LSW deepens to the south
(1600 m to 1800 m), and that the North Atlantic Current has its northern margin at about site G (Fig. 3). With this in mind, the basic statistics (App. 2) and the progressive vector diagrammes (Fig. 4) reveal:

- overflow water enters CGFZ at its northern flank (mooring site C, Fig. 4a),
- further south, the flow at the deepest levels (>3300 m) is stagnant (site G, Fig. 4b) or eastwards (sites F, Z; Fig. 4c, d) with high flow stability (App. 2)
- at G, F, and Z the flow is strongly correlated with the eastward flow within the LSW core (1600 m to 1800 m)

More detailed analysis will investigate possibly associated recirculation pattern in the Iceland Basin.

To measure the overflow transport further north on the eastern flank of the Reykjanaes Ridge, mooring array ISOW was implemented normal to the isobaths. The corresponding hydrographic section (Fig. 5a-c) shows the central sites S and O located in the steep temperature, salinity and density gradient area, flanked by less steep gradients at I and S. Note that the steep gradient area has a bottom-to-surface signal making it impossible to calculate absolute geostrophic current profiles. However, current measurements from ISOW after mooring recovery in 2001 will allow referencing.
5. Scientific equipment, instruments and moorings

5.1 Moorings
During P261 four moorings were recovered near the CGFZ, and four moorings were deployed south of Iceland within the overflow (Table 1). Recovery of the latter is scheduled for June 2001 during POSEIDON cruise 275.

Table 1: P261, arrays of moorings recovered (r) east of the Charly Gibbs Fracture Zone (CGFZ) with depths of Aanderaa current meters RCM8 current meters, and deployed (d) in array ISOW south of Iceland with number of RCM8 and MicroCats (MC)

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<td>1230</td>
<td>V417/I</td>
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5.2 CTD/rosette and salinometer
For the CTD-measurements, an ICTD of Falmouth Scientific Inc. was used. Calibration for pressure and temperature sensors was performed at IFM Kiel in November 1995 and in December 1998, respectively. Due to a malfunction of the electronics after the cruise, a post-cruise calibration cannot be conducted before March 2001.

Water samples for CTD salinity calibration were taken from near the bottom and near the surface. They were analysed on a Guildline AUTOSAL model 8400A (IFMK internal code AS4) using standard seawater batch P134 for calibration. The correction is +0.008 in salinity. As the laboratories onboard are not temperature stable, the estimated accuracy of individual bottle salinities after removing outliers is 0.005 on the ISS78 scale, slightly worse than usual.

All CTD casts are processed and calibrated according to the routines described by Müller (1999). The large time period between laboratory calibrations limits the final accuracies of temperature and pressure data. Accuracies of data after processing and interpolating to 2 dbar intervals are estimated to 0.003 mK, 0.1% in pressure, and 0.003 for salinity.
5.3 Underway measurements

5.3.1 PC-Log
A PC-based programme package, PC-Log, is used to log consecutively the data streams from navigational units, the ship's meteorological sensors, the deep sea echosounder and from the thermosalinograph. Standard output format is binary, but ASCII transformation is an option that was used.

5.3.2 Navigational data
An Ashtech GG24 unit merges positionings from high rate GPS data with high precision GLONASS data. A problem occurred with the date from GG24 which is offset into the past. This correction is constant (7168 d; 15-Nov-1080 indicated on 01-Jul-2000) and can be removed. The UTC time is ok.

Three dimensional GPS data from an Ashtech ADU2 are used to estimate heading, pitch and roll. A check of the September 1997 antenna calibration while in port between P261 and P262, gave no corrections.

Both, GG24 and ADU2 data are input for the standard vmADCP data acquisition and for the underway logging system PC-Log.
5.3.3 Meteorological data
The meteorological sensors have not been served since almost two years because the vessel was out of home port since January 1999, and no regular service is provided. Only the wind and the dry temperature sensors on the starboard side, and the water temperature sensor were working. The digital output is transferred to the PC-Log system.

5.3.4 Deep sea echosounder
A 12 kHz echosounder by ELAC provides depth information, both as standard graph and as digital output. The sound velocity converting travel times to sounding depths was 1500 m/s. The digital output was input to the PC-Log system.

5.3.5 Thermosalinograph
The digital output of the thermosalinograph raw data is transferred to the PC-Log system where it is converted to physical units for temperature and salinity. The accuracy is 0.05 K for temperature and 0.2 for salinity, respectively. Corrections with near surface CTD data while on station, improve the accuracy estimates to 0.02 K and 0.15 for temperature and salinity, respectively.

5.3.6 vmADCP
The vessel mounted ADCP used en route, was a standard 150 kHz instrument made by RDI. Data from the ADCP were merged with the navigational data from the GG24 and the 3-dimensional ADU2, using RDI's data acquisition software DAS (RDI, 1990). Final processing will use the CODAS programme package (Firing et al., 1993).

6. Additional remarks
We would like to thank Captain Bülow and his crew for the excellent advise and help during this cruise. The research programme and in particular POSEIDON cruise 261 is supported by the Deutsche Forschungsgemeinschaft, Bonn, under grant SFB460.
7. References


8. Appendices and figures

*App. 1:*  
POSEIDON cruise 261, log and station list

*App. 2:*  
Mooring array CGFZ at the eastern entrance to Charlie Gibbs Fracture Zone: Basic statistics of low pass filtered daily values.

*Figure captions*  
Fig. 1: Cruise track with positions of moorings, CTD stations and float launches

Fig. 2: Charlie Gibbs Fracture Zone eastern entrance area: mooring array CGFZ; float park FP; Methane intensive sampling stations #171, #176 and at Z.

Fig. 3: CGFZ cross section from North (left) to South (right); (a) potential temperature and (b) salinity

Fig. 4: Progressive vector diagrammes measured at mooring sites C, G, F and Z (Fig. 4a, b, c, d, respectively)

Fig. 5: Hydrographic cross isobath section at the eastern flank of the Reykjanaes Ridge, covering mooring array ISOW: (a) potential temperature, (b) salinity, (c) potential density.
**App 1: P261 station and sample log**


List of abbreviations:
- St: Station no.
- C: CTD cast no., monotonically increasing during the cruise; all casts to near bottom if not indicated else
- Wd: Sounding, 1500 m/s
- Instr: instrument symbol
  - mooring: 1
  - CTD: 2, FSI ICTD 12x12 l bottle rosette
  - float: 3, RAFOS type, 1500 m mission depth
  - vmADCP: 4, vessel mounted RDI ADCP, 150 KHz
  - PC-LOG: 4, on-line log of GPS date, time, position, pitch & roll; near-surface T, S; meteorological data

Additonal sensors on and samples taken from CTD/rosette:
- S salt
- M Methane CH4
- N nutrients
- C CO2 Alkalinity profile for CO2 system

**Date Time** | **St** | **C** | **Latitude** | **Longitude** | **Wd** | **Instr. Inst.** | **Samples / remarks** |
--- | --- | --- | --- | --- | --- | --- | --- |
2000 | | | | | | | |
06 27 0900 | -9 | -9 | 51 32.40 | -08 16.80 | -9 | -9 | 2 | Sail from Cork |
06 28 1658 | -9 | -9 | 50 33.60 | -015 36.70 | 4254 | 4 | 4 | Start PC-LOG; |
06 28 2043 | 166 | 001 | 50 24.96 | -016 46.10 | 4753 | 4782 | 2 | FSI, M, S |
06 29 0020 | 166 | -9 | 50 25.46 | -016 49.84 | 4330 | 4330 | 2 | FSI, M, S |
06 29 1542 | 167 | 002 | 51 03.01 | -020 34.06 | 4332 | 4332 | 2 | Rafos-float 405 |
06 29 1832 | 167 | -9 | 51 02.95 | -020 34.74 | 4332 | 1500 | 3 | Rafos-float 513 |
06 30 0700 | 168 | 003 | 51 31.98 | -023 45.79 | 3538 | 3532 | 2 | FSI, M, S |
06 30 1900 | 168 | -9 | 51 32.40 | -023 46.09 | 3562 | 1500 | 3 | Rafos-float 514 |
07 01 0210 | 169 | -9 | 51 32.14 | -023 46.09 | 3538 | 1500 | 3 | Rafos-float 515 |
07 01 0844 | 170 | 005 | 51 31.88 | -023 46.09 | 3538 | 1500 | 3 | Rafos-float 516 |
07 01 1455 | 171 | 006 | 51 31.92 | -023 46.09 | 3538 | 1500 | 3 | Rafos-float 517 |
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07 02 2030 | 175 | -9 | 52 03.97 | -023 46.09 | 3538 | 1500 | 3 | Rafos-float 526 |
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07 04 2230 | 183 | 018 | 52 03.97 | -023 46.09 | 3538 | 1500 | 3 | Rafos-float 534 |
07 05 0255 | 184 | 019 | 52 03.97 | -023 46.09 | 3538 | 1500 | 3 | Rafos-float 535 |
07 05 1055 | 185 | 020 | 52 03.97 | -023 46.09 | 3538 | 1500 | 3 | Rafos-float 536 |
07 05 1850 | 186 | 021 | 52 03.97 | -023 46.09 | 3538 | 1500 | 3 | Rafos-float 537 |
07 06 0600 | 187 | 022 | 55 00.00 | -031 09.94 | 2826 | 2818 | 2 | Start vADCP; |
07 06 1040 | 188 | 023 | 55 00.00 | -031 09.94 | 2826 | 2818 | 2 | Start vADCP; |

Additional sensors on and samples taken from CTD/rosette:
- S salt
- M Methane CH4
- N nutrients
- C CO2 Alkalinity profile for CO2 system
### App. 1: (continued)

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### App. 2: Mooring array CGFZ at eastern entrance to Charlie Gibbs Fracture Zone

Basic statistics, 04-MAR-2001
Low pass filtered daily values

| ID   | days | mean depth |  | mean depth |  | mean depth |  | mean depth |  | Fluxes |  |
|------|------|------------|---------------|------------|---------------|------------|---------------|---------------|-----------------|-----------------|
|      |      |            |               |            |               |            |               |               | u     | v     | T   | u    | v    | T   | <uv> | <uvd> | <uT> | <vT> |<uv> | <uvd> | <uT> | <vT> |
|      |      |            | SPD | DIR | s   | u   | v   | T   | u   | v   | T   | <uv> | <uvd> | <uT> | <vT> |<uv> | <uvd> | <uT> | <vT> |
| V398 C | 370 | 1.4 | 215 | 0.32 | -0.8 | -1.1 | 2.8 | 9   | 8   | 31  | 1   | 32   | 0.0   | 0.0 | 3.2 | 3.4   | 0.0  |
| V397 G | 370 | 3.8 | 56 | 0.64 | 3.1  | 2.1  | 2.9 | 10  | 5   | 11  | 1   | 86   | 0.0   | 0.0 | 5.7 | 4.0   | 0.0  |
| V396 F | 370 | 7.4 | 73 | 0.84 | 5.8  | 4.3  | NaN | 7   | 8   | NaN | 3   | 79   | NaN   | NaN | 5.8 | 4.3   | NaN  |
| V395 Z | 370 | 1.0 | 21 | 0.72 | 3.8  | 1.3  | 2.9 | 5   | 8   | 12  | 3   | 74   | 0.0   | 0.0 | 4.6 | 3.2   | 0.0  |
POSEIDON cruise 261 report

Figure captions

**Fig. 1:** Cruise track with positions of moorings (*), CTD stations (o) and float launches (+)

**Fig. 2:** Charlie Gibbs Fracture Zone eastern entrance area: mooring array CGFZ; float park FP; Methane intensive sampling stations #171, #176 and at Z.

**Fig. 3:** CGFZ cross section from North (left) to South (right); (a) potential temperature, and (b) salinity

**Fig. 4:** Progressive vector diagrammes measured at mooring sites C, G, F and Z (Fig. 4a, b, c, d, respectively)

**Fig. 5:** Hydrographic cross isobath section at the eastern flank of the Reykjanaes Ridge, covering mooring array ISOW: (a) potential temperature, (b) salinity, (c) potential density.
Fig. 1: Cruise track with positions of moorings, CTD stations and float launches
Fig. 2: Charlie Gibbs Fracture Zone eastern entrance area: mooring array CGFZ; float park FP; Methane intensive sampling stations #171, #176 and at Z.
Fig. 3a: CGFZ cross section from North (left) to South (right); potential temperature
Fig. 3b: As Fig. 3 a for salinity
Fig. 4 a: Progressive vector diagrammes measured at mooring sites C, G, F and Z
Fig. 4 b: As Fig. 4a for mooring site G
Fig. 4 c: As Fig. 4a for mooring site F
Fig. 4 d: As Fig. 4a for mooring site Z
Fig. 5a: Hydrographic cross isobath section at the eastern flank of the Reykjanaes Ridge, covering mooring array ISOW: (a) potential temperature, (b) salinity, (c) potential density.
Fig. 5 b: As Fig 6 a for salinity
Fig. 5 c: As Fig 6 a for potential density