RRS CHARLES DARWIN CRUISE 68
8/5/92-8/6/92

THE NORTH ATLANTIC TRACER RELEASE EXPERIMENT (NATRE): FIRST SAMPLING LEG.

Principal Scientist: A. J. Watson
Co-principal investigator: J. R. Ledwell

Report prepared by: C. S. Law, J. R. Ledwell, A.J. Watson, M. Beney, S. Becker, T. Donaghue, C. Fernandez, B. J. Guest, C. Kinkade, M. I. Liddicoat, K. Lubcke. P. Nightingale, C. Marquette, R. Oxburgh, D. A. Phillips and S. Watts.

Plymouth
Marine
Laboratory

Acknowledgement: We thank the personnel of the RRS Charles Darwin *under Captain P. Macdermott. Their hard work and skilful seamanship helped to make this a successful and enjoyable cruise.*

Funding for NATRE is provided by the Natural Environment Research Council in the UK and the National Science Foundation in the USA.

REPORT: RRS CHARLES DARWIN CRUISE 68, 8/5/92 - 8/6/92. THE NORTH ATLANTIC TRACER RELEASE EXPERIMENT, FIRST SAMPLING LEG.

CONTENTS

Contour Maps

1. Introduction and cruise objectives.

The North Atlantic Tracer Release Experiment (NATRE) is a study of vertical and horizontal mixing processes in the thermocline region of the subtropical gyre of the North Atlantic, with the aim of characterising rates of diapycnal and isopycnal mixing and the processes which give rise to them. The experiment was initiated by the W.H.O.I. vessel R/V Oceanus on a cruise concurrent with CD 68; between 0100 on 5/5/92 and 0700 on 13/5/92, Oceanus released a total of 945 moles of sulphur hexafluoride (SF_6) in a series of 9 streaks on an isopycnal surface at approximately 300m. The streaks were 5 - 10 km long, and were injected into a region of order 20 x 20 Km centred at 25° 38'N, 28° 15'W. Along with the tracer, ten SOFAR "bobber" neutrally buoyant floats were released and ten RAFOS floats.

The plan for the experiment as a whole is to follow the dispersal of this tracer over a period of a year following release. The spread of the tracer in the vertical will give a direct measurement of diapycnal mixing, while the horizontal dispersion of the floats and tracer will enable the quantification of the isopycnal mixing. The floats serve the additional purpose of enabling the location of the tracer. In order to study the processes driving vertical mixing, measurements of fine structure have been and will be made during cruises by R/V Oceanus and the Canadian vessel CSS Hudson in the area of the tracer patch. The overall cruise plan for the experiment is:

April 1992 -- site survey	R/V Oceanus
May 1992 -- injection	R/V Oceanus
May 1992 -- first sampling	RRS Charles Darwin -- this cruise.
October 1992 -- 2nd sampling	R/V Oceanus
March 1993 -- Microstructure	CSS Hudson
April 1993 -- final sampling	RRS Charles Darwin

In this context, the objectives of CD 68 were therefore:

1) To document the "background" concentrations of SF_6 in the region of the experiment. Industrial use of SF_6 has led to a significant global atmospheric background concentration, presently of order 2 x 10^{-12} v/v, and this has in turn generated a concentration in ocean water which decreases with increasing depth. It will be important in the later stages of the experiment to know what background this atmospheric source has generated at the depth of the release, since as the tracer spreads and dilutes, the concentrations will decline sufficiently that the background will begin to become significant in the total after a year.

2) To document the initial distribution of the tracer as soon as practicable after release. The "quality" of the release needed to be verified by obtaining

measurements of its initial vertical and horizontal spread, since it is from these values that any future spreading due to mixing processes within the ocean will be measured. An initial vertical spread as narrow as possible was therefore desirable. In practice we hoped ideally to confine the initial vertical spread to within ±5m, with ±10m considered acceptable.

3) To show that the entire tracer patch has been documented, we wished to attempt a "budget" of the patch, that is, a reconstruction to sufficient accuracy to estimate the total amount of SF_6 in it and show that this agrees with the amount injected.

To achieve these objectives, two main scientific areas were set up on the ship. These were a gas chromatography analysis area in the main lab, and a sample handling area in the wet lab.

2. Itinerary.

Figure 1 shows the cruise track.

2145, 8 May 1992: The vessel departed from Las Palmas, Gran Canaria and set course for the working area. At Las Palmas we had been delayed about 12 hours awaiting a package emergency-shipped from Woods Hole containing parts for an experimental Richardson Number float to be launched from Oceanus. It was agreed that the time lost from our schedule was worthwhile in order to save this project. During the passage we made frequent stops to test equipment and techniques, described in section 3 below.

0600 12 May to 1600 14 May: Arriving near 25°N, 28°W we documented the background concentrations of SF_6 in the working region, in 8 casts. These are described in Section 4 below.

1600 14 May to 1130 31 May: We documented the tracer and float initial distributions resulting from the releases by Oceanus. This was the main part of the work and is described in Section 5.

1130 31 May to 0000 8 June: Passage to Barry, UK.

3. Equipment Tests, 8 - 11 May

9 May, Casts 1 and 2:The CTD sled to be used for tracer "tows" (see below) was modified and tested in the water towing at speeds up to 1 Kt close to the surface. Its behaviour was monitored and we verified that it showed no tendency to rotate or fishtail. We monitored the load on the wire (which did not exceed 400 Kg) and then tested various switches which would form part of the main sampling array (see section 5).

10 May, Casts 3 and 4. We tested the automated winch control system designed and built by R. Powell of RVS, by hanging a heavy (650Kg) weight on the wire , paying out wire and verifying that the winch responded correctly when artificial CTD input was fed into the system.We then tested the system for real by putting the CTD sled on the wire, lowering to 150m and transferring to automatic control. The system showed some tendency to "hunt" but did respond basically correctly.

We also stopped to deploy a hydrophone (cast 5) to listen for the "bobber" SOFAR floats deloyed by Oceanus from 1630 to 1930, but could not hear any of them.

11 May, Cast 6: Intercalibration of CTD and autonomous "SEACAT" CTDs. The SEACATs were mounted on the CTD cage and lowered to 600m, stopping every 100m for 5 minutes to allow time for equilibration of all sensors.

Cast 7: (nearly) full cast of samplers and flying cage at 300m. We were pleased with the automatic winch driving system which on quiet sections was able to maintain density surface with a standard deviation of about 0.0012 -0.0015 units of sigma. However, it also hit noisy sections where it was many times worse. This cast flew for 4 3/4 hours.

4.Background Sampling, 12-14 May..

These casts were made in an octagonal pattern around the central region where the tracer had been laid, but at about 40nmi distance to ensure that the injection did not affect the background values. Initially the samples were collected using the canister samplers designed for obtaining integrated samplers of a streaky tracer. As the analysis proceeded it became apparent that the canister samplers were not well suited for very low levels of SF_6, and we therefore reverted to standard Niskin bottle sampling. Figure 2 shows the positions of the stations, details of which are given in Table I.

The cross - pattern was chosen to make sure that we bracketed the central position, and also to allow close approach and VHF contact with the Oceanus in the centre.

4.1 Hydrographic data

We used the SEACAT autonomous CTDs rather than the Neil Brown CTD as this avoided having to dismount the CTD or the pylon from the cage. The station list gives details of the positions of the SEACATS on the wire. A description of the SEACATS is given in appendix III. The SEACATS are not well configured for measuring salinity because of the slow response of the conductivity cell, and especially for vertical profiles because the cells are oriented horizontally. Therefore, we used temperature as a surrogate for potential density for the casts performed only with the SEACATS, the mean relationship between temperature and potential density having been determined later in the cruise with the EGG Mark III CTD.

The SEACATS were calibrated for the upper 600 m of the water column during Cast 6, when they were deployed together with the Mark III CTD on the sampling sled. A multiplier and addend were established for each SEACAT for temperature and conductivity, and for pressure for the two SEACATS with strain gauges, namely 884 and 885 (Table 2).

4.2 SF_6 data

Casts 8-12 showed some obvious contamination and considerable scatter, though the precision of duplicates taken from the same sampler was generally good. This confirmed a trend seen earlier in the samples analysed from Cast 7, the first flying of the winch, in which two bags gave high results. Several samples had bubbles in, so for instance a total of 5 samples out of cast 9 had to be discarded.

Because of the contamination problem, all interpretation of the background concentrations was made with the last four casts only, for which niskin samples were taken. Figure 3 shows SF_6 concentrations from these casts plotted as a function of depth. Three of the profiles agree closely but the last (cast 15) is consistently high -- it is just possible that this is due to generalised contamination picked up during the transfer of personnel from the Oceanus which took place a few hours before this cast was performed. However, in the absence of firm evidence of contamination this cast was treated in the same way as the other three.

For each sample from casts 12-15, a potential density was assigned using the observed temperature and the cruise-mean temperature v potential density relationship. The four profiles were then linearly interpolated to standard densities and averaged. Figure 4 shows the results of this exercise and also tabulates the basic cast data. At the "target" isopycnal of 28.05, the mean background value is 4.23×10^{-16} moles l^{-1}.

5. Tracer sampling, 14-31 May.

5.1 Method

The difficulties in sampling a tracer when the distribution is streaky are well known and have been described in the literature. Grab samples, as obtained with niskin bottles, cannot be relied on to give an accurate estimate of the vertical profile because there is no way of knowing whether the sample was taken in a streak or out of it, and even small-scale vertical shear in the water column will distort the apparent profile. The method we employed to circumvent the "streakiness problem" was to use a vertical array of custom-designed water samplers which fill with water at a slow and reasonably constant rate, interspersed with SEACAT CTDs. The array was towed through the water for a period of several hours, with its centre kept homed in on the isopycnal surface on which the tracer was released. During this time the array may cross one or more streaks of tracer, and subsequent analysis revealed a vertical cross-section averaged over the tow track. Figure 5 shows the positions of samplers, SEACATs and central CTD in the array used for casts 16 - 28. From cast 29 onwards, extra samplers were added at + 30m and -30m from the centre.

The purpose of the SEACATs was to provide information on the variation in density and density gradient over the region from 30m above to 30m below the centre of the array. Without such information it would be necessary to assume that these properties remained constant over each sampling tow, whereas examination of the data shows that this is frequently far from the truth. Use of the SEACATs is described in more detail in appendix III and figures 30-34 show examples of the kind of data obtained from them.

In order to measure the true tracer distribution with respect to density, it was necessary to keep the centre of the array "flying" along a constant-density surface. Since these surfaces are not at constant depth, a CTD sensor at the centre of the array was required which measured the density there, along with a method of altering the amount of wire out in response to this signal to continuously adjust the sensor to the correct depth. In addition to the CTD, samplers, calibration equipment and an experimental "multichamber sampler" system were mounted at the centre of the array. To carry this equipment, a custom "sled" was built at WHOI. The upper half of the array was attached to the CTD wire itself, while the lower part was attached to an auxiliary wire hung from the bottom of the sled. Upper and lower arrays were triggered by messengers.

The sled, a frame, approx 1m x 1m x2m, held the following:

(a) the CTD (Neil Brown Mk 3)

(b) two or more integrating samplers.

(c) a multisampler holding a carousel of 18 sampling syringes filled sequentially during the tow.

(d) a rosette pylon which fired to perform several tasks, in the following sequence:

i) Release a messenger which tripped the samplers below the sled.

ii) start the samplers on the sled

iii) start the multisampler.

iv) collect up to seven salinity samples and turn four reversing thermometers during the course of the tow, for purposes of calibrating the CTD.

The procedure for the tracer tows was to head due north, that is with the wind on the starboard bow, while towing the sample array at 0.5 - 1 kt from the starboard "A" frame and CTD winch. In order to counteract the westerly drift and wind effect, the ship actually headed at about 30^{o} to starboard to do this. Deployment of the sled and all the associated samplers. took a time of order 2 hours initially, but decreased to one hour after a little practice. The sled was then lowered to 500m in order to get CTD data through the depth of interest. It was then returned to 300m and transferred to automatic winch control, and the messenger dropped to start the samplers filling. After a time of 3.5 hours all the samplers should be filled, but to be sure they were left down for an extra 0.5 hr. Finally another drop to 500m was performed followed by recovery to deck, which took about 45 min. Turn-around of the apparatus was performed during steaming to the next site. The total time of the cycle was generally of order 8 hours.

5.2 Float location.

Hydrophone listening stations were occupied as detailed in the station list on 3 occasions. The vessel steamed a good distance to the NE or SW of the tracer patch (typically 20nmi) in order to obtain a favourable geometry with respect to a Drifting SOFAR receiver deployed by Oceanus, which was about the same distance to the NE of the patch. The hydrophone was lowered to listen during the period 0630-0930 or 1830-2130 when the SOFAR floats deployed by Oceanus were programmed to transmit. We heard respectively 4, 8, and 5 floats out of 10 released on casts 31A, 37A and 44A.

On three occasions we were able to obtain good fixes on some of the floats by using the Simrad PES to listen for the 10KHz pings emitted by them. We used a box-search technique whereby as the point of closest approach is passed (indicated by a flattening out and then decrease in the pattern of pings on the Simrad) a 90^o turn to port or starboard is made. We used this technique between 2340 on 22/5 and 0440 on 23/5 to obtain fixes on four floats. The Simrad proved an excellent instrument for listening to the signal from the floats, with a range of about 3 nmi.

5.3 Hydrographic Data

Additional calibrations of the SEACATs against the Mk III CTD were made at intervals. It was found that, because of a software imperfection, a correction must be applied to the time record from the SEACATS. The time since Startup of the SEACATS must be multiplied by the drift correction in Table 2 to determine the correct time.

The SEACATS were calibrated again at the target density of the sampler tows by towing them for 1 hour on the sled during Cast 28 (Table 3). They were checked once more in this way during Cast 49 (Table 4), and found to have drifted very little.

The Mark III CTD was calibrated for temperature and pressure on shore prior to departure. The temperature calibraition was checked throughout the cruise with four digital reversing thermometers mounted on the Sampling Sled (Appendix II). These were the same thermometers used during the injection cruise on Oceanus. However, for both cruises the strong temperature gradients and the mismatch in time and space between the reversing therms and the CTD probes resulted in rms noise of around 0.090 deg C. Therefore the shore- based calibrations, which should stand to better than 0.004 deg C will be relied upon for temperature.

Salinity calibrations were also performed throughout the cruise, with samples from the 5-liter Niskin bottles during the background casts and from 1.2-Liter Niskin bottles mounted horizontally on the Sampling Sled during the tows (Appendix II). They showed a consistent salinity error of -0.022 PSU for the Mark III system for the part of the water column sampled. This correction was applied in processing the CTD data. The processed CTD data are considered as accurate as possible; no post-cruise adjustment of the data is anticipated.

Each sampler tow was preceeded by a downcast to 500 m at about 25 m/min, and was followed by an upcast from 500 m at roughly the same speed. Since the ship was generally moving at about 1 knot (30 m/min) the descent and ascent angles are about 45 degrees from the vertical. Also the CTD probes, while located in an open area just a few cm from the leading edge of the sled, may see thermal contamination from the sled. For these two reasons the finestructure at scales of 1 m or so are not to be taken as representing the vertical hydrographic structure. Averages of the data over many casts and the individual profiles over scales of 10 m or more should be accurate, however.

Table 1 lists the times and positions at the start and end of the tows, and the tow tracks are plotted in Fig. 6. These can be taken as applying to the downcasts and upcasts, respectively. The data stream from the Mark III Deck Unit to the SUN-based processing system was not always turned on at the start of cast and was sometimes turned off early. Also, although the wire out was always brought to 500 m or more at the bottom of each cast, the pressure did not always reach 500 dbar. Tables 5 to 8 list the properties caught at the top and bottom of each descent and ascent to show what data are available from the processed CTD files.

Representative profiles from the Mark III are shown in Figs. 7 to 11. These are the raw data, with only the spikes near the rosette trips removed. There are still obvious spikes of noise in the data. These also appear in the plots of potential temperature versus salinity shown in Figs. 12 to 16. These spikes are not severe enough to seriously affect the means discussed next.

The data from the CTD descents and ascents were interpolated to standard levels every meter from 10 m to 500 m, where data are available. These were then averaged at the 1 m intervals to produce the mean profiles of Figs. 17 and 18, and the plots of mean potential temperature versus salinity in Figs. 19 and 20. Profiles are allowed to drop out of these averages where there are no data. This can lead to discontinuities in the mean profiles, but does not in this case because the number of profiles remaining is so large. A listing of the mean of the descent data every 10 m is given in Table 9.

Considerable CTD data near the target density surface of $\sigma_p = 28.05$ were also obtained with the Mark III and SEACAT CTDs. Figures 21 to 29 show samples of data from the Mark III for several selected casts, including the ones where problems following the target density were encountered. These figures show about 4 hours of data, and sometimes include the approach and leaving of the target surface at the ends of the records. However, if the winch control system is operating properly, σ_p should remain close to a constant value for the remainder of the record. Figs. 27 to 29 show the CTD data for the tows for which this was not the case.

The winch control system failed during Casts 35, 49 , and 54. Fortunately, no SF6 was found during Cast 35, Cast 49 was a calibration tow without samplers, and only small amounts of SF6 were found from Cast 54. It is possible that the anomalous shape of the SF6 profile from Cast 54 is due to the poor flight control shown in Fig. 29.

The 4 SEACAT CTDs were hung on the wire above and below the Mark III on the sampling sled to give data on the vertical temperature distribution along the sampling track. The SEACATS were hung just below the integrating samplers nominally at 16 m, 6 m, -9 m, and - 20 m above the CTD. The SEACAT probes were located between 40 and 60 cm below the inlet of the sampler above. The positions of these inlets are listed in Table 10. The approximate heights of the SEACAT probes are then: 15.5 m, 5.1 m, -9.8 m, and -20.8 m. The heights for SEACATS 885 and 884, at 15.5 m and -20.8 m, inferred from the pressure records average 15.8 m and -20.2 m, in fair agreement. The differences are not understood completely but may be due in part to the 0.3 dbar digital resolution of the SEACAT sensors and a slight hysteresis in the Mark III gauge.

The discrepancies cannot be explained by wire angle. The angle at the sheave was typically less than 10 degrees, and the 500 lb weight at the bottom of the array will reduce this angle to nearly 0 in the vicinity of the array. Furthermore, the pressure offset at 15.5 m is in the wrong sense to be explained by wire angle. Therefore, no corrections need be attempted for wire angle in the sampler heights.

Examples of the temperature records from the 4 SEACAT CTDs and the Mark III are shown in Figs. 30 to 34. It is clear from these figures how variable the spacing of isothermal and isopycnal surfaces is. A correction for the effect of this finestructure on the vertical distribution of the tracer as it is used to infer the diapycnal distribution will be made in post-cruise analysis.

The data from the 5 CTDs obtained during the 43 tows of the sampling sled give an excellent record of the hydrographic properties in the vicinity of the target density surface. Table 11 summarizes the mean and rms temperature, salinity and density at the tow level of the sled. The target density was not always 28.05 because of errors made in correcting for the calibrated offsets earlier in the cruise. A history of nominal target densities is given in Table 12, along with the actual target density, accounting for the errors made, and the actual mean density of the tow as measured by the Mark III CTD.

The mean and rms potential temperature, salinity, and σ_p at the Mark III are listed for the tows in Table 11. This table also includes an estimate of the gradient $dT/d\sigma_p$ from the SEACAT and Mark III data and the ratio of rms temperature to this gradient. This last ratio gives an estimate of the rms σ_p which is generally lower than that made directly from σ_p, presumably because the latter is strongly affected by noise in the salinity record.

The array of SEACATS and Mark III CTDs has been used to estimate pressure, potential temperature, and salinity at the $\sigma_p = 28.05$ surface by interpolation between the Mark III and the appropriate neighboring SEACAT, usually SEACAT 882, located 9.8 m below the Mark III. Estimates of the gradients dT/dz, dS/dz, and $d\sigma_p/dz$, as well as the Density Ratio (R_ρ) and the Buoyancy Frequency (N) are listed in Table 13. These gradients are estimated using the differences between the mean temperature, conductivity and pressure at the two extreme SEACATS, 885 and 884, separated by 36.3 m. Many of these quantities are shown in contour maps below.

The gradients calculated from the Mark III and the neighboring SEACAT have also been used to estimate the mean height of the Mark III above the $\sigma_p = 28.05$ surface for the tows. These are listed in Table 14, and have been used to estimate the heights of the sampler inlets above the 28.05 surface in reducing the concentration data.

5.4 Lateral Motion of the Patch

The data from the BOBBER floats are described in detail in Appendix III. These data have been used to infer the motion of the tracer patch during the sampling survey. These estimates have been used in chosing locations for the survey, and are used here for plotting and reducing the data. Two estimates for the motion of the patch have been made. The first is based on the positions of 5 of the floats, namely, 55, 56, 57, 58, and 59.

The positions of the floats on the days between actual fixes were estimated by linear interpolation. The longitudes for the days from the last fix to the end of the survey on 31 May were estimated by linear extrapolation, while the latitudes, being more variable, were held fixed at the last known position. The velocities of the floats for each day was estimated from simple differences of the positions. The velocity of a water parcel at any position and day was estimated from a weighted mean of the float velocities, the weighting function taken as inversely proportional to the distance from the float. Displacements of water parcels over a period of several days were then estimated using a day by day stepping procedure of position and velocity. Thus, the sampling tracks could be transformed from their original positions to positions on 23 May, the approximate central time of the survey (see Fig.35).

The translation inferred in this way from the 5 floats mentioned above is considered conservative, in that 3 of the floats, 55, 57, and 58 are relatively stationary and remain close to one another. Thus they are redundant, and their low velocities are weighted too heavily.

A more liberal estimate of the translation was made by using only data from floats 56, 59, and 64, the last representing the slow velocities in the eastern area of the patch (see Fig. 36). Some data have been reduced using 3 sets of positions, namely the original positions of the tracks, those translated with the conservative estimate, and those translated to 23 May with the liberal estimate. Most of the data, however, is presented using the conservatively translated positions.

5.5 Lateral Hydrographic Patterns at $\sigma_p = 28.05$

Contour maps of some of the hydrographic properties listed for the sampler tows in Table 1 are shown in the contour maps. The map of pressure, Map 1, simply illustrates the mean and variation of the pressure on the surface. The pattern is probably a badly aliased picture of internal wave displacements. The potential temperature map (Map 2) shows that there are systematic variations of potential temperature and salinity at constant σ_p, even over the small area of our survey. The salinity map (Map 3) reflects the potential temperature map, and confirms this conclusion.

Density ratio has proven to serve well as a water mass tracer. It is contoured in Map 4. It appears that its value in the western part of the patch, where the tracer was found, is about 1.80, which is characteristic of the region at this level on the larger scale. Since density ratio is the best water mass tracer, it is also mapped using the original positions (Map 5) and in the liberally translated positions (Map 6). The unrealistically fine structure seen in the original positions suggests that the translation was justified, while there is little basis in these figures to choose between the liberal and the conservative translation.

Map 7 contours the density gradient, which is proportional to the local absolute potential vorticity. Like the pressure, this is mostly useful for evaluating the mean and the variance, since the dominant features are probably aliased internal tides and waves.

5.6 Distribution of SF_6 within the patch.

Forty two tows were made to document the distribution of the released tracer. Of these, 13 had no measurable SF_6 (these were casts 19-21, 35, 38-42, 45, 56, 57, and

59). Each of the remainder is summarised in figures and tables 15 to 43. In these summaries the concentrations are plotted at the nominal heights of the samplers above or below the sled, except for casts 16-18 and 23 for which the sled was flying substantially off the true target density surface and the profiles have accordingly been offset.

Fig 37 summarises the contribution of the individual profiles to the mean profile. The profiles are arranged in chronological order. The largest contribution comes from profile number 31, with profiles 16, 17 and 18 close behind. Figure 38 shows the same data with the vertical scale percentage contribution of each cast at the given distance from the target surface. It is notable from this diagram that the earlier profiles tend to be more narrow and higher in the water column than the later profiles. A few profiles (i.e. cast 30, 37, 55) tend to dominate in the wings of the distribution.

Heights from the target isopycnal were subject to two further minor adjustments: these take account of changes in the positions of the samplers on the wire as detailed in table 44, and a further adjustment based on the observed mean density at which the sled was flying during each cast and the temperature gradient between the Mk III and the SEACAT which bracketed the true target surface. These adjusments are small, typically <<1m. The observed profiles (except for cast 51 which was discarded for subsequent analysis because the samplers below the sled did not trigger) were then linearly interpolated to an evenly spaced grid. The results of this interpolation are shown in table 45. Finally, a mean profile was obtained by averaging the interpolated profiles together. The mean profile is shown in table 46 along with the summary statistics. The mean profile has a nearly symmetric shape, an RMS width of 6.8m and a displacement below the target surface of 0.84 m. Such a profile is very satisfactory for the start of the mixing experiment, and should enable accurate measurements of vertical mixing as even if the K_z is as low as 0.01-0.02 $cm^2\ s^{-1}$.

The profiles from each cast can be column-integrated to obtain an amount of SF_6 in moles per unit area for each tow track, as well as a displacement from the target surface, RMS width and second moment about the target surface. The spatial distribution of these data around the patch area are contoured in maps 8 through 13. The data for column integrated amounts are the best, being constrained not only by the profiles which did have SF_6 in them, but also by those which did not.

Map 8 shows the column-integrated SF_6 in the float-guided, conservatively-translated co-ordinates -- those which we believe are the closest to a lagrangian co-ordinate system. According to this and the other maps, the tracer has strained out mostly in an east-west direction as might be expected from the observed direction of drift. It remains however relatively simple in shape, and contours well. In absolute co-ordinates (map 9) the distribution is much more difficult to contour. In "liberally translated" co-ordinates (map 10), the patch shows a more nearly circular shape. Integration of the distrubutions over the maps yields our best estimates of the total amount of tracer in the measured patch. These values are;

1128 moles (conservative co-ordinates)

1111 moles (liberal co-ordinates)

1586 moles (absolute co-ordinates)

Of these, the "absolute" value is clearly suspect because we have plenty of evidence that the patch did move substantially during the course of the cruise. Of the three, we favour the "conservative" figure. The number is about 20% greater than the best estimate of the amount actually released, but this represents a much closer agreement than we had expected to be able to achieve and clearly shows that no major areas of the patch were undocumented. The distribution of zero and near-zero values also indicates that we succeeded in closing off the patch on all sides.

The first moment of the vertical distribution, i.e. the displacement of the centre of mass from the target surface, is mapped in conservative co-ordinates in map 11. There is a clear indication of high values on the northwest edge and low values to the south. Quite substantial offets are shown in an area to the east, but comparison with map 8 shows that there are only very low concentrations of tracer here. The gradient in height across the patch can be interpreted as evidence for shear, tending to move the upper portion of the distribution more rapidly to the northwest than the lower part. The second moment of the patch, that is theRMS widths relative to the centre of mass and to the target surface, are shown in maps 12 and 13. Once again, the centre of the patch shows widths of 6- 8 m, with more extreme values on the edges of the distribution where the concentrations are low.

Table 1. Station List

Cast no. 1

9/5/92, 1530: 27-17.9N, 18-19.7W.
Test CTD sled at surface

Cast no. 2

9/5/92, 1830: 27-15.0N, 18-43.7W.
Test CTD sled and samplers at 100m.

Cast no. 3

10/5/92, 1330: 26-32.7N, 22-42.7W.
Test CTD wire with 1350lb weight using automatic winch controller.

Cast no. 4

10/5/92, 1600: 26-32.3N, 22-49.7W.
Test CTD sled with weight on lower wire. Test fire samplers. Test automatic winch controller.

Cast no. 5

10/5/92, 1745: 26-35.1N, 22-50.0W.
Hydrophone cast to listen for SOFAR floats.

Cast no. 6

11/5/92, 1100: 26-15.02N, 26-42.8W
Intercalibration of RVS CTD and SEACAT autonomous CTDs.

Cast no. 7

11/5/92, 1700: 26-14.7N, 26-43.3W
Test complete sampler array and automatic control system for CTD winch.

Casts 8 - 15: 600 m casts to determine background SF_6 concentrations, using CTD wire, SEACAT CTDs and 14 water samplers. The arrangement of samplers and SEACATs on the wire was as follows:

Depth	
10m	sampler
50m	sampler
100m	sampler, SEACAT
150m	sampler
200m	sampler
250m	sampler, pressure SEACAT
300m	2 samplers
350m	sampler
400m	sampler, SEACAT
450m	sampler
500m	sampler
550m	sampler

600m sampler, pressure SEACAT, pinger, weight.

Times and positions of the casts were

Cast 8 0600, 12/5/92 Position A: 26-08.0N, 27-38.0W

Cast 9 1530, 12/5/92 Position B: 25-11.0N, 28-42.0W

(Done in two hoists, Messenger dropped too soon).

Cast 10 2300 12/5/92 Position C: 25-11N, 27-38W.

Cast 11 0830 13/5/92 Position D: 26- 08N, 28-42W.

Cast 12 1300 13/5/92 Position E: 25-39N, 28-55W.

Cast 13 2000 13/5/92 Position F: 24-58N, 28-10W

Cast 14 0300 14/5/92 Position G: 25-39N, 27-24.5W.

Cast 15 1450 14/5/92 Station H: 26-220N, 28-10W.

Casts 16-59: Tracer sampling tows and hydrophone casts. See text for descriptions of these. The following table gives times and positions of deployment, triggering of the sampler array and end of the sampling tow.

Cast no.	Date /Time begun	Posn begun	Time triggerd	posn triggered	Time ended	Posn ended
16	14/5, 2035	24-35N, 28-18W	2240	24-37N. 28-18W	0342	25-42.0N, 28-18.0W
17	15/5, 0915	25-40.10, 28-18.0W	1110	25-41.5N, 28-18.7W	1521	25-45.9N, 28.18W
18	16/5, 1915	25-34.8N, 28-23.5W	2113	25-36.7N, 23.5W	0142	25-41.4N, 28-23.3W
19	15/5, 0443	25-29.5N, 28-23.5W	0620	25-06N, 28-23.5W	1100	25-36.7N, 28-23.5W
20	16/5, 1521	25-28.1N, 28-18.1W	1652	25-28.8N, 28-18.2W	2130	25-32.9N, 28-18.0W
21	16/5, 2324	25-28.1N, 28-12.3W	0050	25-21.1N, 28-12.3W	0442	25-33.0N, 28-12.3W
22	17/5, 0638	25-36.5N, 28-12.5W	0753	25-37.4N, 28-12.5W	1200	25-41.8N, 28-12.9W
23	17/5, 1510	25-40.0N, 28-23.7W	1630	25-41.1N, 28-23.4W	2050	25-45.6N, 28-23.5W
24	17/5, 2316	25-44.7N, 28-23.4W	0040	25-44.6N, 28-23.3W	0415	25-49.N, 23.5W

25	18/5, 0705	25-47.9N, 28-23.5W	0828	25-48.9N, 28-23.4W	1236	25-53.2N, 28-23.6W
26	18/5, 1532	25-44.1N, 28-32.9W	1701	25-45.2N, 28-33.1W	2112	25-49.1N, 28-32.9W
27	18/5, 2354	25-42.0N, 28-29.1W	0145	25-43.5N, 28-30.2W	0548	25-47.4N, 28-30.1W
28	19/5, 0841	25-43.7N, 28-30.6W	SEACAT CALIB.		1102	25-45.4N, 28-30.0W
29	19/5, 1244	25-46.7N, 28-30.2W	1442	25-47.6N, 28-30.0W	1843	25-51.4N, 28-30.0W
30	19/5, 2335	25-38.5N, 28-30.0W	0109	25-40.0N, 28-30.1W	0519	25-44.5N, 28-30.0W
31	20/5, 0815	25-38.9N, 28-26.7W	0912	25-39.7N, 28-26.5W	1344	25-43.7N, 28-26.7W
31A	20/5, 1740	26-05.7N, 28-41.1W	H'PHONE CAST		2152	26-05.4N, 28-41.3W
32	21/5, 0051	25-34,8N, 28-26.6W	0220	25-35.9N, 28-26.4W	0620	25-40.1N, 28-26.5W
33	21/5, 0836	25-36.0N, 28-20.7W	0946	25-36,8N, 28-20.7W	1354	25-40.9N, 28-20.7W
34	21/5, 1650	25-32.2N, 28-20.6W	1810	25-32.8N, 28-20.8W	2216	25-36.3N, 28-20.7W
35	22/5, 0106	25-31.3N, 28-27.3W	0215	25-31.9N, 28-27.3W	0620	25-36.0N, 28-27.2W
36	22/5, 0900	25-38.9N, 28-24.1W	1008	25-39.7N, 28-24.0W	1410	25-44.3N, 28-24.0W
37	22/5, 1612	25-37.8N, 28-28.6W	1736	25-38.5N, 28-28.4W	2136	25-41.0N, 28-28.6W
37A	23/5, 0615	28-55.8N, 28-30.7W	H'PHONE CAST		1000	25-54.6N, 28-31.1W
38	23/5, 1150	25-40.3N, 28-21.0W	1303	25-41.5N, 28-21.0W	1722	25-46.7N, 28-21.2W
39	23/5, 1913	25-40.5N, 28-17.9W	2025	25-41.5N, 28-18.0W	0045	25-46.0N, 28-18.0W
40	24/5, 0230	25-37.8N, 28-13.1W	0400	25-38.8N, 28-13.0W	0824	25-43.5N, 28-13.1W
41	24/5, 1039	25-36.2N, 28-17.0W	1148	25-37.2N, 28-18.0W	1552	25-42.6N, 28-17.9W

42	24/5, 1837	25-30.8N, 28-17.4W	1955	25-32.2N, 28-18.0W	2400	25-37.2N, 28-18.0W
43	25/5, 0226	25-43.3N, 28-26.8W	03:42	25-43.9N, 28-26.6W	07:07	25-47.2N, 28-26.7W
44	25/5, 1024	25-40.0N, 28-33.0W	11:28	25-40.8N, 28-33.0W	14:53	25-43.6N, 28-33.0W
44A	25/5, 1754	25-52.1N, 28-49.3W	H'PHONE CAST		2154	25-50.5N, 38-50.3W
45	26/5, 0146	25-50.0N, 28-58.0W	03:02	25-50.6N, 28-52.0W	06:27	25-53.4N, 28-52.1W
46	26/5, 0915	25-46.3N, 28-47.9W	10:37	25-47.0N, 28-48.0W	14:02	25-49.7N, 28-48.1W
47	26/5, 1700	25-43.3N, 28-43.4W	18:23	25-44.0N, 28-43.3W	21:48	25-46.8N, 28-43.3W
48	27/5, 0043	25-41.5N, 28-38.2W	02:02	25-42.5N, 28-38.1W	05:27	25-46.4N, 28-38.2W
49 SAMP. TEST	27/5, 0850	25-41.9N, 28-38.1W	09:48	25-42.3N, 28-38.3W	13:13	25-44.5N, 28-38.2W
50	27/5, 1631	25-38.3N, 28-43.6W	18:23	25-39.5N, 28-43.5W	21:48	25-42.9N, 28-43.6W
51	28/5, 0124	25-47.8N, 28-45.8W	02:32	25-48.2N, 28-43.5W	05:57	25-52.4N, 28-43.5W
52	28/5, 1906	25-50.0N, 28-33.0W	2040	25-50.7N, 28-33.0W	0115	25-53.7N, 28-33.0W
53	29/5, 0447	25-48.6N, 28-38.3W	0603	25-49.9N, 28-38.2W	1015	25-55.1N, 28-38.2W
54	29/5, 1306	25-38.6N, 28-49.9W	1419	25-39.4N, 28-49.8W	1826	25-43.2N, 28-49.2W
55	29/5, 2032	25-38.4N, 28-39.6W	2139	25-39.5N, 28-39.6W	0215	25-44.3N, 28-39.7W
56	30/5, 0421	25-34.3N, 28-39.7W	0527	25-35.0N, 28-39.6W	0939	25-38.9N, 28-39.6W
57	30/5, 1115	25-34.9N, 28-45.5W	1222	25-35.7N, 28-45.5W	1650	25-39.8N, 28-45.5W
58	30/5, 1945	25-44.2N, 28-26.0W	2056	25-45.1N, 28-25.9W	0120	25-48.3N, 28-26.0W
59	31/5, 0248	25-48.6N, 28-26.5W	0458	25-53.6N, 28-31.5W	0910	25-57.0N, 28-31.5W

Table 2. Calibration corrections applied to Seacat data, based on calibration against Neil Brown Mk III on cast 06.

Seacat #882

	Multiplier	Offset
Drift correction:	0.983849899	
Temperature correction	1.000278	-0.01240748
Salinity correction	1.124062	-4.622366

Seacat #883

	Multiplier	Offset
Drift correction:	0.983906705	
Temperature correction	1.000361	-0.01404851
Salinity correction	1.115245	-4.302094

Seacat #884

	Multiplier	Offset
Drift correction:	0.99389002	
Pressure correction	0.9999573	-1.757815
Temperature correction	1.000758	-0.02062131
Salinity correction	1.006024	-0.2179918

Seacat #885

	Multiplier	Offset
Drift correction:	0.983131138	
Pressure correction	0.9967492	-0.4828761
Temperature correction	0.999859	-0.004138292
Salinity correction	1.00462	-0.1611892

Table 3. Calibration of Seacats against Neil Brown Mk III CTD at 300dbar -- data from calibration cast 28

Seacat #	Drift rate	pressure offset	Temp. offset	Cond'tivity offset	Salinity offset
882	1.62945%		-0.0095	-0.0087	-0.1081
883	1.75418%		-0.0099	-0.0010	-0.01012
884	1.63915%	-1.58	-0.0087	-0.0161 (x10)	+0.0094
885	1.71583%	-1.48	-0.0092	-0.0160 (x10)	+0.0099

Table 4. Cast 49: CTD Statistics for Sampling Tow

1992 Day 148 094800 to 148 110100

PRESSURE

Seacat 885	300.820874	5.332479
Neil Brown CTD	301.105831	5.285254
Seacat 884	300.961885	5.354265

TEMPERATURE

Seacat 885	15.594228	0.043623
Seacat 883	15.593399	0.047821
Neil Brown CTD	15.594038	0.047859
Seacat 882	15.593965	0.046916
Seacat 884	15.593898	0.048917

SALINITY

Seacat 885		
Seacat 883		
Neil Brown CTD	36.153473	0.008629
Seacat 882		
Seacat 884		

CONDUCTIVITY

Seacat 885	44.893842	0.053844
Seacat 883	44.891008	0.073334
Neil Brown CTD	44.896755	0.055768
Seacat 882	44.890871	0.062482
Seacat 884	44.890484	0.067821

SIGMA-300

Seacat 885		
Neil Brown CTD	28.051692	0.005511
Seacat 884		

Table 5. Properties at the Top of the Neil Brown CTD Descents

Cast	Julian Day	Seconds into day	Pressure (dbar)	Theta_p deg C	Salinity (PSU)	Sigma_p
16d	135	78256	0.34	21.2582	0.2809	-0.4830
17d	136	36326	0.19	18.9850	0.1094	-0.1311
18d	136	73382	1.51	21.4317	37.2930	27.4200
19d	137	19507	0.14	21.1232	0.8075	-0.0533
20d	137	58022	0.41	21.8762	1.6959	0.4474
21d	137	86391	0.73	21.5103	37.2884	27.3943
22d	138	25746	0.21	21.3257	10.3008	7.0596
23d	138	57156	5.01	21.5931	37.2883	27.3708
24d	138	85972	1.09	21.4446	37.2899	27.4141
25d	139	28980	127.14	20.2860	37.1375	27.6197
26d	139	58361	1.41	21.4727	37.3092	27.4208
27d	140	3262	0.23	20.9413	1.0347	0.1596
28d	140	31999	0.17	19.2450	0.6327	0.2159
29d	140	49087	1.63	21.3179	37.2822	27.4439
30d	141	1702	0.57	21.3503	37.2945	27.4442
31d	141	33062	36.89	21.3357	37.2870	27.4425
32d	142	5324	0.73	21.3543	37.2941	27.4427
33d	142	33810	186.26	18.0808	36.6373	27.8187
34d	142	63780	92.42	20.3565	37.1502	27.6101
35d	143	6291	15.93	21.3724	37.2931	27.4368
36d	143	33933	0.77	21.3656	37.2967	27.4415
37d	143	60656	1.35	22.4469	37.3185	27.1489
38d	144	44739	0.95	21.7407	37.2868	27.3278
39d	144	71039	0.19	19.4363	0.0000	-0.3065
40d	145	12660	233.10	17.6264	36.5629	27.8763
41d	145	39792	0.83	21.6874	37.3032	27.3554
42d	145	69254	7.80	21.6076	37.3033	27.3781
43d	146	11356	48.20	21.1639	37.2708	27.4785
44d	146	38893	1.26	21.8164	37.3128	27.3260
45d	147	9034	96.92	20.3478	37.1435	27.6074
46d	147	36304	210.41	17.6216	36.5401	27.8600
47d	147	64284	95.04	20.4434	37.1658	27.5982
48d	148	4595	0.81	21.8180	37.3236	27.3337
49d	148	32412	1.59	21.7437	37.3218	27.3535
50d	148	63024	1.59	22.1419	37.3172	27.2360
51d	149	6483	1.16	21.9427	37.3073	27.2857
52d	149	71658	1.21	22.4409	37.3084	27.1429
53d	150	18905	1.19	22.1395	37.3216	27.2400
54d	150	48865	1.31	22.6381	37.3565	27.1221
55d	150	75514	0.83	22.4751	37.3467	27.1620
56d	151	17711	30.63	21.5388	37.3022	27.3968
57d	151	41712	1.44	22.6527	37.3532	27.1153
58d	151	72485	0.71	23.3006	37.3444	26.9179
59d	152	15742	0.97	22.7859	37.3459	27.0708

Table 6. Properties at the Bottom of the Neil Brown CTD - Descents

Cast	Julian day	Pressure (dbar)	Seconds into day	Theta (p)	Salinity (PSU)	Sigma(p)
16d	135	80818	498.66	12.6069	35.7042	28.3558
17d	136	38617	489.61	12.7608	35.7218	28.3380
18d	136	75236	491.99	12.6462	35.7094	28.3518
19d	137	21952	482.58	12.6894	35.7139	28.3464
20d	137	60058	491.71	12.6498	35.7072	28.3494
21d	138	1978	501.04	12.4053	35.6723	28.3720
22d	138	27660	495.08	12.6771	35.7081	28.3445
23d	138	58680	474.47	12.8694	35.7365	28.3270
24d	139	1420	499.54	12.9337	35.7456	28.3208
25d	139	29744	494.65	12.6525	35.7067	28.3484
26d	139	60480	494.50	12.6448	35.7086	28.3515
27d	140	5440	500.37	12.6366	35.7078	28.3525
28d	140	33000	497.44	12.4300	35.6839	28.3760
29d	140	51956	501.72	12.7125	35.7192	28.3459
30d	141	3420	488.08	12.6735	35.7135	28.3494
31d	141	34138	498.16	12.8211	35.7336	28.3347
32d	142	7140	511.62	12.2985	35.6654	28.3881
33d	142	34493	516.44	12.3578	35.6740	28.3828
34d	142	64620	481.16	12.7009	35.7137	28.3439
35d	143	7320	501.82	12.3088	35.6716	28.3909
36d	143	35743	486.72	12.7578	35.7265	28.3422
37d	143	62640	516.76	12.1840	35.6492	28.3985
38d	144	46238	513.38	12.3675	35.6715	28.3790
39d	144	72840	509.95	12.4579	35.6814	28.3684
40d	145	13609	507.70	12.3231	35.6649	28.3828
41d	145	41400	505.99	12.4774	35.6876	28.3693
42d	145	70832	503.51	12.2044	35.6491	28.3943
43d	146	12540	515.70	12.5163	35.6958	28.3678
44d	146	40282	507.83	12.3835	35.6778	28.3807
45d	147	10080	509.87	12.6964	35.7173	28.3477
46d	147	37076	503.35	12.4709	35.6857	28.3691
47d	147	65214	514.68	12.4854	35.6886	28.3684
48d	148	6180	491.33	12.6938	35.7152	28.3466
49d	148	34800	511.67	12.1570	35.6483	28.4032
50d	148	64904	498.92	12.3149	35.6659	28.3852
51d	149	8340	524.09	12.3311	35.6632	28.3798
52d	149	73664	505.70	12.6098	35.7016	28.3532
53d	150	20998	522.41	12.5210	35.6908	28.3629
54d	150	50580	496.78	12.7732	35.7107	28.3269
55d	150	77271	505.23	12.4169	35.6806	28.3761
56d	151	18994	527.96	11.9414	35.6228	28.4261
57d	151	43560	519.71	12.2596	35.6581	28.3903
58d	151	74340	518.39	12.3799	35.6759	28.3799
59d	152	17280	509.87	12.4563	35.6872	28.3732

Table 7. Properties at the Top of the Neil Brown CTD Ascents

Cast	Julian Day	Seconds into Day	Pressure (dbar)	Theta_p (deg C)	Salinity (PSU)	Sigma_p
16u	136	16446	0.49	21.3638	19.3258	13.8454
17u	136	57559	0.14	21.4197	1.6603	0.5257
18u	137	7303	0.17	21.3213	1.5079	0.4328
19u	137	40560	0.4	21.4488	23.3218	16.8369
20u	137	78353	0.71	21.5724	37.2848	27.374
21u	138	19302	0.85	21.3825	37.2838	27.427
22u	138	44548	0.25	21.3736	2.1037	0.8715
23u	138	76702	0.63	21.4025	37.2417	27.3893
24u	139	20089	0.19	21.1489	1.2381	0.2674
25u	139	47568	1.15	21.2992	37.275	27.4437
26u	139	78456	0.94	21.3274	37.2887	27.4462
27u	140	23397	0.56	21.2334	37.2855	27.4701
28u	140	38940	2.96	21.3176	37.289	27.4492
29u	140	69407	4.73	21.4082	37.2806	27.4172
30u	141	21677	0.99	21.363	37.2898	27.4369
31u	141	51812	0.4	21.3372	1.0766	1.6148
32u	142	24502	0.57	21.2573	37.2836	27.462
33u	142	52188	1.49	21.6646	37.2893	27.3513
34u	142	82495	0.59	21.4103	37.1151	27.2909
35u	143	24636	0.73	21.3149	37.2902	27.4509
36u	143	52974	11.36	21.3536	37.2805	27.4326
37u	143	80099	0.65	21.607	37.2895	27.3675
38u	144	64541	0.97	22.0864	37.2955	27.2355
39u	145	4320	1.49	21.5655	37.287	27.3777
40u	145	31674	0.87	21.3878	37.2733	27.4174
41u	145	59040	10.74	21.4661	37.2773	27.3984
42u	146	2640	1.89	21.7949	37.2866	27.3122
43u	146	30414	5.18	21.5673	37.2955	27.3836
44u	146	57838	1.31	22.4475	37.3266	27.1548
45u	147	27852	0.73	21.7522	37.3164	27.347
46u	147	54718	5.41	22.0836	37.3174	27.2529
47u	147	83507	1.31	21.7733	37.2955	27.3251
48u	148	23934	1.34	21.8227	37.3198	27.3294
49u	148	50253	1.43	22.3059	37.3301	27.1985
50u	148	84655	0.56	22.0309	36.8436	26.9084
51u	149	25260	1.53	21.7706	37.3016	27.3305
52u	150	7070	2.05	22.0583	37.31	27.2546
53u	150	38688	1.39	22.0309	37.3018	27.2562
54u	150	68386	0.63	23.1462	37.3428	26.9625
55u	151	9719	2.03	22.3472	37.3422	27.1957
56u	151	36720	1.95	22.1385	37.3389	27.2535
57u	151	62148	1.73	24.5593	37.3409	26.5355
58u	152	6958	1.35	23.2408	37.3589	26.9466
59u	152	34426	2.17	22.4994	37.3423	27.1517

Table 8. Properties at the Bottom of the Neil Brown CTD Ascents.

Cast	Julian Day	Seconds into day	Pressure (dbar)	Theta_p (deg C)	Salinity (PSU)	Sigma_p
16u	136	13937	473.1	13.034	35.754	28.3065
17u	136	55620	506.75	12.7168	35.7163	28.3427
18u	137	5289	485.26	12.9031	35.7442	28.326
19u	137	39016	458.6	13.1505	35.7744	28.298
20u	137	76677	466.53	13.0542	35.765	28.3108
21u	138	17180	507.93	12.4136	35.6784	28.3751
22u	138	42803	485.69	12.8517	35.729	28.3249
23u	138	75261	443.22	13.5857	35.8329	28.2513
24u	139	17760	504.17	12.6692	35.7127	28.3497
25u	139	45927	492.97	12.9515	35.7478	28.3188
26u	139	76709	483.4	12.9688	35.7559	28.3215
27u	140	21378	490.27	12.7157	35.7178	28.3441
28u	140	37777	494.33	12.6176	35.7067	28.3555
29u	140	67560	463.27	13.2134	35.7949	28.3007
30u	141	19755	515.6	12.1002	35.6382	28.4067
31u	141	50107	540.26	11.9877	35.6244	28.4183
32u	142	23059	453.32	13.1617	35.7801	28.3
33u	142	50720	494.17	12.7227	35.719	28.3436
34u	142	80760	504.28	12.32	35.6689	28.3865
35u	143	23294	453.7	13.2227	35.7908	28.2956
36u	143	51432	478.05	12.8492	35.7366	28.3312
37u	143	78512	507.23	12.4344	35.6813	28.373
38u	144	62936	477.81	12.8907	35.7394	28.3249
39u	145	2520	521.04	12.5386	35.6924	28.3606
40u	145	30149	444.05	13.4985	35.8128	28.2543
41u	145	57496	467.8	13.1636	35.7766	28.2969
42u	146	600	506.26	12.4432	35.6886	28.3769
43u	146	28693	510.16	12.6191	35.7078	28.3561
44u	146	56583	487.39	12.6889	35.7181	28.3498
45u	147	25981	474.01	13.5117	35.8294	28.2644
46u	147	52991	563.21	11.7947	35.6086	28.444
47u	147	81780	504.93	12.4182	35.6782	28.374
48u	148	22080	459.31	13.0592	35.7697	28.3134
49u	148	49094	122.53	20.075	37.0987	27.6475
50u	148	82860	510.29	12.3346	35.679	28.3914
51u	149	23895	511.97	12.5282	35.6952	28.3648
52u	150	5281	522.61	12.2319	35.6564	28.3945
53u	150	37320	517.95	12.1265	35.6383	28.4015
54u	150	66960	507.33	12.4211	35.678	28.3732
55u	151	8160	507.77	12.357	35.6765	28.385
56u	151	35334	539.23	11.9537	35.6207	28.4222
57u	151	60965	507.45	12.4427	35.6817	28.3717
58u	152	5280	514.14	12.4959	35.692	28.369
59u	152	33420	494.87	12.6804	35.7148	28.349

Table 9. Properties from Mean CTD Descents, Every 10 meters

Pressure (dbar)	Temp (deg C)	Salinity (PSU)	Theta_p (deg C)	Sigma_p	No. of Casts
10.00	21.57305	37.30002	21.63052	27.36887	33
20.00	21.45244	37.29626	21.50771	27.40087	34
30.00	21.34286	37.28670	21.39598	27.42527	34
40.00	21.24914	37.28141	21.30014	27.44820	36
50.00	21.09182	37.26035	21.14062	27.47685	37
60.00	20.90601	37.23727	20.95258	27.51174	37
70.00	20.71635	37.21013	20.76069	27.54436	37
80.00	20.56622	37.19018	20.60843	27.57127	37
90.00	20.45977	37.17726	20.49992	27.59133	37
100.00	20.39057	37.16598	20.42872	27.60230	40
110.00	20.33001	37.15538	20.36618	27.61136	40
120.00	20.28678	37.14857	20.32101	27.61854	40
130.00	20.25225	37.14402	20.28454	27.62501	41
140.00	20.17220	37.12433	20.20251	27.63227	41
150.00	19.98104	37.07616	20.00928	27.64762	41
160.00	19.67337	37.00503	19.69944	27.67624	41
170.00	19.25053	36.90044	19.27437	27.70937	41
180.00	18.73830	36.78456	18.75990	27.75582	41
190.00	18.33539	36.69576	18.35489	27.79286	42
200.00	18.03154	36.63043	18.04907	27.82114	42
210.00	17.76588	36.57335	17.78150	27.84515	42
220.00	17.53421	36.52689	17.54797	27.86805	43
230.00	17.31602	36.48521	17.32796	27.89072	43
240.00	17.11163	36.44425	17.12177	27.91015	44
250.00	16.87285	36.39695	16.88124	27.93268	44
260.00	16.64774	36.34906	16.65439	27.95090	44
270.00	16.42510	36.30563	16.43004	27.97150	44
280.00	16.21507	36.26471	16.21834	27.99051	44
290.00	16.01777	36.22707	16.01940	28.00867	44
300.00	15.84139	36.19549	15.84139	28.02616	44
310.00	15.66008	36.16225	15.65849	28.04326	44
320.00	15.47762	36.13086	15.47446	28.06178	44
330.00	15.30321	36.10009	15.29850	28.07854	44
340.00	15.11845	36.07133	15.11222	28.09888	44
350.00	14.94773	36.04194	14.93998	28.11530	44
360.00	14.75218	36.01200	14.74297	28.13651	44
370.00	14.56572	35.98169	14.55506	28.15505	44
380.00	14.38669	35.95404	14.37462	28.17365	44
390.00	14.22174	35.92818	14.20824	28.19028	44
400.00	14.04675	35.90171	14.03187	28.20835	44
410.00	13.89028	35.87844	13.87404	28.22454	44
420.00	13.73195	35.85514	13.71435	28.24092	44
430.00	13.58628	35.83419	13.56735	28.25613	44
440.00	13.42790	35.81186	13.40765	28.27276	44
450.00	13.28405	35.79082	13.26250	28.28707	44
460.00	13.15516	35.77372	13.13231	28.30110	44
470.00	13.01684	35.75459	12.99273	28.31536	44
480.00	12.87444	35.73553	12.84906	28.33029	43
490.00	12.74474	35.71761	12.71814	28.34332	38
500.00	12.58365	35.69616	12.55585	28.35985	26

Table 10. Estimates of Heights of the Integrating Sampler
Inlets above the C/T Probes on the Sled

Date:	14	19	19	24	27	27	31 May
Casts:	16-28	29	30-40	41-50	50	51-59	final check
nominal height							
30	------	29.68		29.42			29.48
24	23.68			23.44			23.52
20	19.68			19.42			19.48
16	15.68			15.42			15.47
12	11.68			11.32			11.36
9	8.68			8.45			8.83
6	5.68			5.46			5.54
4	3.68			3.43			3.47
2	1.68			1.49			1.56
0	-0.28			-0.28			-0.28
-2	-2.33			-2.48	-2.51	-2.48	-2.49
-4	-4.33			-4.87	-5.69	-4.87	-4.85
-6	-6.33	-6.03	-6.33	-6.95	-6.54	-6.95	-6.93
-9	-9.33			- 9.28	-9.04	-9.28	-9.28
-12	-12.33	-12.03	-12.33	-12.28	-12.30	-12.28	-12.28
-16	-16.33			-16.26	-15.66	-16.26	-16.27
-20	-20.33			-20.28	-19.95	-20.28	-20.16
-24	-24.33			-24.37	-24.42	-24.37	-23.94
-30	-----	-30.33		-30.44	-30.62	-30.44	-30.42

Table 11. CTD Statistics for Sampler Tows

Cast	Mean θ_p deg C	rms T deg C X1000	Mean S PSU	rms S PSU X1000	Mean σ_p	rms σ_p X1000	Mean $-dT/d\sigma_p$ deg C	rmsT $-dT/d\sigma_p$ X1000
16	15.7592	17.6	36.1791	3.92	28.0330	2.89	10.3	1.71
17	15.7742	30.9	36.1832	6.70	28.0326	4.43	10.1	3.06
18	15.7571	27.9	36.1783	5.81	28.0328	4.30	9.4	2.97
19	15.7282	24.6	36.1696	4.97	28.0329	3.78	9.3	2.64
20	15.5934	21.0	36.1483	4.51	28.0479	2.87	9.3	2.26
21	15.6044	19.6	36.1515	4.56	28.0477	2.95	10.0	1.96
22	15.6084	16.1	36.1527	3.71	28.0477	2.55	9.8	1.64
23	15.5604	22.3	36.1435	4.65	28.0518	3.01	9.1	2.45
24	15.6296	30.8	36.1591	6.37	28.0478	4.42	9.8	3.15
25	15.6266	23.8	36.1582	5.60	28.0477	4.26	9.7	2.45
26	15.6435	18.3	36.1632	4.38	28.0476	2.76	9.4	1.94
27	15.6447	19.4	36.1635	4.20	28.0476	3.08	9.4	2.06
28	15.6423	33.1	36.1622	6.77	28.0472	5.15	9.8	3.38
30	15.6242	21.9	36.1574	4.60	28.0477	3.17	9.3	2.35
31	15.6164	21.7	36.1550	4.46	28.0477	3.29	9.5	2.29
32	15.6069	33.4	36.1547	6.6	28.0496	5.11	9.8	3.42
33	15.6103	23.6	36.1565	5.43	28.0503	3.43	10.0	2.36
34	15.5918	20.5	36.1508	4.6	28.0501	3.18	9.8	2.09
35	15.5490	194.1	36.1461	31.12	28.0563	21.07	10.3	2.71
37	15.5888	21.8	36.1498	4.61	28.0500	3.37	9.7	2.25
38	15.6327	28.3	36.1629	5.76	28.0499	3.53	10.4	2.71
39	15.6349	18.2	36.1636	3.86	28.0500	2.29	10.7	1.71
40	15.6247	59.6	36.1605	17.17	28.0499	3.41	10.7	5.55
41	15.6266	33.0	36.1607	6.47	28.0497	4.05	10.2	3.23
42	15.6223	26.3	36.1594	5.27	28.0497	3.70	10.1	2.61
43	15.6346	45.5	36.1637	8.90	28.0501	5.35	10.4	4.39
44	15.6151	21.7	36.1576	4.40	28.0499	3.28	9.6	2.26
45	15.6197	20.0	36.1588	4.56	28.0499	3.12	9.5	2.10
46	15.6216	19.8	36.1596	4.43	28.0500	3.30	9.5	2.09
47	15.6203	24.3	36.1591	5.50	28.0499	4.17	9.5	2.55
48	15.6281	26.3	36.1612	5.48	28.0497	4.36	9.5	2.76
49	15.5939	47.9	36.1535	8.63	28.0517	5.51	-0.2	-299.48
50	15.6153	26.8	36.1574	6.25	28.0497	3.47	9.2	2.92
51	15.6188	28.8	36.1582	5.65	28.0495	3.95	9.6	3.01
52	15.6063	29.5	36.1542	5.91	28.0494	4.27	9.7	3.04
53	15.5691	25.2	36.1436	6.16	28.0498	2.63	9.4	2.67
54	15.5890	104.1	36.1478	31.75	28.0484	10.29	9.3	11.25
55	15.6199	20.3	36.1590	4.30	28.0499	2.32	9.5	2.15
56	15.6897	27.5	36.1801	5.24	28.0499	3.32	9.8	2.81
57	15.6700	28.5	36.1741	7.23	28.0499	2.51	9.9	2.89
58	15.6476	25.6	36.1673	5.31	28.0499	3.05	10.4	2.46
59	15.6269	29.8	36.1611	6.99	28.0499	2.97	9.1	3.28

Table 12. History of the Target Densities

Casts	Target	Est	Actual	Comments
Inject	28.035	28.050	unknown	Sea-bird. Assume correct T; Correct for S offset; Correct for 1990 T-scale.
16-19	28.033	28.035	28.0328	BBC. Corrected for S-offset, not realizing it had already been done. Est. based on no correction for 0.005 deg offset and 1990 T-scale for S.
20-22	28.050	28.050	28.0478	
23	28.050	28.054	28.0518	Reset the S-offset in the BBC from +0.018 to +0.013 PSU. This was not correct.
24-31	28.050	28.050	28.0476	Back to same condition as for Casts 20-22
32-59	28.052	28.052	28.0501	Empirical adjustment based on actual sigma from the SUN, which was be believed to be correct.

Table 13. Properties at $\sigma_p = 28.050$

Cast	P (dbar)	τ_p (deg C)	S (PSU) X1000	dT/dz deg/m X1000	dS/dz PSU/m X1000	R_ρ	$d\sigma/dz$	N cph
16	312.95	15.5833	36.1477	20.1	3.59	1.71	-1.94	2.47
17	311.88	15.5989	36.1523	23.6	4.15	1.73	-2.34	2.70
18	307.02	15.5959	36.1514	18.3	3.06	1.83	-1.95	2.47
19	311.11	15.5685	36.1432	21.6	3.57	1.85	-2.32	2.69
20	311.11	15.5735	36.1450	16.8	2.75	1.86	-1.81	2.38
21	300.82	15.5817	36.1476	19.6	3.39	1.76	-1.97	2.48
22	313.15	15.5860	36.1489	20.5	3.50	1.78	-2.09	2.56
23	320.05	15.5769	36.1462	15.8	2.53	1.89	-1.74	2.33
24	320.50	15.6079	36.1554	22.8	3.90	1.78	-2.34	2.70
25	325.34	15.6046	36.1544	21.2	3.59	1.79	-2.17	2.61
26	315.39	15.6213	36.1595	17.5	2.90	1.83	-1.86	2.41
27	318.51	15.6226	36.1599	20.1	3.32	1.84	-2.13	2.58
28	305.57	15.6347	36.1635	0.0	0.00	0.00	0.00	0.00
29	316.65	15.6145	36.1574	18.9	3.24	1.78	-1.93	2.46
30	311.43	15.6025	36.1538	16.2	2.66	1.85	-1.74	2.33
31	320.68	15.5945	36.1514	16.7	2.77	1.83	-1.77	2.35
32	298.98	15.6034	36.1541	19.2	3.28	1.78	-1.97	2.48
33	303.40	15.6129	36.1570	22.0	3.80	1.75	-2.20	2.62
34	309.46	15.5929	36.1510	17.1	2.93	1.77	-1.74	2.33
35	300.53	15.6069	36.1555	20.4	3.29	1.87	-2.21	2.63
36	309.03	15.6154	36.1577	18.9	3.34	1.72	-1.84	2.40
37	317.51	15.5893	36.1499	16.8	2.83	1.79	-1.73	2.33
38	304.98	15.6322	36.1628	19.5	3.49	1.69	-1.86	2.42
39	324.32	15.6348	36.1636	22.6	4.10	1.67	-2.12	2.58
40	306.37	15.6238	36.1603	19.4	3.53	1.67	-1.81	2.38
41	309.77	15.6236	36.1602	21.6	3.79	1.73	-2.12	2.58
42	309.88	15.6192	36.1589	19.9	3.47	1.74	-1.97	2.48
43	314.98	15.6354	36.1638	21.8	3.88	1.71	-2.11	2.57
44	308.15	15.6145	36.1575	18.2	3.05	1.81	-1.89	2.43
45	316.85	15.6183	36.1586	19.2	3.21	1.82	-2.02	2.51
46	315.03	15.6215	36.1596	16.2	2.71	1.82	-1.70	2.31
47	304.34	15.6195	36.1590	21.3	3.57	1.82	-2.24	2.65
48	312.14	15.6253	36.1607	17.0	2.84	1.81	-1.78	2.36
49	301.22	15.5936	36.1512	0.0	0.00	0.00	0.00	0.00
50	305.86	15.6129	36.1569	16.4	2.66	1.88	-1.79	2.36
51	315.85	15.6144	36.1574	21.5	3.60	1.81	-2.25	2.65
52	315.58	15.6005	36.1532	23.7	4.00	1.80	-2.45	2.77
53	320.22	15.5676	36.1433	20.3	3.35	1.84	-2.15	2.59
54	314.06	15.5745	36.1455	15.2	2.48	1.86	-1.64	2.26
55	317.89	15.6191	36.1588	15.6	2.60	1.83	-1.65	2.27
56	297.90	15.6885	36.1799	21.8	3.73	1.77	-2.22	2.63
57	309.03	15.6693	36.1740	18.7	3.21	1.77	-1.89	2.43
58	309.93	15.6463	36.1670	20.1	3.60	1.70	-1.93	2.46
59	323.59	15.6261	36.1610	18.1	2.90	1.90	-2.00	2.50

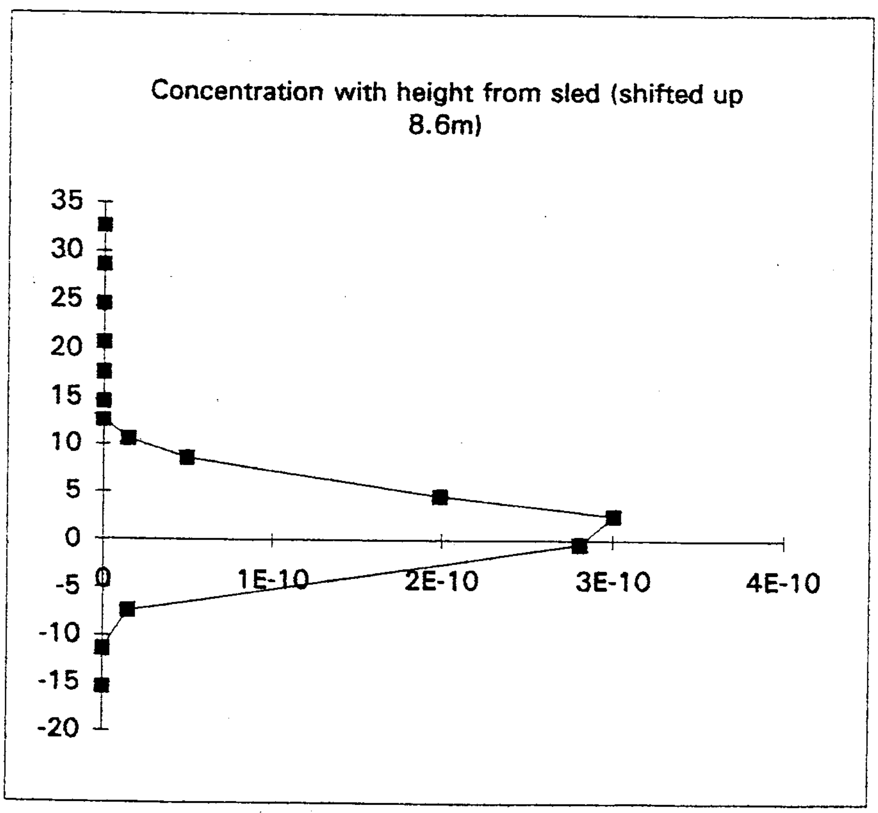
Table 14. Estimates of Height of the C/T probes above the σ_p= 28.050 surface

Cast	del_h
16	10.08
17	6.65
18	9.08
19	0.00
20	0.00
21	0.00
22	1.18
23	-0.53
24	1.11
25	1.03
26	1.63
27	1.08
28	0.00
29	1.46
30	1.39
31	1.17
32	0.19
33	-0.06
34	-0.03
35	0.00
36	-0.03
37	-0.01
38	0.04
39	0.01
40	0.04
41	0.14
42	0.17
43	-0.02
44	0.01
45	0.08
46	0.01
47	0.04
48	0.17
49	-.001
50	0.16
51	0.21
52	0.25
53	0.08
54	1.00
55	0.04
56	0.05
57	0.04
58	0.07
59	0.04

The heights of all the Integrated Samplers above the CTD should be raised by del_h, for height above the target surface.

Cast 16: Concentrations adjusted for memory

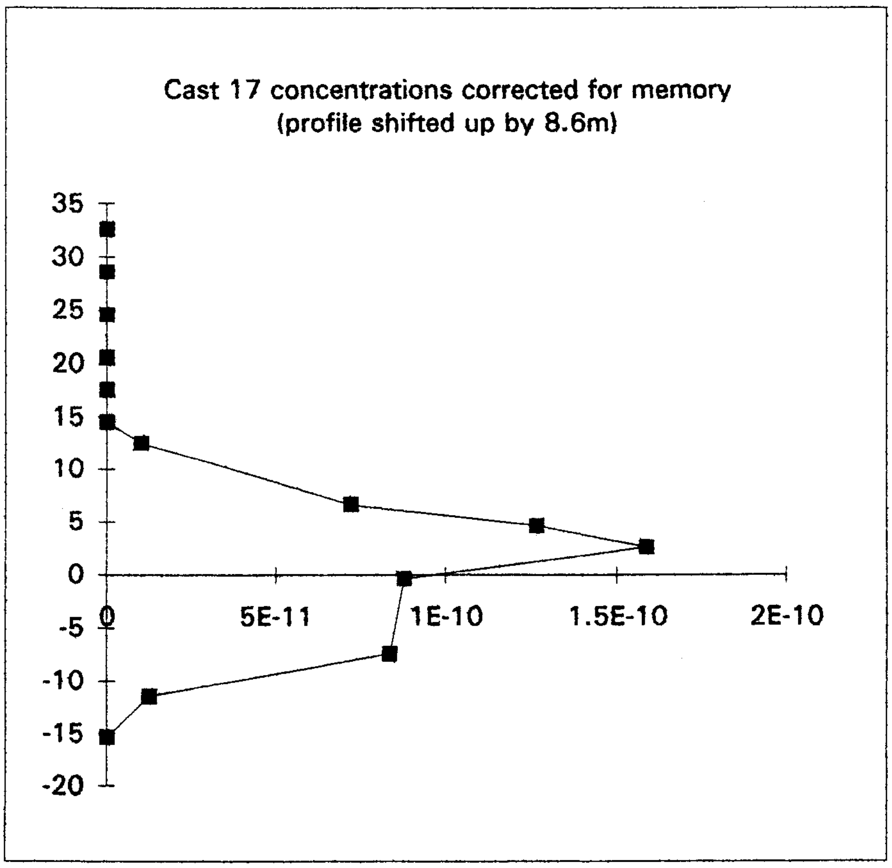
Depth	Water conc	Memories	Final Concn	Height from sled (shiftec
30				38.6
24	0	0	0	32.6
20	0	0	0	28.6
16	0	0	0	24.6
12	0	0	0	20.6
9	0	0	0	17.6
6	0	0	0	14.6
4	0	0	0	12.6
2	1.409E-11	8.454E-13	1.49354E-11	10.6
0	4.661E-11	2.7966E-12	4.94066E-11	8.6
-2				6.6
-4	1.918E-10	7.054E-12	1.98854E-10	4.6
-6	2.8875E-10	1.199E-11	3.0074E-10	2.6
-9	2.718E-10	8.9285E-12	2.80729E-10	-0.4
-12				-3.4
-16	1.3795E-11	8.277E-13	1.46227E-11	-7.4
-20	0	0	0	-11.4
-24	0	0	0	-15.4
-30				-21.4



CAST 17: Mean concentrations

(memories estimated as 6% when no measurement available

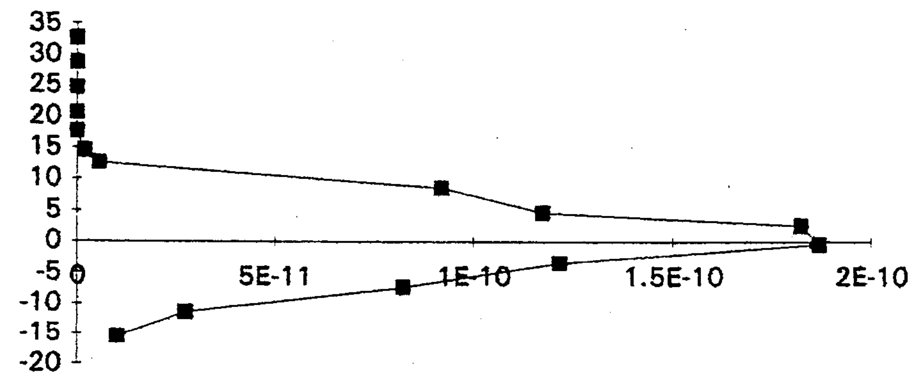
Depth	Water conc	Memories	Final Concn	Ht shifted 8.6m
30				
24	0	0	0	32.6
20	0	0	0	28.6
16	0	0	0	24.6
12	0	0	0	20.6
9	0	0	0	17.6
6	0	0	0	14.6
4	9.67433E-12	5.8E-13	1.0255E-11	12.6
2				10.6
0				8.6
-2	6.792E-11	4.08E-12	7.1995E-11	6.6
-4	1.1975E-10	6.83E-12	1.2658E-10	4.6
-6	1.5195E-10	6.8E-12	1.5875E-10	2.6
-9	8.779E-11	0	8.779E-11	-0.4
-12				-3.4
-16	8.3555E-11	0	8.3555E-11	-7.4
-20	1.254E-11	0	1.254E-11	-11.4
-24	0	0	0	-15.4
-30				



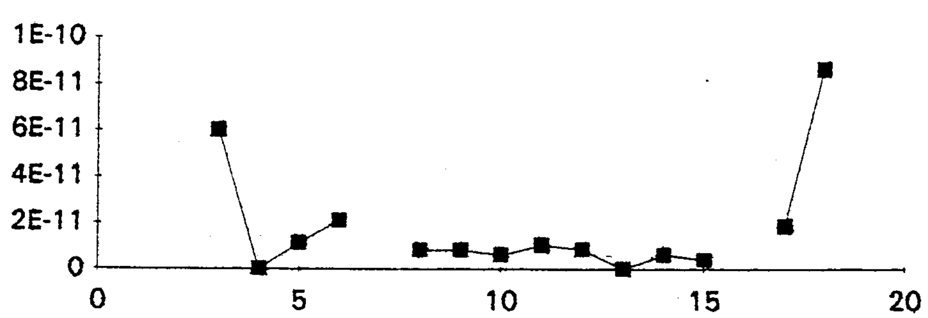
CAST 18: concentrations corrected for memory

Depth	Water conc	Memories	Final Concn	Height Shifted up 8.2 m	Carousel Posn	Concn
24	0	0	0	32.6		
20	0	0	0	28.6	3	6.04E-11
16	0	0	0	24.6	4	0.00E+00
12	0	0	0	20.6	5	1.14E-11
9	0	0	0	17.6	6	2.12E-11
6	1.7045E-12	1.02E-13	1.8068E-12	14.6		
4	5.32E-12	3.19E-13	5.6392E-12	12.6	8	8.32E-12
2					9	8.38E-12
0	8.6723E-11	5.2E-12	9.1927E-11	8.6	10	6.33E-12
-2					11	1.07E-11
-4	1.126E-10	4.63E-12	1.1723E-10	4.6	12	8.59E-12
-6	1.734E-10	8.85E-12	1.8225E-10	2.6	13	0.00E+00
-9	1.7535E-10	1.16E-11	1.8694E-10	-0.4	14	6.17E-12
-12	1.1705E-10	4.51E-12	1.2156E-10	-3.4	15	4.17E-12
-16	7.7575E-11	4.65E-12	8.223E-11	-7.4		
-20	2.573E-11	1.54E-12	2.7274E-11	-11.4	17	1.89E-11
-24	9.4215E-12	5.65E-13	9.9868E-12	-15.4	18	8.66E-11

Cast 18: concentrations with height above sled -- profile shifted up 8.6m



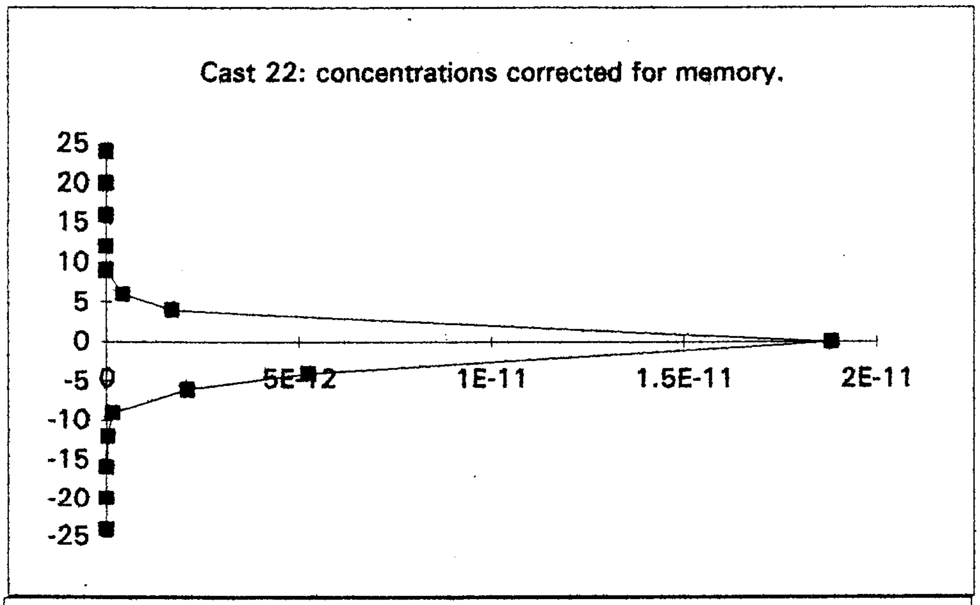
Carousel

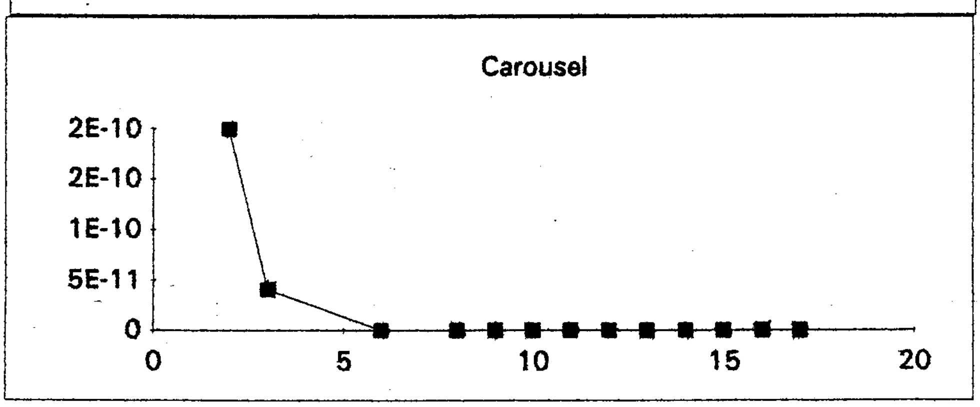


Cast 22: Averaged concenentrations corrected for memory effect.

(memories estimated at 6%)

Depth	Water conc	Memories	Final Concn	Height above sled	Carousel Posn	Concn
30		0				
24	0	0	0	24	2	2.00E-10
20	0	0	0	20	3	4.04E-11
16	0	0	0	16	6	7.88E-14
12	0	0	0	12	8	0.00E+00
9	0	0	0	9	9	0.00E+00
6	4.1045E-13	2.46E-14	4.3508E-13	6	10	5.50E-14
4	1.6075E-12	9.65E-14	1.704E-12	4	11	0.00E+00
2				2	12	0.00E+00
0	1.7735E-11	1.06E-12	1.8799E-11	0	13	5.95E-14
-2				-2	14	6.95E-14
-4	4.9285E-12	2.96E-13	5.2242E-12	-4	15	0.00E+00
-6	1.981E-12	1.19E-13	2.0999E-12	-6	16	1.18E-13
-9	1.5585E-13	9.35E-15	1.652E-13	-9	17	0.00E+00
-12	3.2175E-14	1.93E-15	3.4106E-14	-12		0.00E+00
-16	0	0	0	-16		
-20	0	0	0	-20		
-24	0	0	0	-24		
-30						

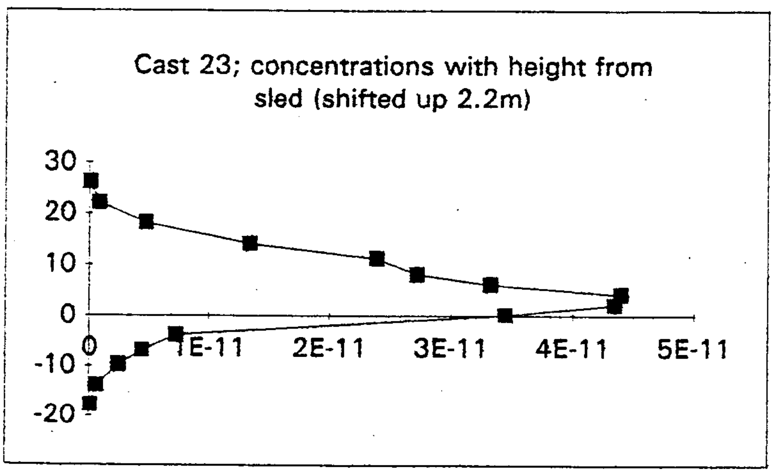


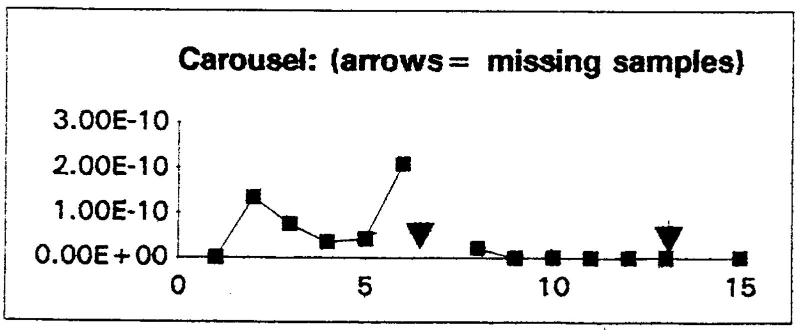


CAST 23: Averaged concentrations corrected for memory

Depth	Water conc	Memories	Final Concn	Height (shifted up 2.2m)
30				
24	1.02E-13	6.10E-15	1.08E-13	26.2
20	7.76E-13	4.60E-14	8.22E-13	22.2
16	4.48E-12	2.65E-13	4.74E-12	18.2
12	1.33E-11	1.01E-13	1.34E-11	14.2
9	2.3E-11	9.02E-13	2.39E-11	11.2
6	2.55E-11	1.75E-12	2.72E-11	8.2
4	3.32E-11	3.03E-14	3.32E-11	6.2
2	4.14E-11	2.64E-12	4.4E-11	4.2
0	4.1E-11	2.38E-12	4.34E-11	2.2
-2	3.26E-11	1.84E-12	3.45E-11	0.2
-4				-1.8
-6	7.02E-12	3.11E-13	7.33E-12	-3.8
-9	4.15E-12	2.49E-13	4.4E-12	-6.8
-12	2.47E-12		2.47E-12	-9.8
-16	5.85E-13	3.51E-14	6.2E-13	-13.8
-20	1.15E-13	6.88E-15	1.21E-13	-17.8
-24				
-30				

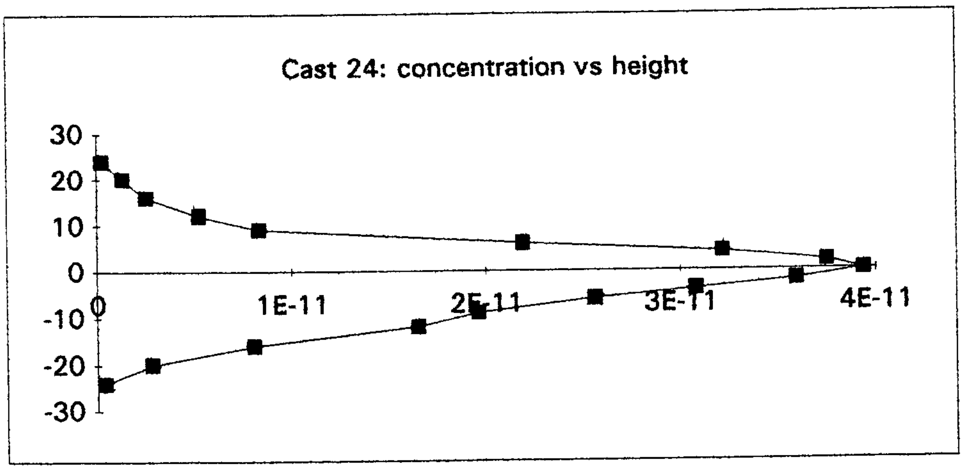
Carousel: number	Concn
1	0.00E+00
2	1.33E-10
3	7.60E-11
4	3.57E-11
5	4.33E-11
6	2.09E-10
8	2.04E-11
9	0.00E+00
10	0.00E+00
11	0.00E+00
12	0.00E+00
13	0.00E+00
15	0.00E+00

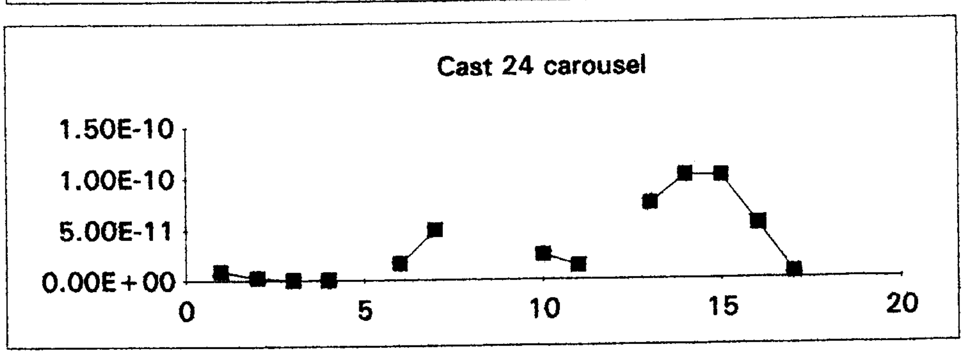




Cast 24: Concentrations adjusted for memory and carousel results

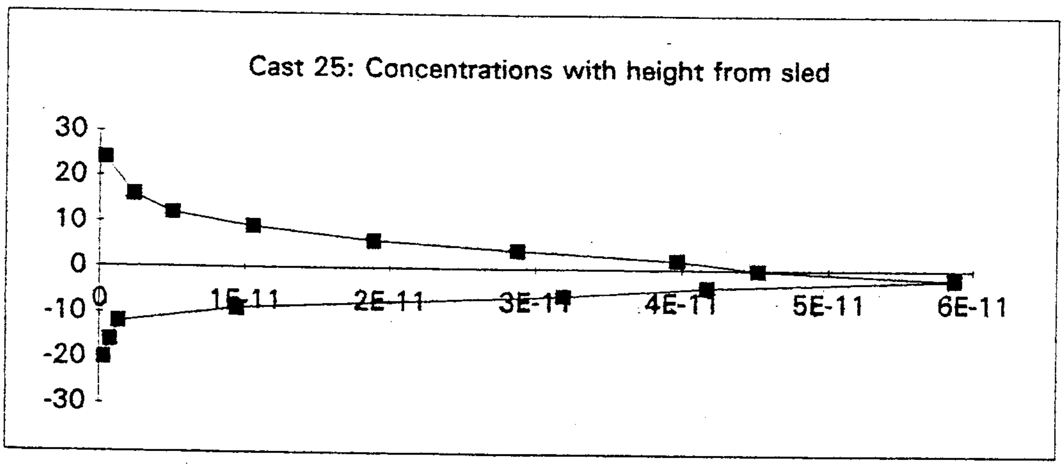
Depth	Water conc	Memories	Final Concn	Height above sled	carousel: posn	concn
30						
24	2.092E-13	1.26E-14	2.2175E-13	24	1	9.04E-12
20	1.238E-12	7.43E-14	1.3123E-12	20	2	2.61E-12
16	2.439E-12	6.43E-14	2.5033E-12	16	3	2.90E-13
12	4.944E-12	2.97E-13	5.2406E-12	12	4	1.60E-13
9	7.887E-12	4.73E-13	8.3602E-12	9		
6	2.067E-11	1.24E-12	2.191E-11	6	6	1.58E-11
4	3.033E-11	1.82E-12	3.215E-11	4	7	4.90E-11
2	3.532E-11	2.12E-12	3.7439E-11	2		
0	3.71E-11	2.23E-12	3.9326E-11	0		
-2	3.438E-11	1.49E-12	3.5866E-11	-2	10	2.47E-11
-4	2.925E-11	1.5E-12	3.0746E-11	-4	11	1.42E-11
-6	2.416E-11	1.45E-12	2.561E-11	-6		
-9	1.848E-11	1.11E-12	1.9589E-11	-9	13	7.43E-11
-12	1.556E-11	9.34E-13	1.6494E-11	-12	14	1.02E-10
-16	7.603E-12	4.56E-13	8.0592E-12	-16	15	1.00E-10
-20	2.713E-12	9.45E-14	2.8075E-12	-20	16	5.35E-11
-24	3.487E-13	2.09E-14	3.6962E-13	-24	17	5.69E-12
-30						

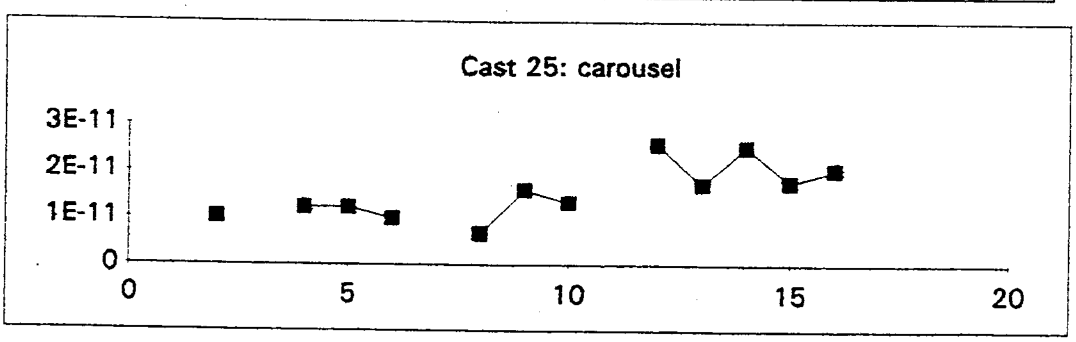




Cast 25: Concentrations adjusted for memory and carousel

Depth	Water conc	Memories	Final Concn	Height above sled	Carousel: Posn	Concn
30						
24	3.065E-13	1.84E-14	3.2489E-13	24	2	1.02E-11
20				20		
16	2.227E-12	1.32E-13	2.3588E-12	16	4	1.23E-11
12	4.868E-12	1.57E-13	5.0249E-12	12	5	1.23E-11
9	1.0006E-11	5.21E-13	1.0526E-11	9	6	9.81E-12
6	1.816E-11	7.37E-13	1.8897E-11	6		
4	2.7255E-11	1.48E-12	2.8731E-11	4	8	6.58E-12
2	3.742E-11	2.22E-12	3.9639E-11	2	9	1.60E-11
0	4.231E-11	2.82E-12	4.5127E-11	0	10	1.32E-11
-2	5.6E-11	2.68E-12	5.868E-11	-2		
-4	3.9965E-11	1.71E-12	4.167E-11	-4	12	2.58E-11
-6	3.006E-11	1.8E-12	3.1864E-11	-6	13	1.72E-11
-9	8.924E-12	5.35E-13	9.4594E-12	-9	14	2.51E-11
-12	1.148E-12	1.54E-13	1.3015E-12	-12	15	1.76E-11
-16	7.165E-13	4.3E-14	7.5949E-13	-16	16	2.02E-11
-20	2.812E-13	1.69E-14	2.9807E-13	-20		
-24				-24		
-30						

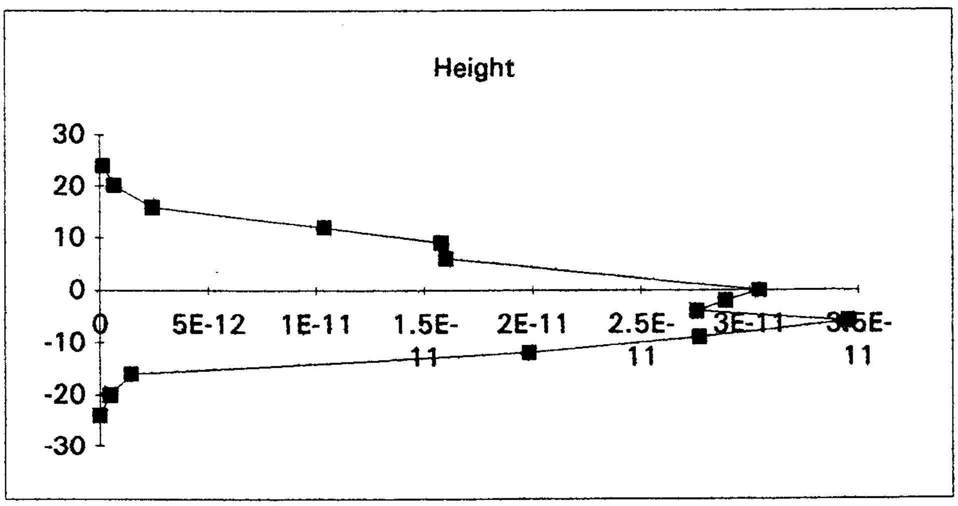


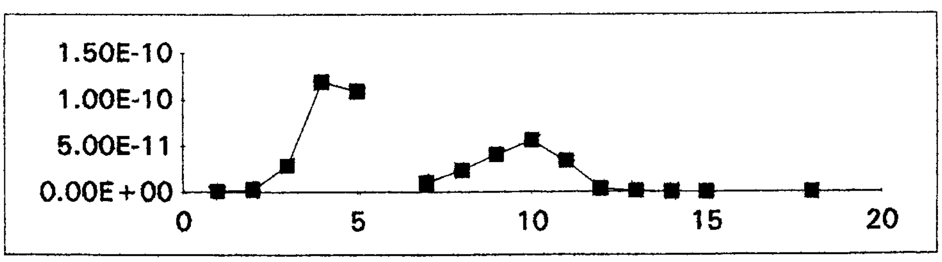


Cast 26: Concentrations adjusted for memory and carousel

Depth	Water conc	Memories	Final Concn	Height
30				
24	1.439E-13	8.634E-15	1.5253E-13	24
20	6.35E-13	3.81E-14	6.731E-13	20
16	2.31E-12	1.386E-13	2.4486E-12	16
12	9.795E-12	5.877E-13	1.0383E-11	12
9	1.53E-11	4.908E-13	1.5791E-11	9
6	1.529E-11	7.147E-13	1.6005E-11	6
4				4
2				2
0	2.9305E-11	1.132E-12	3.0437E-11	0
-2	2.783E-11	1.087E-12	2.8917E-11	-2
-4	2.6E-11	1.56E-12	2.756E-11	-4
-6	3.258E-11	1.955E-12	3.4535E-11	-6
-9	2.652E-11	1.168E-12	2.7688E-11	-9
-12	1.907E-11	7.465E-13	1.9817E-11	-12
-16	1.378E-12	8.268E-14	1.4607E-12	-16
-20	4.473E-13	2.684E-14	4.7414E-13	-20
-24	0	0	0	-24
-30				-30

Carousel Posn	Concn
1	5.98E-13
2	2.52E-12
3	2.85E-11
4	1.20E-10
4	1.20E-10
5	1.09E-10
7	9.96E-12
8	2.37E-11
9	4.11E-11
10	5.57E-11
11	3.36E-11
12	3.91E-12
13	6.05E-13
14	7.12E-14
15	6.94E-14
18	0.00E+00

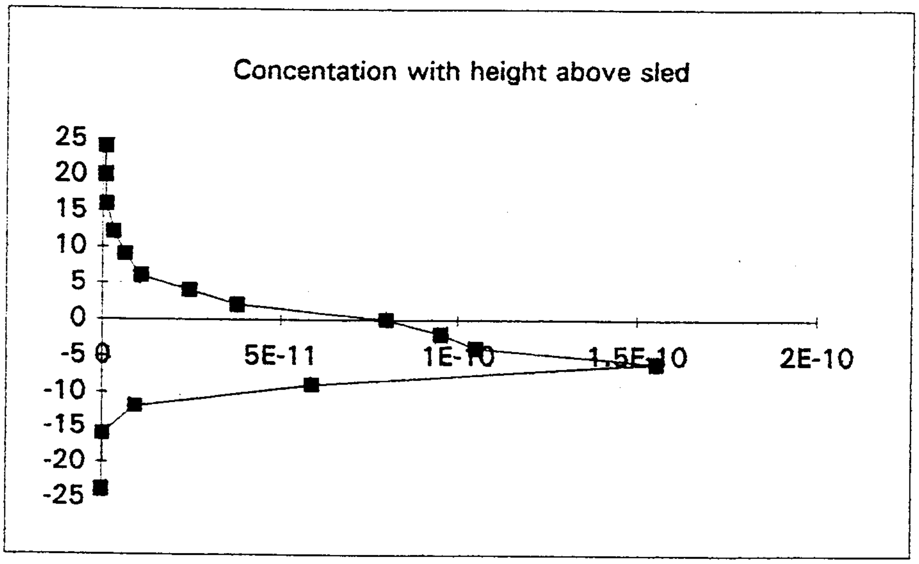


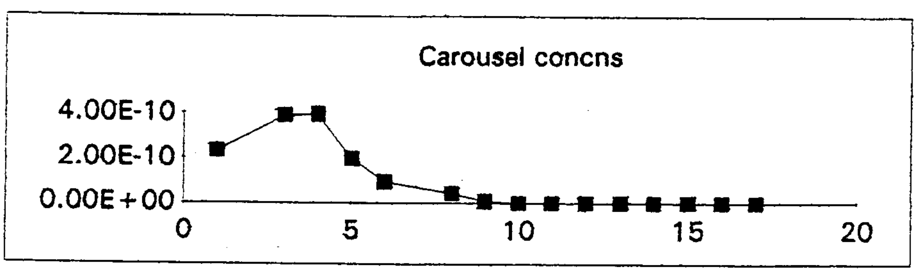


Cast 27: Concentrations adjusted for memory and Carousel

Depth	Water conc	Memories	Final Concn	Height above sled
24	5.84E-13	3.5E-14	6.19E-13	24
20	5.77E-13	3.46E-14	6.11E-13	20
16	9E-13	5.4E-14	9.54E-13	16
12	2.85E-12	2.29E-13	3.07E-12	12
9	6.05E-12	2.65E-13	6.32E-12	9
6	1.03E-11	4.39E-13	1.07E-11	6
4	2.34E-11	8.82E-13	2.43E-11	4
2	3.63E-11	1.46E-12	3.77E-11	2
0	7.75E-11	2.16E-12	7.97E-11	0
-2	9.07E-11	4.61E-12	9.53E-11	-2
-4	1E-10	5.17E-12	1.05E-10	-4
-6	1.5E-10	5.8E-12	1.56E-10	-6
-9	5.7E-11	1.83E-12	5.88E-11	-9
-12	8.86E-12	3.11E-13	9.17E-12	-12
-16	1.14E-13	6.84E-15	1.21E-13	-16
-20				-20
-24	0	0	0	-24
-30			0	-30

Carousel Posn	Concn
1	2.32E-10
3	3.90E-10
4	3.93E-10
5	1.97E-10
6	9.55E-11
8	4.39E-11
9	8.69E-12
10	0.00E+00
11	0.00E+00
12	0.00E+00
13	0.00E+00
14	0.00E+00
15	0.00E+00
16	0.00E+00
17	0.00E+00



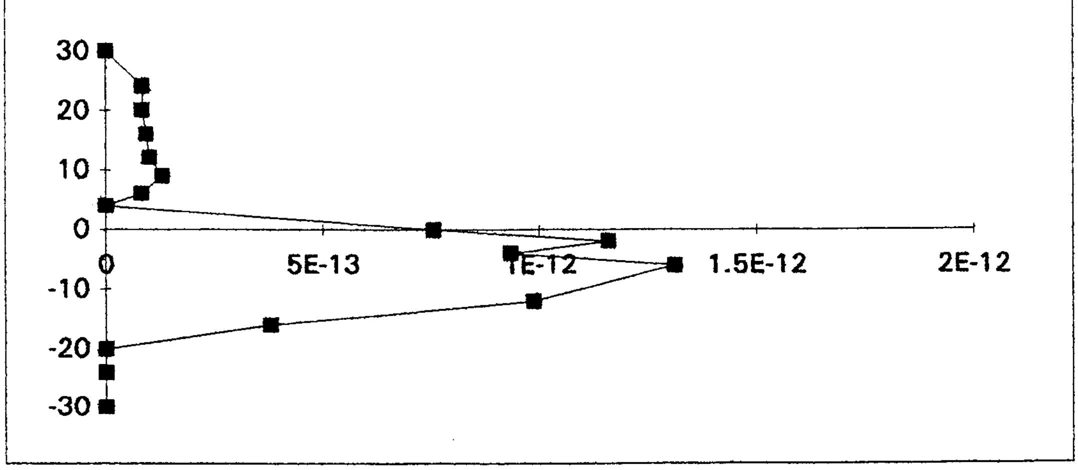


Cast 29: concentrations adjusted form memory and carousel

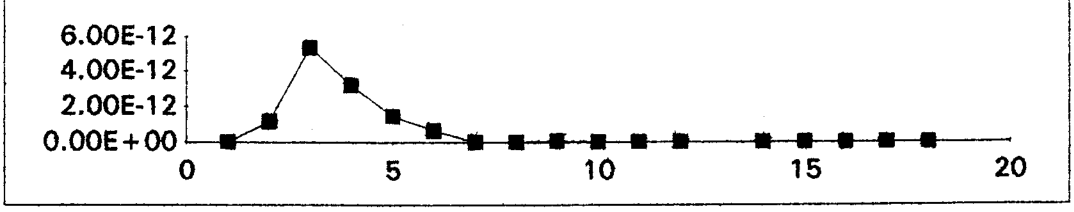
Depth	Water conc	Memories	Final Concn	Height above sled
30	0	0	0	30
24	7.937E-14	4.76E-15	8.413E-14	24
20	7.952E-14	4.77E-15	8.429E-14	20
16	8.766E-14	5.26E-15	9.292E-14	16
12	9.473E-14	5.68E-15	1.004E-13	12
9	1.225E-13	7.35E-15	1.299E-13	9
6	7.7E-14	4.62E-15	8.162E-14	6
4	0	0	0	4
2				2
0	7.123E-13	4.27E-14	7.55E-13	0
-2	1.094E-12	6.56E-14	1.16E-12	-2
-4	8.805E-13	5.28E-14	9.333E-13	-4
-6	1.238E-12	7.43E-14	1.312E-12	-6
-9				-9
-12	9.317E-13	5.59E-14	9.876E-13	-12
-16	3.571E-13	2.14E-14	3.785E-13	-16
-20	0	0	0	-20
-24	0	0	0	-24
-30	0	0	0	-30

Carousel:

Posn	Concn
1	0.00E+00
2	1.11E-12
3	5.34E-12
4	3.19E-12
5	1.46E-12
6	6.39E-13
7	0.00E+00
8	0.00E+00
9	8.30E-14
10	0.00E+00
11	0.00E+00
12	0.00E+00
14	0.00E+00
15	0.00E+00
16	0.00E+00
17	0.00E+00
18	0.00E+00



Cast 29: Concentration with height above sled

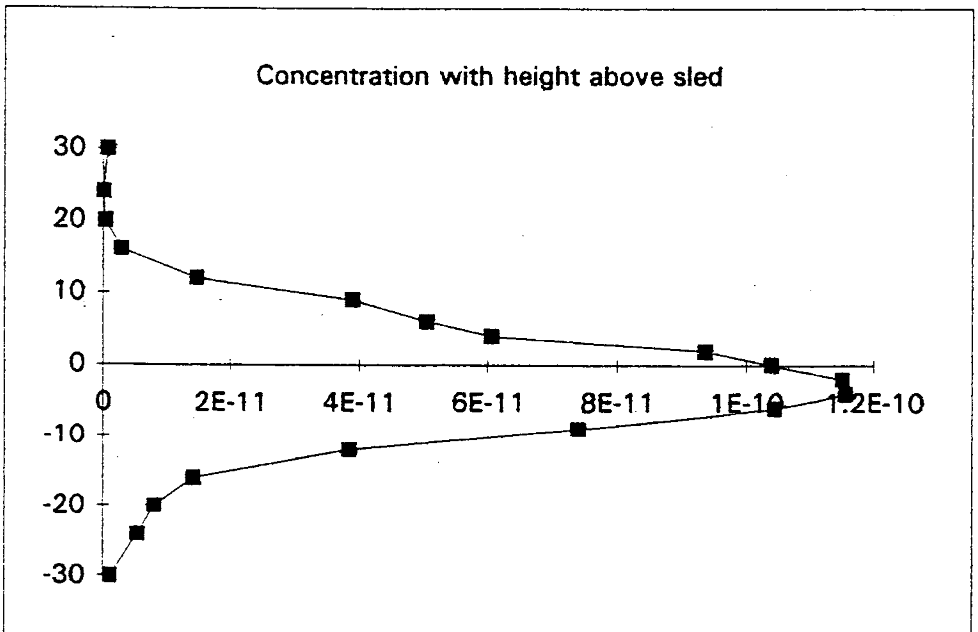


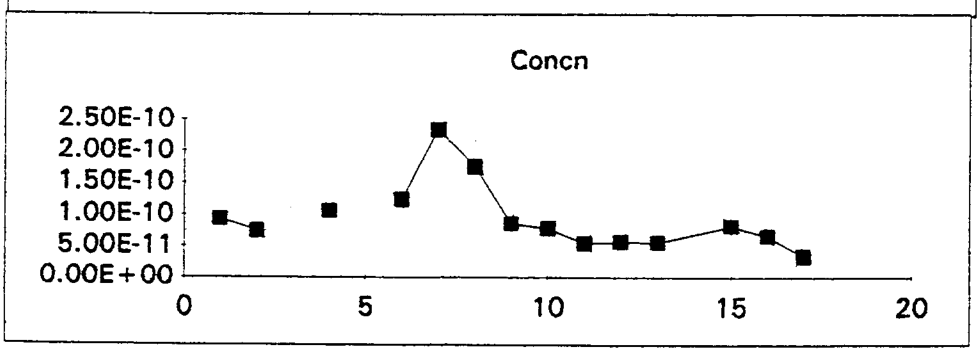
Cast 29: carousel

Cast 30: Concentrations corrected for memory and carousel.

Depth	Water conc	Memories	Final Concn	Height above sled
30	5.164E-13	1.21E-13	6.373E-13	30
24	8.116E-14	4.87E-15	8.603E-14	24
20	2.628E-13	1.58E-14	2.7857E-13	20
16	2.759E-12	9.52E-14	2.8542E-12	16
12	1.42E-11	4.83E-13	1.4683E-11	12
9	3.761E-11	1.48E-12	3.9088E-11	9
6	4.83E-11	2.25E-12	5.0545E-11	6
4	5.805E-11	2.62E-12	6.0671E-11	4
2	9.048E-11	3.12E-12	9.3599E-11	2
0	9.956E-11	4.35E-12	1.0391E-10	0
-2	1.086E-10	6.52E-12	1.1512E-10	-2
-4	1.091E-10	6.55E-12	1.1565E-10	-4
-6	9.856E-11	5.91E-12	1.0447E-10	-6
-9	7.073E-11	3.33E-12	7.4065E-11	-9
-12	3.701E-11	1.44E-12	3.845E-11	-12
-16	1.353E-11	5.95E-13	1.4125E-11	-16
-20	7.727E-12	3.21E-13	8.0475E-12	-20
-24	5.107E-12	1.66E-13	5.273E-12	-24
-30	1.019E-12	6.11E-14	1.0801E-12	-30

Carousel Posn	Concn
1	9.38E-11
2	7.48E-11
4	1.06E-10
6	1.24E-10
7	2.35E-10
8	1.75E-10
9	8.59E-11
10	7.71E-11
11	5.47E-11
12	5.64E-11
13	5.54E-11
15	8.20E-11
16	6.50E-11
17	3.45E-11

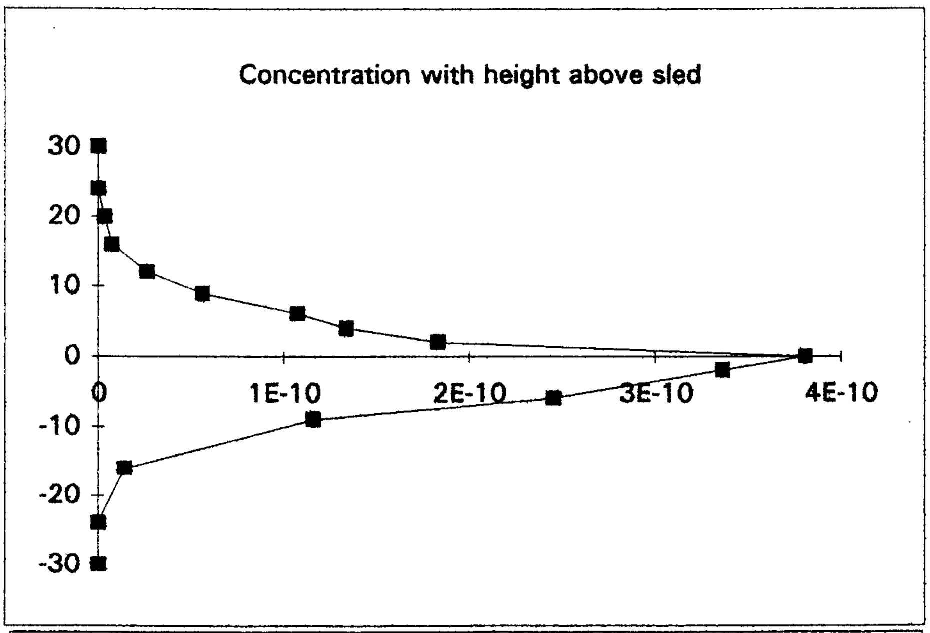


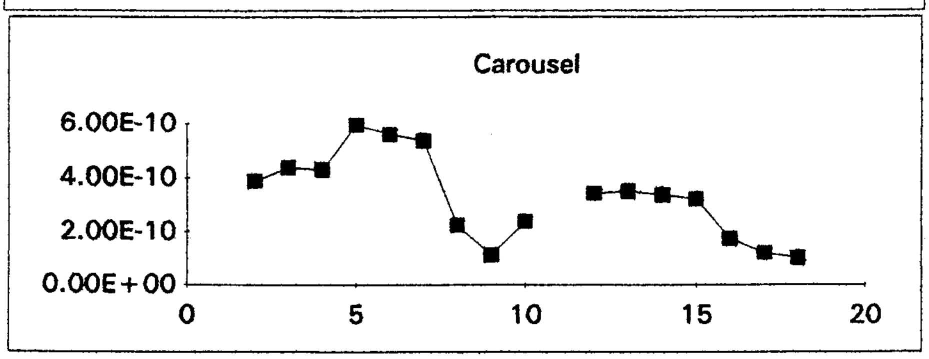


Cast 31: Concentrations corrected for memory and carousel

Depth	Water conc	Memories	Final Concn	Height above sled
30	0	0	0	30
24	0	0	0	24
20	3.14E-12	1.89E-13	3.33E-12	20
16	7.02E-12	4.21E-13	7.44E-12	16
12	2.48E-11	1.49E-12	2.63E-11	12
9	5.28E-11	3.17E-12	5.6E-11	9
6	1.04E-10	3.39E-12	1.08E-10	6
4	1.26E-10	7.42E-12	1.34E-10	4
2	1.73E-10	1.02E-11	1.83E-10	2
0	3.37E-10	4.35E-11	3.81E-10	0
-2	3.18E-10	1.85E-11	3.36E-10	-2
-4				-4
-6	2.33E-10	1.25E-11	2.45E-10	-6
-9	1.11E-10	4.48E-12	1.16E-10	-9
-12	0	0		-12
-16	1.32E-11	7.92E-13	1.4E-11	-16
-20				-20
-24	0	0	0	-24
-30	0	0	0	-30

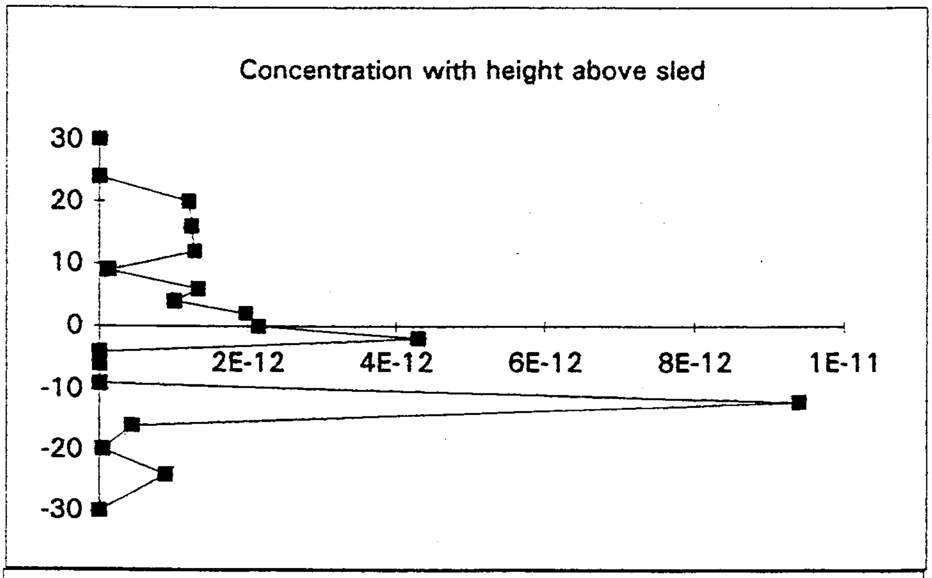
Carousel: Posn	Carousel
2	3.88E-10
3	4.38E-10
4	4.27E-10
5	5.95E-10
6	5.59E-10
7	5.37E-10
8	2.24E-10
9	1.14E-10
10	2.38E-10
12	3.42E-10
13	3.50E-10
14	3.36E-10
15	3.21E-10
16	1.73E-10
17	1.20E-10
18	1.02E-10

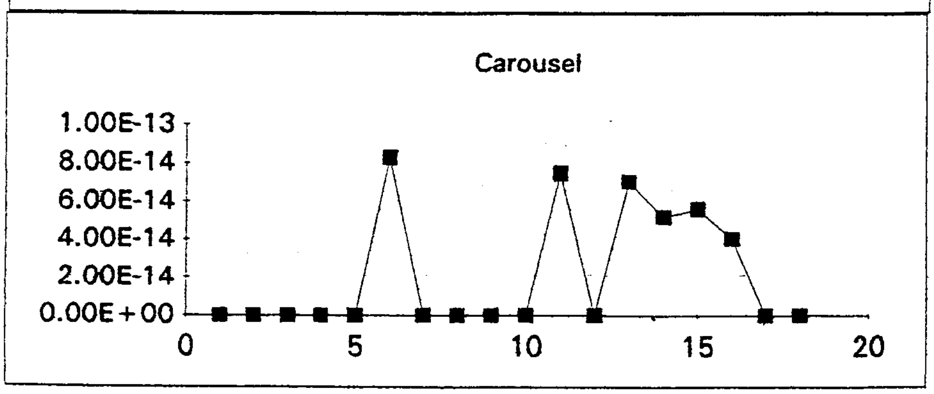




Cast 32: Concentrations adjusted for memory and carousel

Depth	Water conc	Memories	Final Concn	Height above sled	Carousel Posn	Carousel
30	0	0	0	30	1	0.00E+00
24	0	0	0	24	2	0.00E+00
20	1.13E-12	6.77E-14	1.2E-12	20	3	0.00E+00
16	1.16E-12	6.97E-14	1.23E-12	16	4	0.00E+00
12	1.23E-12	4.53E-14	1.27E-12	12	5	0.00E+00
9	1.15E-13	6.9E-15	1.22E-13	9	6	8.31E-14
6	1.26E-12	7.53E-14	1.33E-12	6	7	0.00E+00
4	9.74E-13	3.33E-14	1.01E-12	4	8	0.00E+00
2	1.91E-12	6.45E-14	1.97E-12	2	9	0.00E+00
0	1.52E-12	6.28E-13	2.15E-12	0	10	0.00E+00
-2	4.19E-12	1.22E-13	4.31E-12	-2	11	7.50E-14
-4	0	0	0	-4	12	0.00E+00
-6	0	0	0	-6	13	7.02E-14
-9	0	0	0	-9	14	5.18E-14
-12	9.01E-12	3.84E-13	9.4E-12	-12	15	5.59E-14
-16	4.1E-13	2.46E-14	4.34E-13	-16	16	4.05E-14
-20	4.56E-14	2.74E-15	4.83E-14	-20	17	0.00E+00
-24	8.38E-13	5.03E-14	8.88E-13	-24	18	0.00E+00
-30	0	0	0	-30		



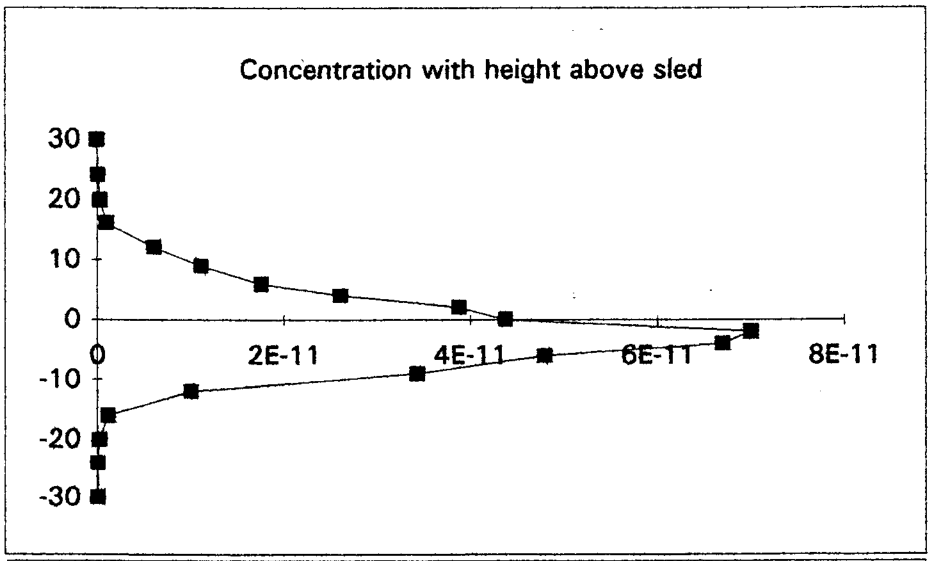


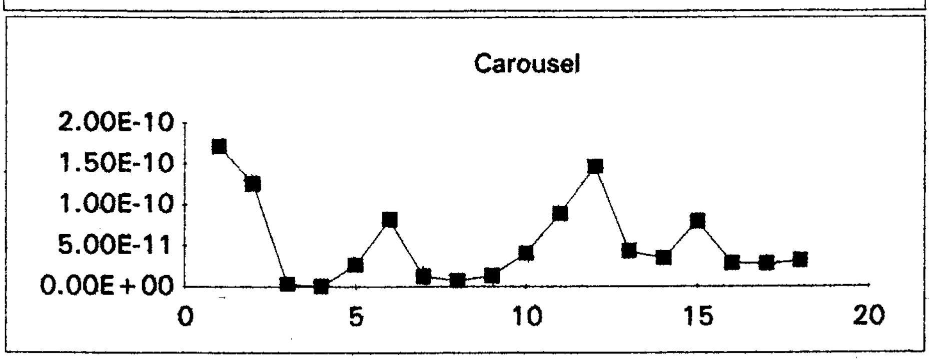
Cast 33: Concentratiions adjusted for memory and carousel

Depth	Water conc	Memories	Final Concn	Height above sled
30	0	0	0	30
24	8.85E-14	5.31E-15	9.38E-14	24
20	2.95E-13	1.77E-14	3.13E-13	20
16	9.57E-13	9.24E-14	1.05E-12	16
12	5.78E-12	2.85E-13	6.07E-12	12
9	1.06E-11	5.37E-13	1.12E-11	9
6	1.7E-11	6.18E-13	1.76E-11	6
4	2.48E-11	1.28E-12	2.61E-11	4
2	3.73E-11	1.49E-12	3.88E-11	2
0	4.19E-11	1.86E-12	4.38E-11	0
-2	6.76E-11	2.44E-12	7E-11	-2
-4	6.39E-11	3.19E-12	6.71E-11	-4
-6	4.56E-11	2.4E-12	4.8E-11	-6
-9	3.24E-11	1.95E-12	3.44E-11	-9
-12	9.49E-12	5.7E-13	1.01E-11	-12
-16	1.14E-12	6.86E-14	1.21E-12	-16
-20	1.96E-13	1.18E-14	2.08E-13	-20
-24	7.23E-14	4.34E-15	7.66E-14	-24
-30	6.72E-14	4.03E-15	7.12E-14	-30

Carousel:

Posn	Concn
1	1.71E-10
2	1.26E-10
3	2.75E-12
4	0.00E+00
5	2.63E-11
6	8.15E-11
7	1.22E-11
8	6.48E-12
9	1.26E-11
10	4.01E-11
11	8.85E-11
12	1.46E-10
13	4.22E-11
14	3.44E-11
15	7.88E-11
16	2.83E-11
17	2.71E-11
18	3.11E-11



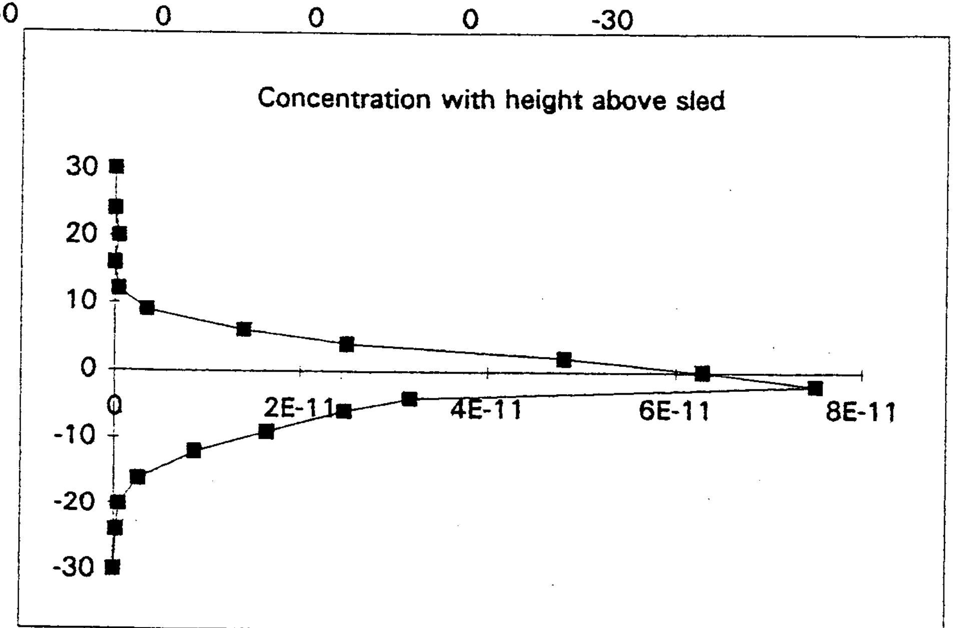


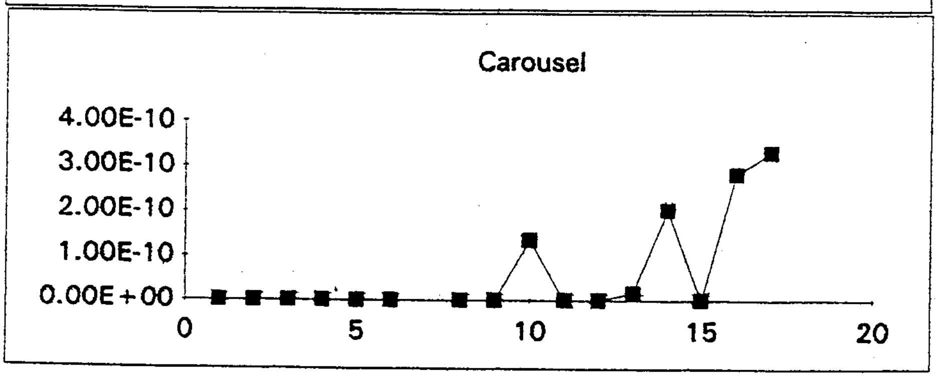
Cast 34: concentrations adjusted for memory and carousel

Depth	Water conc	Memories	Final Concn	Height above sled
30	0	0	0	30
24	0	0	0	24
20	4.42E-13	2.65E-14	4.68E-13	20
16	4.74E-14	2.85E-15	5.03E-14	16
12	4.31E-13	2.58E-14	4.56E-13	12
9	3.3E-12	1.98E-13	3.5E-12	9
6	1.34E-11	5.53E-13	1.4E-11	6
4	2.38E-11	1.22E-12	2.5E-11	4
2	4.57E-11	2.42E-12	4.81E-11	2
0	6.04E-11	2.5E-12	6.29E-11	0
-2	7.25E-11	2.49E-12	7.5E-11	-2
-4	3.07E-11	1.02E-12	3.18E-11	-4
-6	2.37E-11	1.01E-12	2.47E-11	-6
-9	1.55E-11	9.02E-13	1.64E-11	-9
-12	8.18E-12	4.91E-13	8.67E-12	-12
-16	2.42E-12	1.45E-13	2.57E-12	-16
-20	4.93E-13	2.96E-14	5.23E-13	-20
-24	3.12E-13	1.87E-14	3.31E-13	-24
-30	0	0	0	-30

Carousel:

Posn	Concn
1	0.00E+00
2	2.31E-13
3	2.26E-13
4	1.88E-13
5	1.20E-13
6	1.37E-13
8	1.33E-13
9	2.60E-13
10	1.36E-10
11	1.79E-13
12	2.12E-13
13	1.74E-11
14	2.04E-10
15	0.00E+00
16	2.83E-10
17	3.33E-10



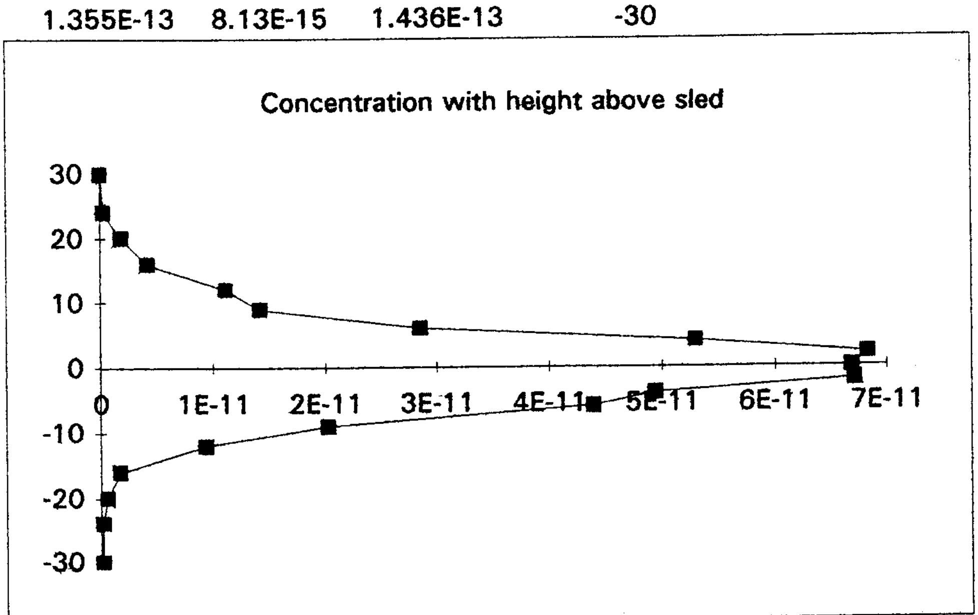


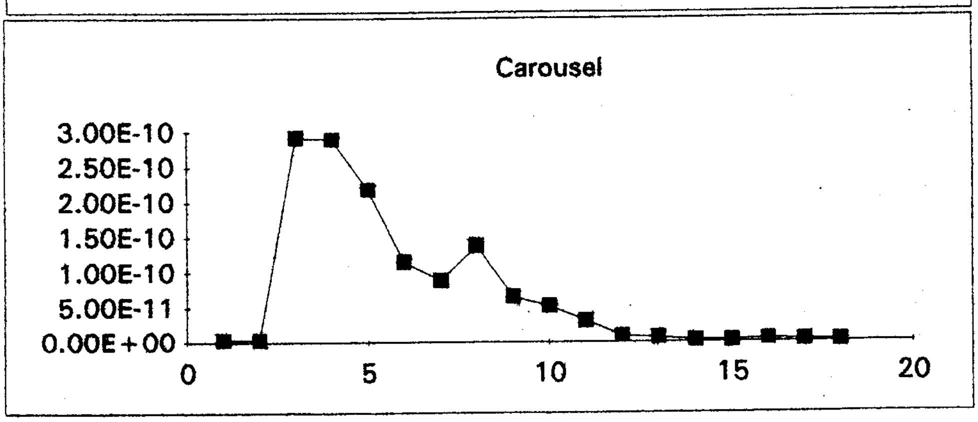
Cast 36: Concentrations adjusted for memory and carousel

Depth	Water conc	Memories	Final Concn	Height above sled
30	0	0	0	30
24	2.399E-13	1.44E-14	2.543E-13	24
20	1.742E-12	1.05E-13	1.847E-12	20
16	3.951E-12	2.37E-13	4.188E-12	16
12	1.046E-11	7.06E-13	1.117E-11	12
9	1.338E-11	7.94E-13	1.417E-11	9
6	2.724E-11	1.27E-12	2.851E-11	6
4	5.05E-11	2.47E-12	5.297E-11	4
2	6.497E-11	3.31E-12	6.828E-11	2
0	6.3825E-11	3.09E-12	6.692E-11	0
-2	6.352E-11	3.54E-12	6.706E-11	-2
-4	4.645E-11	2.95E-12	4.94E-11	-4
-6	4.1725E-11	2.15E-12	4.388E-11	-6
-9	1.93E-11	9.31E-13	2.023E-11	-9
-12	8.996E-12	3.64E-13	9.36E-12	-12
-16	1.628E-12	9.77E-14	1.726E-12	-16
-20	5.347E-13	3.21E-14	5.668E-13	-20
-24	1.374E-13	8.24E-15	1.456E-13	-24
-30	1.355E-13	8.13E-15	1.436E-13	-30

Carousel:

Posn	Concn
1	3.27E-12
2	3.32E-12
3	2.91E-10
4	2.89E-10
5	2.18E-10
6	1.15E-10
7	8.87E-11
8	1.38E-10
9	6.52E-11
10	5.12E-11
11	3.07E-11
12	9.09E-12
13	6.36E-12
14	2.69E-12
15	2.99E-12
16	4.46E-12
17	3.46E-12
18	2.14E-12



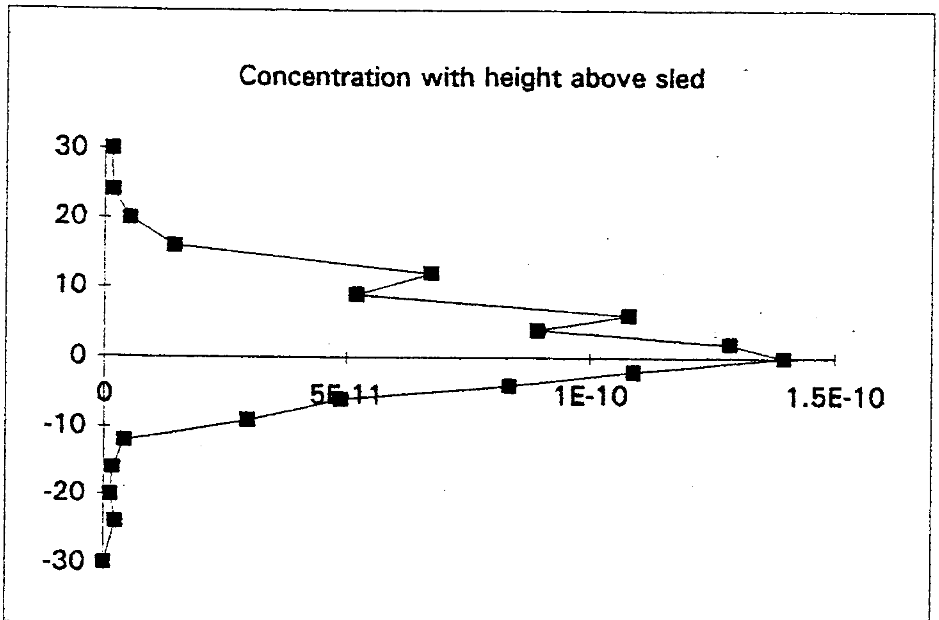


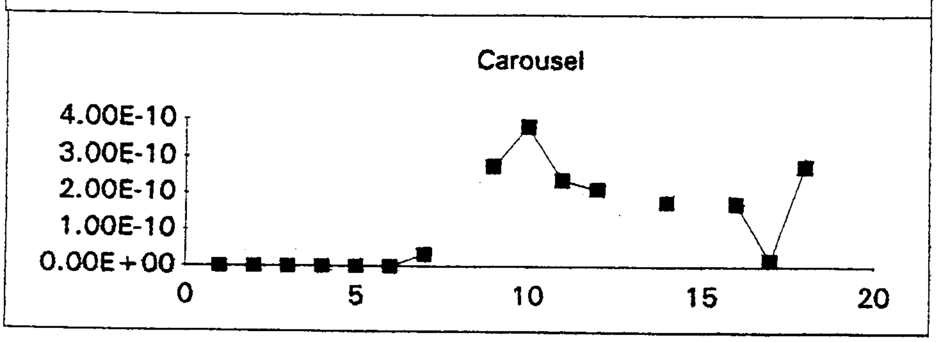
Cast 37: Concentrations adjusted for memory and carousel

Depth	Water conc	Memories	Final Concn	Height above sled
30	1.38E-12	8.3E-14	1.47E-12	30
24	1.49E-12	8.95E-14	1.58E-12	24
20	4.97E-12	2.98E-13	5.27E-12	20
16	1.36E-11	8.17E-13	1.44E-11	16
12	6.36E-11	3.81E-12	6.74E-11	12
9	4.9E-11	2.94E-12	5.2E-11	9
6	1.02E-10	6.1E-12	1.08E-10	6
4	8.44E-11	5.06E-12	8.94E-11	4
2	1.21E-10	7.27E-12	1.28E-10	2
0	1.32E-10	7.9E-12	1.39E-10	0
-2	1.03E-10	6.16E-12	1.09E-10	-2
-4	7.89E-11	4.73E-12	8.36E-11	-4
-6	4.62E-11	2.77E-12	4.9E-11	-6
-9	2.8E-11	1.68E-12	2.97E-11	-9
-12	3.93E-12	2.36E-13	4.17E-12	-12
-16	1.83E-12	1.1E-13	1.94E-12	-16
-20	1.25E-12	7.49E-14	1.32E-12	-20
-24	2.25E-12	1.35E-13	2.39E-12	-24
-30	7.41E-14	4.45E-15	7.85E-14	-30

Carousel:

Posn	Concn
1	0.00E+00
2	0.00E+00
3	0.00E+00
4	0.00E+00
5	0.00E+00
6	0.00E+00
7	3.37E-11
9	2.73E-10
10	3.82E-10
11	2.36E-10
12	2.11E-10
14	1.76E-10
16	1.71E-10
17	1.69E-11
18	2.75E-10

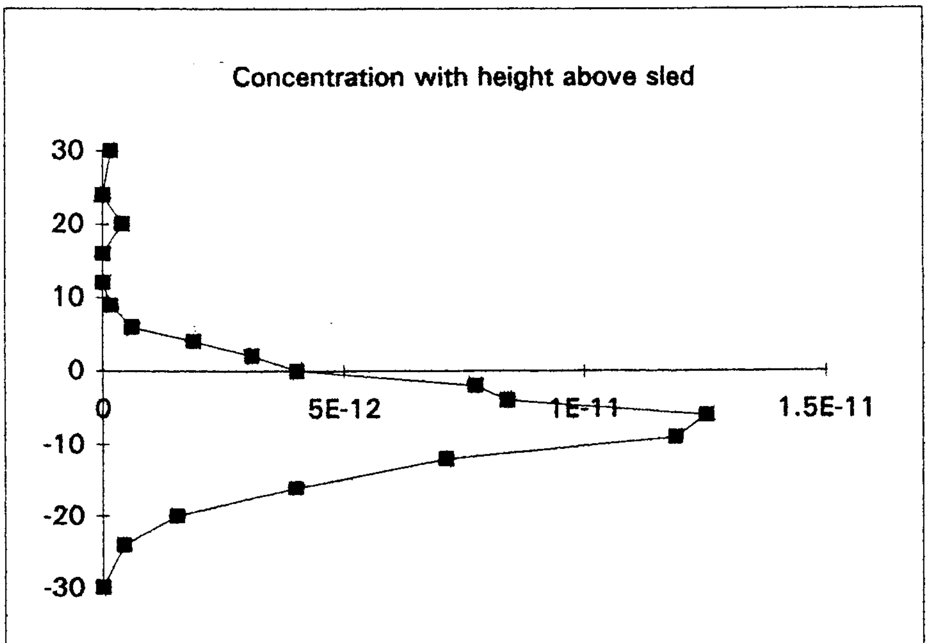


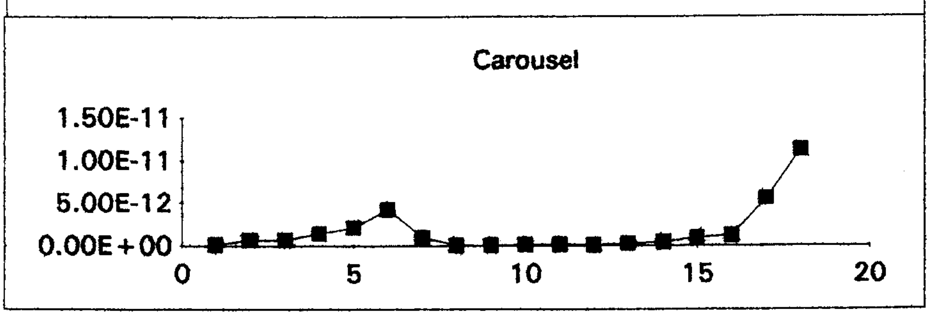


Cast 43: Concentrations adjusted for memory and carousel

Depth	Water conc	Memories	Final Concn	Height above sled
30	1.65E-13	9.9E-15	1.75E-13	30
24	0	0	0	24
20	3.74E-13	2.24E-14	3.96E-13	20
16	0	0	0	16
12	0	0	0	12
9	1.65E-13	9.88E-15	1.75E-13	9
6	5.68E-13	3.41E-14	6.02E-13	6
4	1.83E-12	6.26E-14	1.89E-12	4
2	2.97E-12	1.28E-13	3.1E-12	2
0	3.84E-12	1.85E-13	4.03E-12	0
-2	7.51E-12	2.37E-13	7.75E-12	-2
-4	7.96E-12	4.45E-13	8.4E-12	-4
-6	1.19E-11	6.62E-13	1.25E-11	-6
-9	1.13E-11	6.15E-13	1.19E-11	-9
-12	6.8E-12	3.17E-13	7.12E-12	-12
-16	3.79E-12	2E-13	3.99E-12	-16
-20	1.47E-12	6.47E-14	1.53E-12	-20
-24	4.12E-13	2.47E-14	4.37E-13	-24
-30	0	0	0	-30

Carousel Posn	Concn
1	1.89E-13
2	7.19E-13
3	7.05E-13
4	1.48E-12
5	2.09E-12
6	4.31E-12
7	1.03E-12
8	9.35E-14
9	5.54E-14
10	1.53E-13
11	1.90E-13
12	1.36E-13
13	2.19E-13
14	4.58E-13
15	8.92E-13
16	1.21E-12
17	5.54E-12
18	1.13E-11

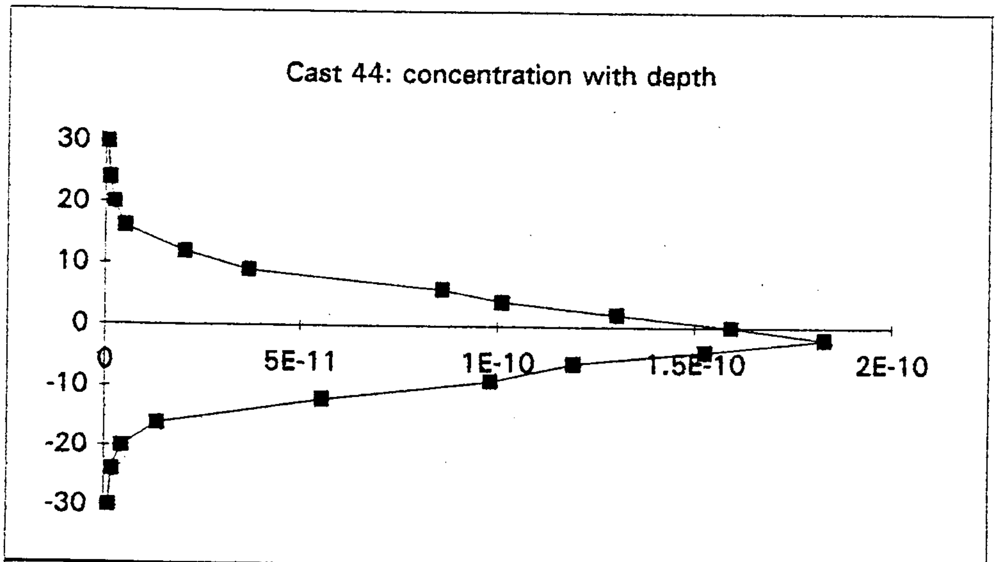


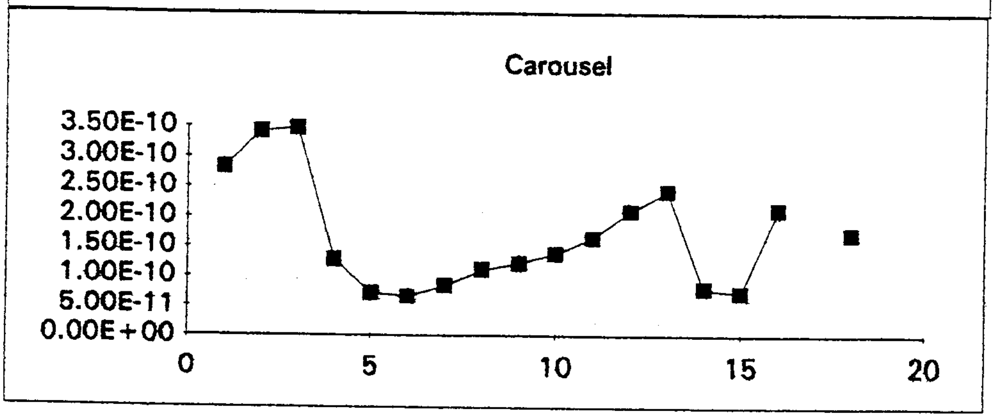


Cast 44: Concentrations adjusted for memory and carousel

Depth	Water conc	Memories	Final Concn	Depth
30	5.708E-13	3.42E-14	6.0505E-13	30
24	1.056E-12	6.34E-14	1.1194E-12	24
20	2.17E-12	8.1E-14	2.251E-12	20
16	4.805E-12	2.19E-13	5.0244E-12	16
12	1.945E-11	9.38E-13	2.0388E-11	12
9	3.674E-11	9.68E-14	3.6837E-11	9
6	8.373E-11	2.21E-12	8.5938E-11	6
4	9.91E-11	1.95E-12	1.0105E-10	4
2	1.281E-10	2.12E-12	1.3022E-10	2
0	1.55E-10	4.03E-12	1.5901E-10	0
-2	1.793E-10	3.49E-12	1.8279E-10	-2
-4	1.489E-10	3.66E-12	1.5256E-10	-4
-6	1.163E-10	2.88E-12	1.1918E-10	-6
-9	9.664E-11	1.56E-12	9.8199E-11	-9
-12	5.419E-11	1.29E-12	5.5475E-11	-12
-16	1.286E-11	5E-13	1.336E-11	-16
-20	3.992E-12	2.29E-13	4.2206E-12	-20
-24	1.661E-12	1.34E-13	1.7945E-12	-24
-30	1.003E-12	6.02E-14	1.0632E-12	-30

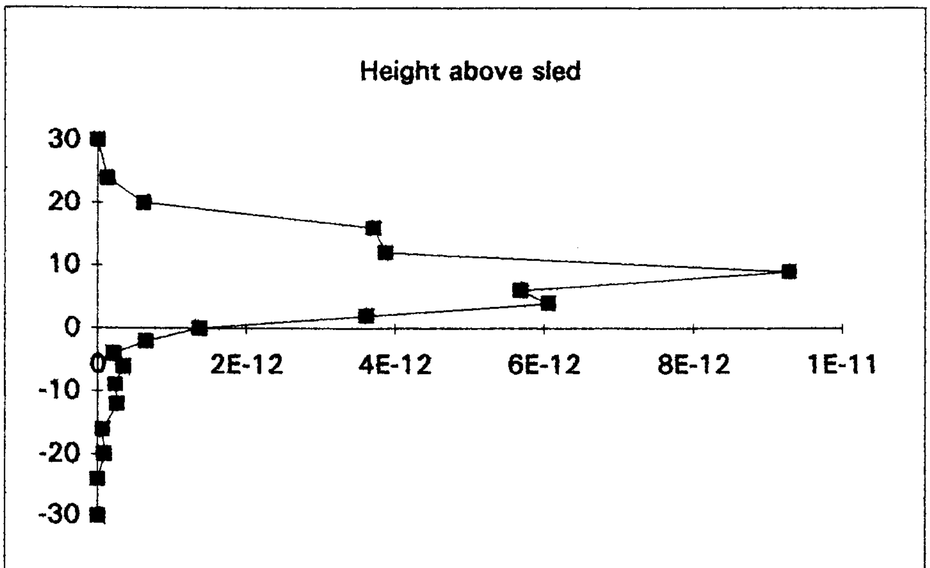
Posn	Carousel
1	2.83E-10
2	3.41E-10
3	3.46E-10
4	1.29E-10
5	7.14E-11
6	6.58E-11
7	8.43E-11
8	1.11E-10
9	1.23E-10
10	1.38E-10
11	1.65E-10
12	2.09E-10
13	2.43E-10
14	7.92E-11
15	7.26E-11
16	2.13E-10
18	1.72E-10

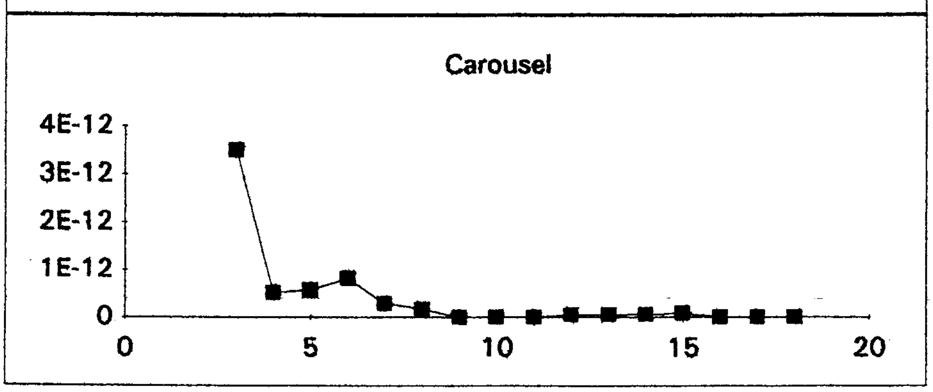




Cast 46: Concentrations adjusted for memory and carousel

Depth	Water conc	Memories	Final Concn	Height above sled	Posn	Carousel
30	0	0	0	30		
24	1.35E-13	8.11E-15	1.43E-13	24		
20	5.91E-13	3.54E-14	6.26E-13	20	3	3.51E-12
16	3.5E-12	2.1E-13	3.71E-12	16	4	5.13E-13
12	3.38E-12	4.92E-13	3.87E-12	12	5	5.64E-13
9	8.86E-12	4.3E-13	9.29E-12	9	6	8.12E-13
6	5.36E-12	3.18E-13	5.68E-12	6	7	2.87E-13
4	5.63E-12	4.3E-13	6.05E-12	4	8	1.66E-13
2	3.36E-12	2.51E-13	3.61E-12	2	9	0.00E+00
0	1.25E-12	1.22E-13	1.38E-12	0	10	0.00E+00
-2	6.21E-13	3.73E-14	6.59E-13	-2	11	0.00E+00
-4	2.15E-13	1.29E-14	2.28E-13	-4	12	4.51E-14
-6	3.26E-13	1.96E-14	3.46E-13	-6	13	5.08E-14
-9	2.29E-13	1.37E-14	2.43E-13	-9	14	6.47E-14
-12	2.54E-13	1.52E-14	2.69E-13	-12	15	7.29E-14
-16	7.27E-14	4.36E-15	7.71E-14	-16	16	0.00E+00
-20	8.9E-14	5.34E-15	9.44E-14	-20	17	0.00E+00
-24	0	0	0	-24	18	0.00E+00
-30	0	0	0	-30		



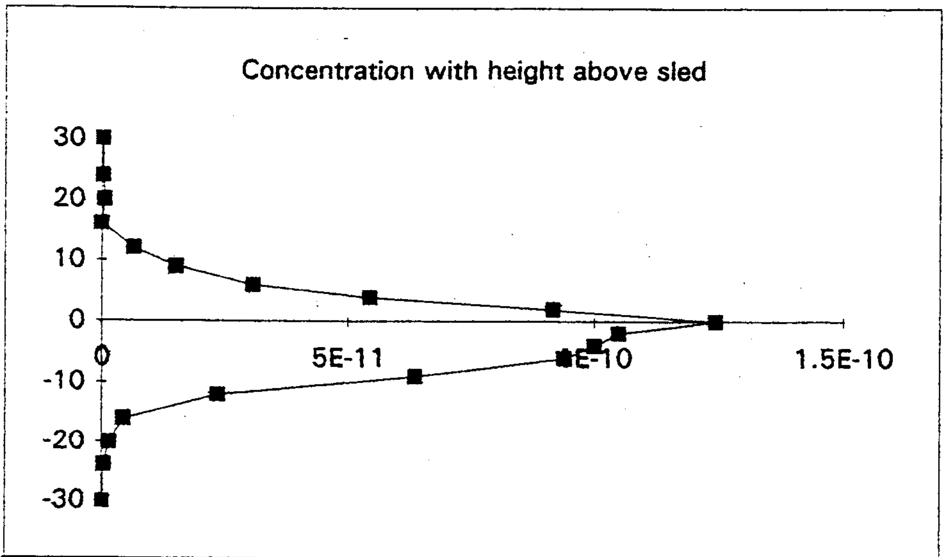


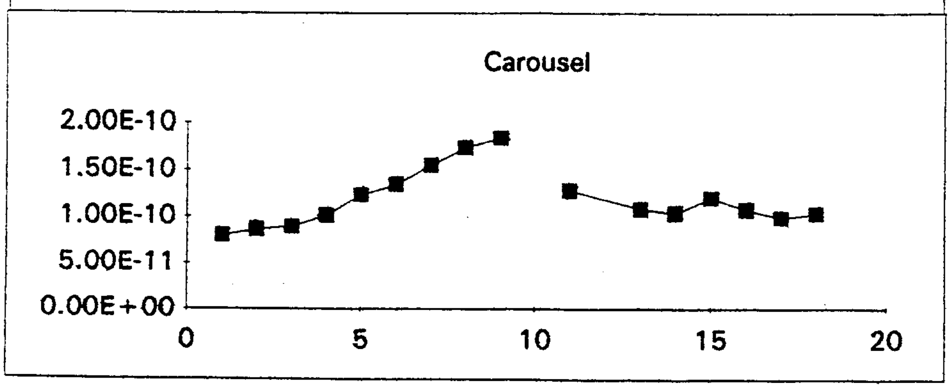
Cast 47: Concentrations adjusted for memory and carousel

Depth	Water conc	Memories	Final Concn	Height above sled
30	3.58E-13	2.15E-14	3.79E-13	30
24	2.46E-13	1.48E-14	2.61E-13	24
20	6.66E-13	3.99E-14	7.06E-13	20
16	0	0	0	16
12	6.19E-12	3.72E-13	6.56E-12	12
9	1.42E-11	8.5E-13	1.5E-11	9
6	2.89E-11	1.73E-12	3.06E-11	6
4	5.43E-11	0	5.43E-11	4
2	9.16E-11	0	9.16E-11	2
0	1.24E-10	5.25E-14	1.24E-10	0
-2	1.05E-10	0	1.05E-10	-2
-4	9.42E-11	5.65E-12	9.99E-11	-4
-6	8.86E-11	5.31E-12	9.39E-11	-6
-9	5.99E-11	3.6E-12	6.35E-11	-9
-12	2.21E-11	1.33E-12	2.35E-11	-12
-16	4.06E-12	2.43E-13	4.3E-12	-16
-20	1.48E-12	8.85E-14	1.56E-12	-20
-24	4.86E-13	2.91E-14	5.15E-13	-24
-30	1.77E-13	1.06E-14	1.88E-13	-30

Carousel concs

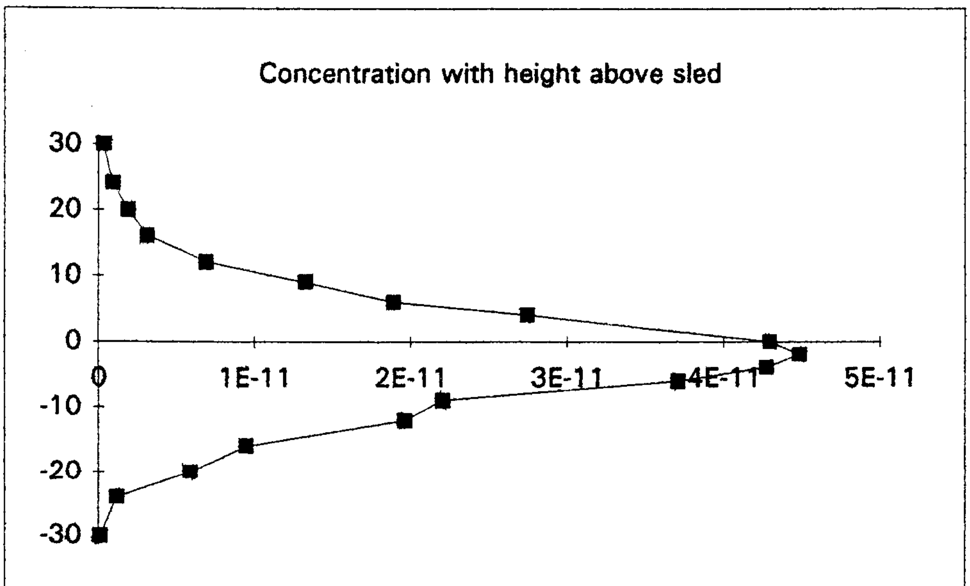
Posn	Carousel
1	7.97E-11
2	8.65E-11
3	8.91E-11
4	1.01E-10
5	1.24E-10
6	1.34E-10
7	1.56E-10
8	1.74E-10
9	1.84E-10
11	1.28E-10
13	1.08E-10
14	1.04E-10
15	1.20E-10
16	1.08E-10
17	9.87E-11
18	1.03E-10

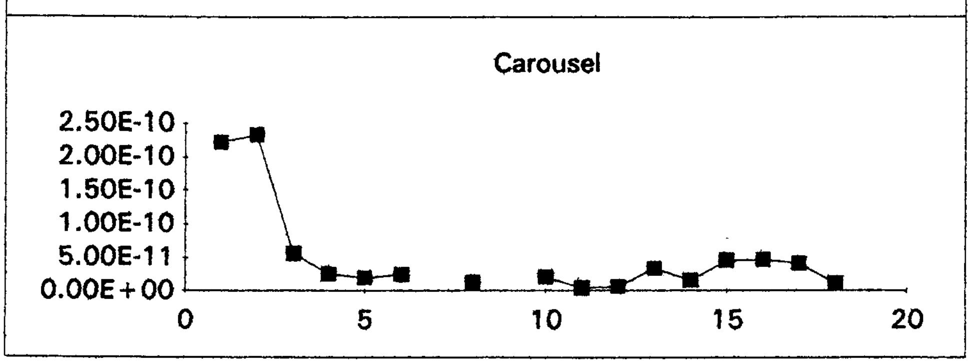




Cast 48: Concentrations adjusted for memory and carousel.

Depth	Water conc	Memories	Final Concn	Height above sled	Carousel Posn	Carousel
30	3.174E-13	1.9E-14	3.3644E-13	30	1	2.23E-10
24	8.599E-13	5.16E-14	9.1149E-13	24	2	2.32E-10
20	1.8E-12	7.84E-14	1.8784E-12	20	3	5.66E-11
16	2.913E-12	2.03E-13	3.1163E-12	16	4	2.54E-11
12	6.514E-12	3.91E-13	6.9048E-12	12	5	1.93E-11
9	1.226E-11	9.89E-13	1.3249E-11	9	6	2.38E-11
6	1.717E-11	1.76E-12	1.8925E-11	6		
4	2.407E-11	3.39E-12	2.7461E-11	4	8	1.29E-11
0	4.096E-11	1.95E-12	4.2912E-11	0		
-2	4.215E-11	2.64E-12	4.4793E-11	-2	10	2.05E-11
-4	4.043E-11	2.27E-12	4.2702E-11	-4	11	4.22E-12
-6	3.507E-11	2E-12	3.7072E-11	-6	12	6.34E-12
-9	2.064E-11	1.4E-12	2.2037E-11	-9	13	3.37E-11
-12	1.858E-11	1.04E-12	1.9623E-11	-12	14	1.53E-11
-16	8.963E-12	5.12E-13	9.4745E-12	-16	15	4.52E-11
-20	5.589E-12	2.83E-13	5.8717E-12	-20	16	4.67E-11
-24	1.114E-12	6.68E-14	1.1808E-12	-24	17	4.08E-11
-30	6.8845E-14	4.13E-15	7.2976E-14	-30	18	1.05E-11

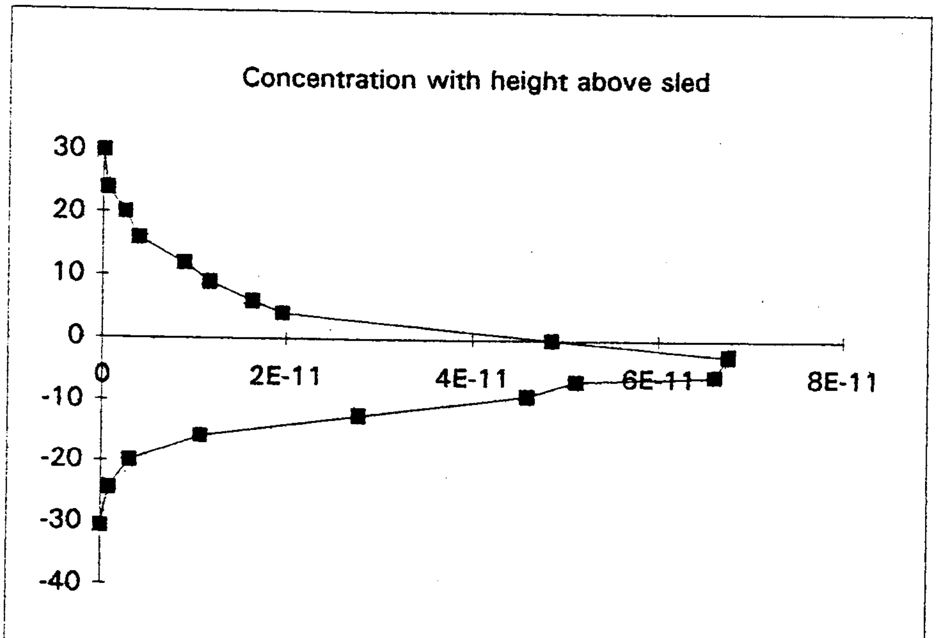


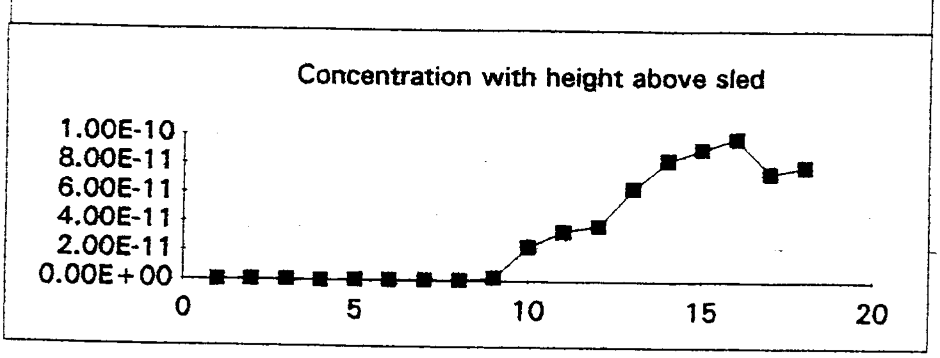


Cast 50: Concentrations adjusted for memory and carousel

Depth	Water conc	Memories	Final Concn	Height above sled
30	8.06E-14	4.84E-15	8.54E-14	30
24	5.03E-13	3.02E-14	5.33E-13	24
20	2.32E-12	1.39E-13	2.46E-12	20
16	3.74E-12	2.26E-13	3.96E-12	16
12	8.52E-12	3.9E-13	8.91E-12	12
9	1.11E-11	6.58E-13	1.17E-11	9
6	1.55E-11	8.87E-13	1.64E-11	6
4	1.84E-11	1.16E-12	1.96E-11	4
0	4.61E-11	2.44E-12	4.85E-11	0
-2	6.43E-11	3.22E-12	6.75E-11	-2.51
-4	6.27E-11	3.42E-12	6.61E-11	-5.69
-6	4.81E-11	3.07E-12	5.11E-11	-6.54
-9	4.33E-11	2.6E-12	4.59E-11	-9.04
-12	2.64E-11	1.52E-12	2.79E-11	-12.3
-16	1.02E-11	5.94E-13	1.08E-11	-15.66
-20	2.93E-12	1.76E-13	3.1E-12	-19.95
-24	7.75E-13	4.65E-14	8.21E-13	-24.42
-30	0	0	0	-30.62

Carousel Posn	Carousel
1	6.27E-14
2	3.98E-13
3	2.76E-13
4	1.40E-13
5	1.94E-13
6	2.52E-13
7	4.11E-13
8	1.91E-13
9	2.13E-12
10	2.32E-11
11	3.38E-11
12	3.79E-11
13	6.34E-11
14	8.28E-11
15	9.03E-11
16	9.81E-11
17	7.46E-11
18	7.89E-11





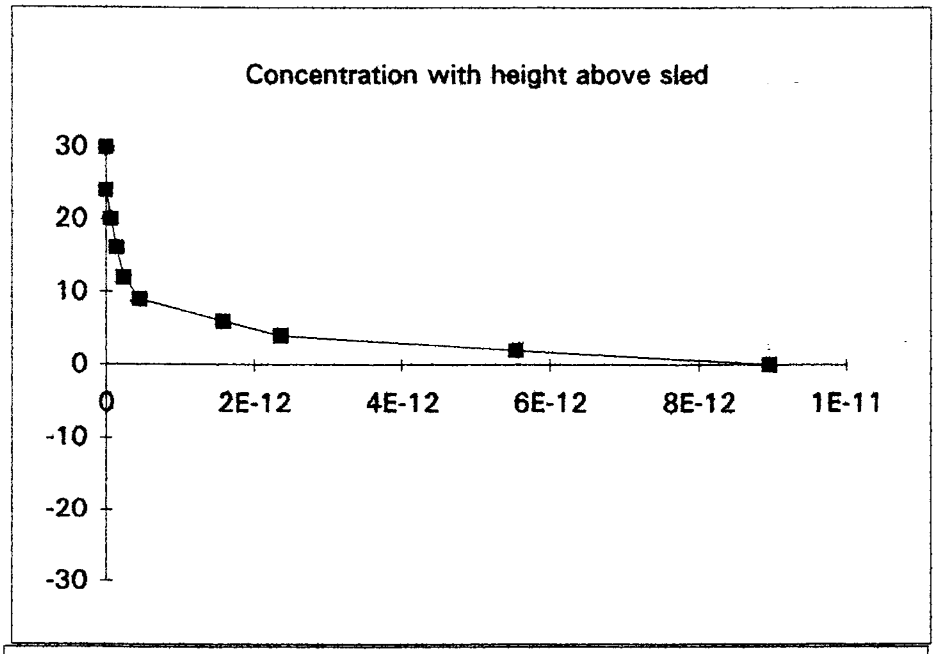
Cast 51: Concentrations adjusted for memory and carousel

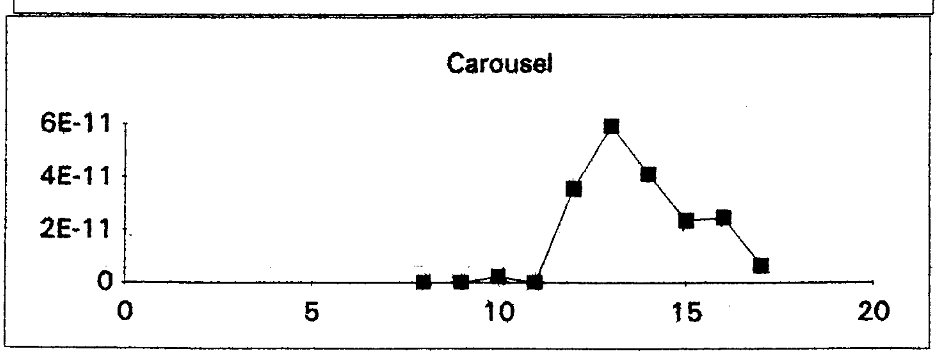
Bottom half of cast didn't trip

Depth	Water conc	Memories	Final Concn	Height above sled
30	0	0	0	30
24	0	0	0	24
20	6.27E-14	3.76E-15	6.64E-14	20
16	1.26E-13	7.58E-15	1.34E-13	16
12	2.24E-13	1.34E-14	2.37E-13	12
9	4.36E-13	2.61E-14	4.62E-13	9
6	1.51E-12	7.69E-14	1.59E-12	6
4	2.22E-12	1.43E-13	2.36E-12	4
2	5.23E-12	3.07E-13	5.54E-12	2
0	8.54E-12	4.11E-13	8.95E-12	0

Carousel

Posn	Carousel
1	
2	
3	
4	
5	
6	
7	
8	0.00E+00
9	0.00E+00
10	2.31E-12
11	0.00E+00
12	3.56E-11
13	5.92E-11
14	4.11E-11
15	2.35E-11
16	2.44E-11
17	6.57E-12



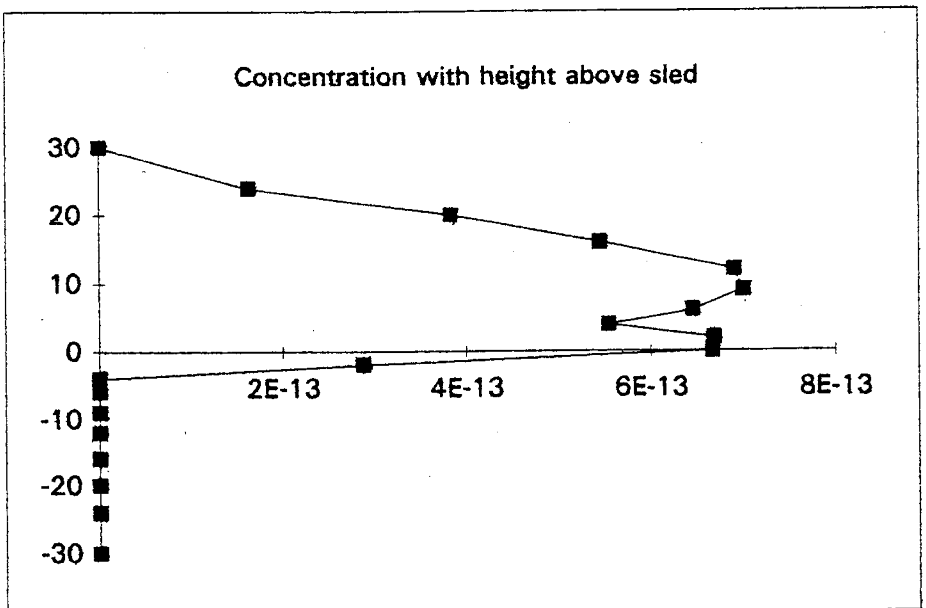


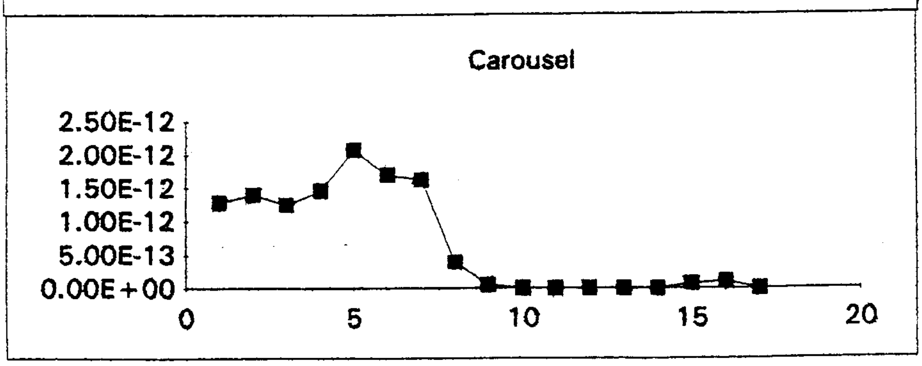
Cast 52: Concentrations adjusted for memory and carousel

Depth	Water conc	Memories	Final Concn	Height above sled
30	0	0	0	30
24	1.54E-13	9.25E-15	1.63E-13	24
20	3.62E-13	2.17E-14	3.84E-13	20
16	5.14E-13	3.08E-14	5.45E-13	16
12	6.5E-13	3.9E-14	6.89E-13	12
9	6.6E-13	3.96E-14	7E-13	9
6	6.09E-13	3.65E-14	6.46E-13	6
4	5.23E-13	3.14E-14	5.54E-13	4
2	6.3E-13	3.78E-14	6.68E-13	2
0	6.29E-13	3.77E-14	6.66E-13	0
-2	2.72E-13	1.63E-14	2.88E-13	-2
-4	0	0	0	-4
-6	0	0	0	-6
-9	0	0	0	-9
-12	0	0	0	-12
-16	0	0	0	-16
-20	0	0	0	-20
-24	0	0	0	-24
-30	0	0	0	-30

Carousel

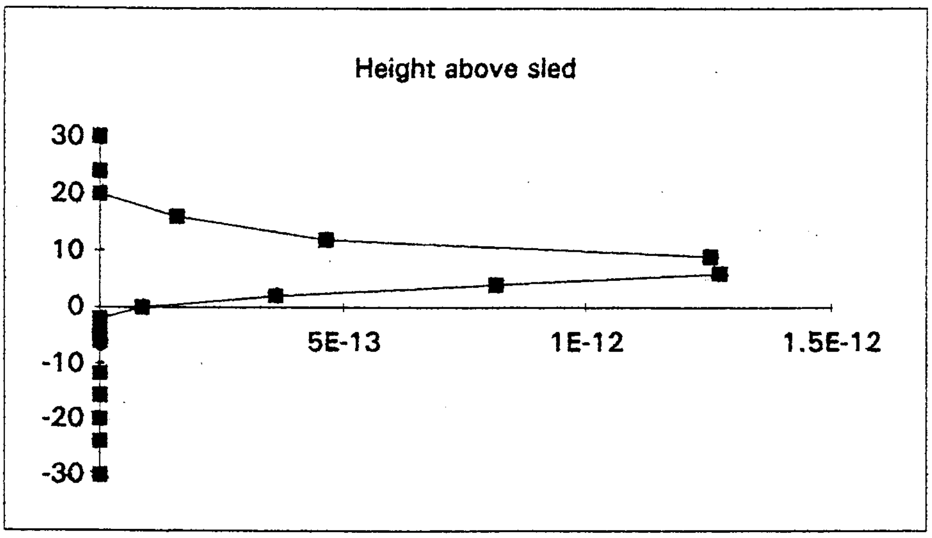
Posn	Carousel
1	1.29E-12
2	1.40E-12
3	1.24E-12
4	1.45E-12
5	2.07E-12
6	1.69E-12
7	1.63E-12
8	3.97E-13
9	5.47E-14
10	0.00E+00
11	0.00E+00
12	0.00E+00
13	0.00E+00
14	0.00E+00
15	7.06E-14
16	1.07E-13
17	0.00E+00





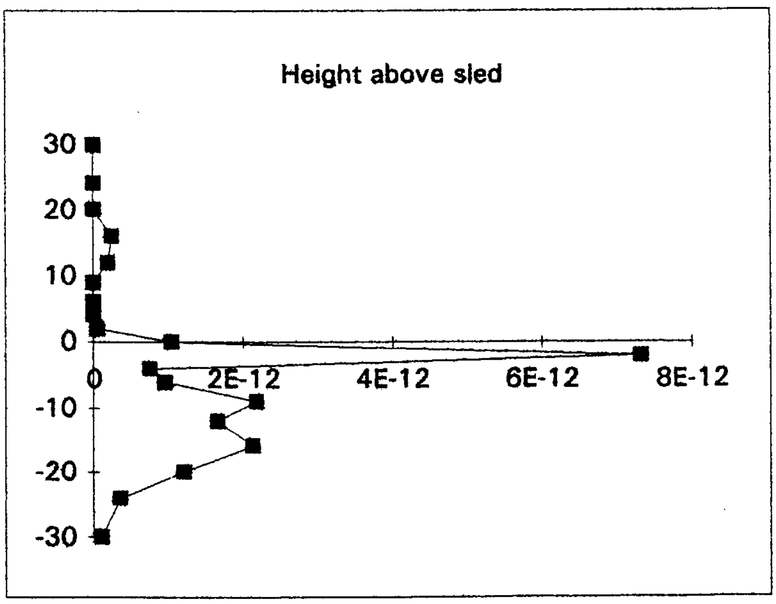
Cast 53: Concentrations adjusted for depth (no Carousel data)

Depth	Water conc	Memories	Final Concn	Height above sled
30	0	0	0	30
24	0	0	0	24
20	0	0	0	20
16	1.49E-13	8.92E-15	1.58E-13	16
12	4.36E-13	2.62E-14	4.62E-13	12
9	1.18E-12	7.09E-14	1.25E-12	9
6	1.2E-12	7.19E-14	1.27E-12	6
4	7.69E-13	4.61E-14	8.15E-13	4
2	3.39E-13	2.04E-14	3.6E-13	2
0	8.16E-14	4.9E-15	8.65E-14	0
-2	0	0	0	-2
-4	0	0	0	-4
-6	0	0	0	-6
			0	
-12	0	0	0	-12
-16	0	0	0	-16
-20	0	0	0	-20
-24	0	0	0	-24
-30	0	0	0	-30



Cast 54: Concentrations adjusted for memory (no carousel data)

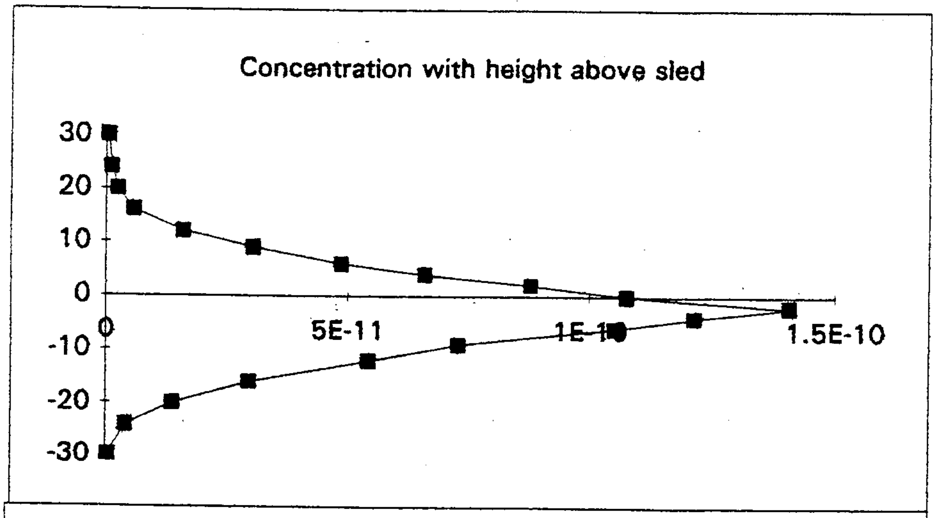
Depth	Water conc	Memories	Final Concn	Height above sled
30	0	0	0	30
24	0	0	0	24
20	0	0	0	20
16	2.28E-13	1.37E-14	2.42E-13	16
12	1.85E-13	1.11E-14	1.96E-13	12
9	0	0	0	9
6	0	0	0	6
4	0	0	0	4
2	5.54E-14	3.32E-15	5.87E-14	2
0	9.88E-13	5.93E-14	1.05E-12	0
-2	6.9E-12	4.14E-13	7.32E-12	-2
-4	7.06E-13	4.24E-14	7.49E-13	-4
-6	8.94E-13	5.36E-14	9.48E-13	-6
-9	2.05E-12	1.23E-13	2.18E-12	-9
-12	1.56E-12	9.36E-14	1.65E-12	-12
-16	2.01E-12	1.21E-13	2.13E-12	-16
-20	1.13E-12	6.79E-14	1.2E-12	-20
-24	3.4E-13	2.04E-14	3.61E-13	-24
-30	1.04E-13	6.26E-15	1.11E-13	-30

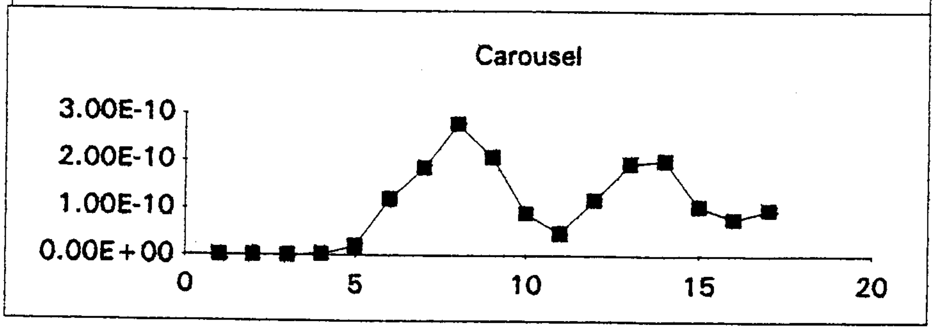


60

Cast 55: Concentrations adjusted for memory and carousel

Depth	Water conc	Memories	Final Concn	Height above sled	Carousel Posn	Carousel
30	4.74E-13	2.84E-14	5.02E-13	30	1	1.48E-13
24	1.23E-12	7.36E-14	1.3E-12	24	2	2.91E-13
20	2.37E-12	9.17E-14	2.46E-12	20	3	2.89E-13
16	5.09E-12	8.62E-13	5.95E-12	16	4	2.13E-12
12	1.51E-11	9.05E-13	1.6E-11	12	5	2.01E-11
9	2.95E-11	9.68E-13	3.05E-11	9	6	1.18E-10
6	4.6E-11	2.66E-12	4.87E-11	6	7	1.85E-10
4	6.22E-11	3.73E-12	6.59E-11	4	8	2.79E-10
2	8.38E-11	4.13E-12	8.8E-11	2	9	2.08E-10
0	1.01E-10	6.06E-12	1.07E-10	0	10	8.87E-11
-2	1.33E-10	7.15E-12	1.41E-10	-2	11	4.71E-11
-4	1.14E-10	7.32E-12	1.21E-10	-4	12	1.18E-10
-6	1E-10	5.02E-12	1.05E-10	-6	13	1.94E-10
-9	6.95E-11	3.54E-12	7.3E-11	-9	14	2.01E-10
-12	5.16E-11	2.77E-12	5.44E-11	-12	15	1.04E-10
-16	2.84E-11	1.21E-12	2.96E-11	-16	16	7.67E-11
-20	1.31E-11	7.81E-13	1.39E-11	-20	17	9.67E-11
-24	3.99E-12	2.23E-13	4.21E-12	-24	18	
-30	4.34E-13	2.6E-14	4.6E-13	-30		





Cast 58: concentrations adjusted for momory (no carousel data)

Depth	Water conc	Memories	Final Concn	Height above sled
30	0	0	0	30
24	0	0	0	24
20	0	0	0	20
16	0	0	0	16
12	0	0	0	12
9	0	0	0	9
6	0	0	0	6
4	0	0	0	4
2	0	0	0	2
0	0	0	0	0
-2	0	0	0	-2
-4		0	0	-4
-6	1.76E-13	1.05E-14	1.86E-13	-6
-9	2.26E-13	1.35E-14	2.39E-13	-9
-12	2.44E-13	1.46E-14	2.58E-13	-12
-16	4.28E-13	2.57E-14	4.54E-13	-16
-20	6.73E-13	4.04E-14	7.13E-13	-20
-24	3.24E-13	1.94E-14	3.43E-13	-24
-30	6.56E-14	3.94E-15	6.96E-14	-30

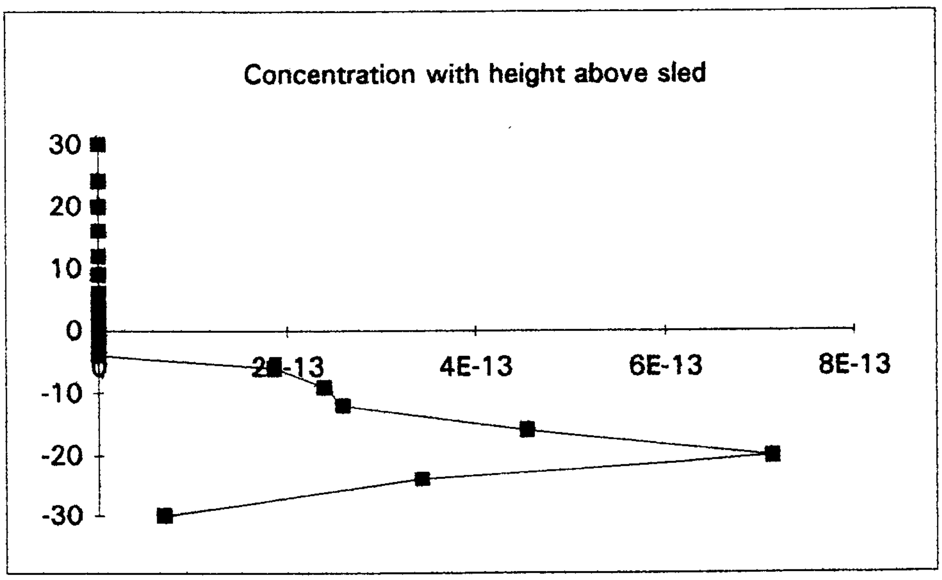


Table 44. Sequence of Events in Marking Wire Out

Day: Time	Casts	Event
14:2000	16-28	First marking of wire and measurement of sled pendants.
19:2000	29	Two tapes found in error on lower wire.
19:2000	30-40	Tapes restored by Andy.
24:0900	41-50	Remeasured all distances; found tapes shifted; left them alone.
26:0900	46	"-20 m" tape replaced over the side with the string-ruler.
27:2300	50	"-16 m" tape moved up 1 m; some others changed or lost. Remeasured lower wire tapes after cast 50.
27:2300	51-59	Restored tapes to their positions of 24 May for the lower wire. No measurements made for the upper wire.
31:1400		Checked all measurements at the end of sampling.

Notes from Cast Sheets

5/21	33	The "-4 m" tape was noted at -5.2 m. Seacat 883 slipped to the top of the sampler at +4 m during the cast.
5/26	46	The "-20 m" tape was replaced over the side using a string-ruler. Seacat 883 slid down 10 cm during the cast. Seacat 885 slid down 20 cm during the cast.
5/27	50	The "-16 m" tape was moved up 1 m; others had been lost, and were replaced. The tapes on the lower wire were measured after this cast, and then reset to the distances of 24 May.
5/31	59	The "-24 m" tape was replaced over the side using the string-ruler at a position 3.5 m below the "-20 m" tape.

Interpolated casts

Height	Cast 16	Cast 17	Cast 18	Cast 22	Cast 23	Cast 24	Cast 25	Cast 26	Cast 27	Cast 29	Cast 30
30	0	0	0	0	0	2.92E-14	3.85E-14	3.33E-14	7.84E-14	1.6E-14	5.39E-13
28	0	0	0	0	2.07E-14	1.03E-13	1.47E-13	8.41E-14	2.85E-13	4.4E-14	3.55E-13
26	0	0	0	0	5.67E-14	1.77E-13	2.55E-13	1.35E-13	4.91E-13	7.2E-14	1.71E-13
24	0	0	0	0	9.27E-14	4.37E-13	5.06E-13	3.23E-13	6.17E-13	8.42E-14	1.38E-13
22	0	0	0	0	3.13E-13	9.81E-13	1.01E-12	5.83E-13	6.13E-13	8.43E-14	2.34E-13
20	0	0	0	0	6.7E-13	1.55E-12	1.52E-12	1.25E-12	6.76E-13	8.68E-14	9.67E-13
18	0	0	0	0	1.95E-12	2.14E-12	2.03E-12	2.14E-12	8.48E-13	9.11E-14	2.25E-12
16	0	0	1.06E-12	0	3.91E-12	3.04E-12	2.83E-12	5.05E-12	1.36E-12	9.49E-14	6.02E-12
14	0	0	3.27E-12	0	7.23E-12	4.41E-12	4.16E-12	9.01E-12	2.41E-12	9.85E-14	1.19E-11
12	1.31E-11	1.7E-12	2.22E-11	0	1.16E-11	6.06E-12	6.32E-12	1.27E-11	3.89E-12	1.11E-13	2.34E-11
10	6.11E-11	1.37E-11	6.58E-11	0	1.74E-11	8.14E-12	9.97E-12	1.58E-11	6.06E-12	1.28E-13	3.94E-11
8	1.26E-10	3.43E-11	9.7E-11	2.7E-13	2.41E-11	1.64E-11	1.53E-11	1.6E-11	8.89E-12	9.55E-14	4.7E-11
6	1.91E-10	5.48E-11	1.09E-10	9.79E-13	2.63E-11	2.59E-11	2.24E-11	1.92E-11	1.59E-11	3.51E-14	5.6E-11
4	2.89E-10	8.11E-11	1.42E-10	5.41E-12	3.07E-11	3.42E-11	3.26E-11	2.4E-11	2.94E-11	2.53E-13	7.83E-11
2	2.89E-10	1.32E-10	1.83E-10	1.41E-11	3.94E-11	3.82E-11	4.16E-11	2.89E-11	6.05E-11	6.97E-13	9.93E-11
0	2.52E-10	1.51E-10	1.87E-10	1.58E-11	4.36E-11	3.79E-11	5.01E-11	2.94E-11	8.79E-11	1.03E-12	1.1E-10
-2	1.76E-10	1.04E-10	1.49E-10	9.05E-12	3.82E-11	3.38E-11	5.27E-11	2.8E-11	9.9E-11	1.03E-12	1.16E-10
-4	9.98E-11	8.7E-11	1.14E-10	3.88E-12	2.67E-11	2.87E-11	3.82E-11	3.21E-11	1.24E-10	1.18E-12	1.1E-10
-6	2.37E-11	8.58E-11	9.45E-11	1.55E-12	1.31E-11	2.4E-11	2.66E-11	3.15E-11	1.31E-10	1.23E-12	9.33E-11
-8	8.18E-12	8.46E-11	7.18E-11	2.55E-13	6.21E-12	2E-11	1.16E-11	2.69E-11	6.66E-11	1.13E-12	7.33E-11
-10	8.76E-13	7.77E-11	4.43E-11	8.38E-14	4.3E-12	1.78E-11	4.81E-12	2.16E-11	2.97E-11	1.02E-12	4.95E-11
-12	0	4.22E-11	2.39E-11	2.68E-14	3.02E-12	1.48E-11	1.2E-12	1.38E-11	7.45E-12	7.85E-13	3.2E-11
-14	0	1.15E-11	1.53E-11	9.72E-15	1.94E-12	1.06E-11	9.33E-13	4.63E-12	2.93E-12	5.01E-13	1.98E-11
-16	0	5.22E-12	8.72E-12	0	1.01E-12	7.02E-12	6.77E-13	1.14E-12	1.1E-13	2.71E-13	1.25E-11
-18	0	0	5.39E-12	0	4.77E-13	4.4E-12	4.47E-13	6.44E-13	7.93E-14	8.15E-14	9.46E-12
-20	0	0	2.06E-12	0	2.27E-13	2.33E-12	2.77E-13	3.19E-13	4.9E-14	0	7.31E-12
-22	0	0	0	0	8.62E-14	1.11E-12	2.17E-13	8.18E-14	1.88E-14	0	5.92E-12
-24	0	0	0	0	2.57E-14	3.21E-13	1.58E-13	0	0	0	4.52E-12
-26	0	0	0	0	0	1.98E-13	9.8E-14	0	0	0	3.13E-12
-28	0	0	0	0	0	7.46E-14	3.84E-14	0	0	0	1.73E-12
-29.999	0	0	0	0	0	0	0	0	0	0	1.12E-12
Integrated am	3.06E-06	1.93E-06	2.68E-06	1.03E-07	6.05E-07	6.9E-07	6.57E-07	6.51E-07	1.36E-06	2.05E-08	2.03E-06

Table 45. Interpolated cast data

Cast 31	Cast 32	Cast 33	Cast 34	Cast 36	Cast 37	Cast 43	Cast 44	Cast 46	Cast 47	Cast 48	Cast 50
0	0	0	0	0	1.42E-12	1.65E-13	5.72E-13	0.00E+00	3.60E-13	3.23E-13	8.20E-14
0	0	2.53E-14	0	6.98E-14	1.5E-12	1.34E-13	7.28E-13	3.4E-14	3.5E-13	4.89E-13	2.04E-13
0	0	5.66E-14	0	1.55E-13	1.54E-12	7.55E-14	9E-13	8.2E-14	3.11E-13	6.82E-13	3.53E-13
7.08E-13	0	8.79E-14	0	2.39E-13	1.57E-12	1.7E-14	1.07E-12	1.3E-13	2.71E-13	8.74E-13	5.03E-13
2.37E-12	5.61E-13	1.83E-13	1.93E-13	9.12E-13	3.12E-12	1.4E-13	1.53E-12	3.16E-13	4.25E-13	1.3E-12	1.3E-12
4.2E-12	1.16E-12	2.92E-13	4.27E-13	1.71E-12	4.97E-12	3.37E-13	2.09E-12	5.56E-13	6.46E-13	1.78E-12	2.26E-12
6.26E-12	1.21E-12	6.11E-13	2.96E-13	2.82E-12	9.08E-12	2.57E-13	3.24E-12	1.72E-12	4.48E-13	2.37E-12	3.05E-12
1.14E-11	1.23E-12	9.8E-13	8.68E-14	3.99E-12	1.36E-11	5.94E-14	4.63E-12	3.26E-12	9.53E-14	2.99E-12	3.8E-12
2.09E-11	1.25E-12	3.08E-12	2.18E-13	7.08E-12	3.65E-11	0	1.04E-11	3.77E-12	2.34E-12	4.59E-12	5.87E-12
3.47E-11	1.27E-12	5.59E-12	4.21E-13	1.06E-11	6.3E-11	0	1.79E-11	3.85E-12	5.54E-12	6.43E-12	8.28E-12
5.45E-11	5.54E-13	8.84E-12	2.13E-12	1.29E-11	5.88E-11	7.93E-14	2.8E-11	6.36E-12	1.06E-11	1.02E-11	1.04E-11
8.81E-11	4.72E-13	1.25E-11	5.78E-12	1.73E-11	6.45E-11	2.36E-13	4.44E-11	8.74E-12	1.76E-11	1.44E-11	1.27E-11
1.19E-10	1.28E-12	1.68E-11	1.28E-11	2.68E-11	1.02E-10	5.22E-13	7.72E-11	6.33E-12	2.8E-11	1.82E-11	1.58E-11
1.55E-10	1.03E-12	2.45E-11	2.31E-11	4.87E-11	9.25E-11	1.52E-12	9.69E-11	5.95E-12	4.81E-11	2.58E-11	1.89E-11
2.69E-10	1.91E-12	3.64E-11	4.41E-11	6.56E-11	1.22E-10	2.77E-12	1.23E-10	4.25E-12	8.26E-11	4.02E-11	3.2E-11
3.61E-10	2.14E-12	4.29E-11	6.06E-11	6.71E-11	1.37E-10	3.87E-12	1.55E-10	1.73E-12	1.2E-10	4.47E-11	4.76E-11
3.17E-10	4.17E-12	6.51E-11	7.29E-11	6.71E-11	1.14E-10	6.9E-12	1.78E-10	8.15E-13	1.09E-10	4.3E-11	6.45E-11
2.71E-10	2.8E-13	6.77E-11	3.94E-11	5.25E-11	8.78E-11	8.16E-12	1.63E-10	3.85E-13	1.02E-10	3.87E-11	6.68E-11
2.08E-10	0	5.16E-11	2.59E-11	4.49E-11	5.47E-11	1.06E-11	1.34E-10	2.92E-13	9.65E-11	2.77E-11	6.05E-11
1.22E-10	0	4.07E-11	2.01E-11	3.09E-11	3.83E-11	1.22E-11	1.1E-10	2.99E-13	7.97E-11	2.08E-11	4.84E-11
4.45E-11	2.73E-12	2.94E-11	1.47E-11	1.79E-11	2.4E-11	1.08E-11	8.78E-11	2.49E-13	5.34E-11	1.66E-11	4.06E-11
2.98E-12	8.99E-12	1.32E-11	9.57E-12	1.06E-11	6.98E-12	7.6E-12	5.93E-11	2.67E-13	2.67E-11	9.85E-12	2.86E-11
9.98E-12	5.21E-12	6.5E-12	6.15E-12	6.21E-12	3.24E-12	5.78E-12	3.72E-11	1.86E-13	1.5E-11	7.76E-12	1.98E-11
1.1E-11	7.25E-13	2.05E-12	3.1E-12	2.4E-12	2.12E-12	4.21E-12	1.6E-11	8.96E-14	5.36E-12	5.95E-12	1.12E-11
4.03E-12	2.54E-13	8.04E-13	1.73E-12	1.25E-12	1.68E-12	2.94E-12	9.38E-12	8.46E-14	3.09E-12	3.64E-12	7.14E-12
0	6.08E-14	3.03E-13	7.02E-13	6.69E-13	1.37E-12	1.71E-12	4.83E-12	9.32E-14	1.73E-12	1.31E-12	3.33E-12
0	4.41E-13	1.55E-13	4.44E-13	3.93E-13	1.77E-12	1.08E-12	3.19E-12	5.47E-14	1.11E-12	6.69E-13	2.06E-12
0	8.61E-13	8.91E-14	3.48E-13	1.83E-13	2.3E-12	5.41E-13	2.01E-12	8.54E-15	6E-13	1.27E-13	9.38E-13
0	6.11E-13	7.51E-14	2.4E-13	1.45E-13	1.75E-12	3.21E-13	1.6E-12	0	4.25E-13	5.13E-14	8.82E-13
0	3.15E-13	7.33E-14	1.3E-13	1.45E-13	9.76E-13	1.77E-13	1.36E-12	0	3.17E-13	2.73E-14	9.5E-13
0	1.94E-14	7.15E-14	1.94E-14	1.44E-13	2.06E-13	3.32E-14	1.12E-12	0	2.09E-13	3.26E-15	1.02E-12
4.24E-06	7.74E-08	8.61E-07	6.91E-07	1E-06	2.11E-06	1.66E-07	2.75E-06	9.98E-08	1.62E-06	7.03E-07	1.04E-06

Table 45 (cont.) Interpolated cast data

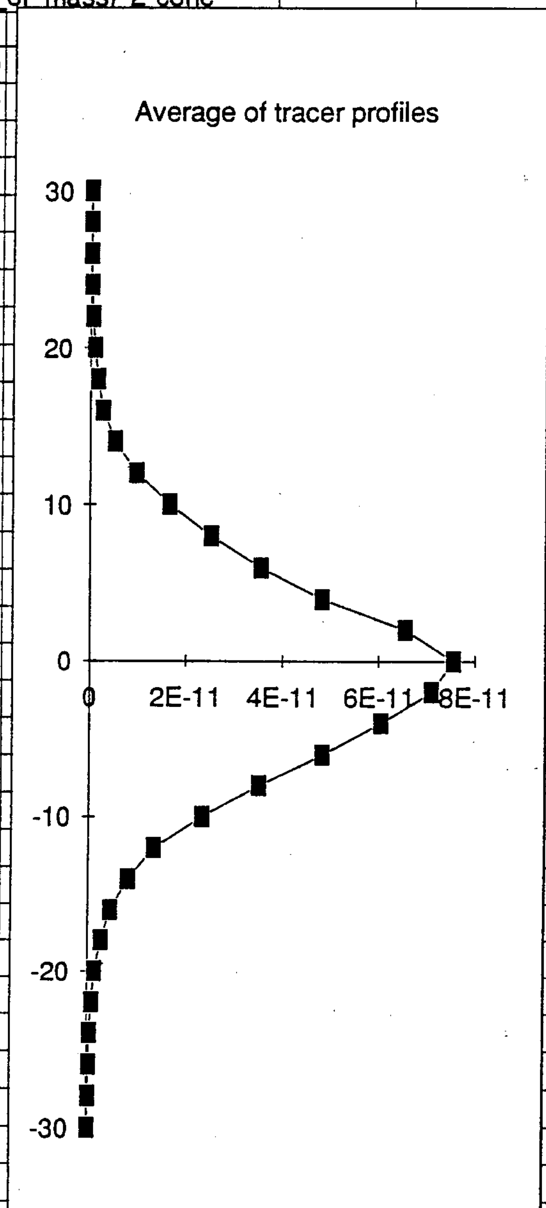
Interpolated casts

Cast 52	Cast 53	Cast 54	Cast 55	Cast 58	AVERAGE	Height
0.00E+00	0.00E+00	0.00E+00	4.76E-13	0.00E+00	1.477E-13	30
4.55E-14	0	0	6.97E-13	0	1.899E-13	28
1E-13	0	0	9.64E-13	0	2.348E-13	26
1.55E-13	0	0	1.23E-12	0	3.235E-13	24
2.56E-13	0	0	1.73E-12	0	6.485E-13	22
3.66E-13	0	2.54E-14	2.3E-12	0	1.066E-12	20
4.51E-13	5.93E-14	1.46E-13	3.73E-12	0	1.686E-12	18
5.32E-13	1.38E-13	2.37E-13	5.48E-12	0	2.713E-12	16
6.04E-13	2.69E-13	2.15E-13	9.53E-12	0	5.326E-12	14
6.74E-13	4.18E-13	1.74E-13	1.44E-11	0	9.8E-12	12
6.95E-13	8.46E-13	3.76E-14	2.29E-11	0	1.662E-11	10
6.87E-13	1.25E-12	0	3.35E-11	0	2.527E-11	8
6.51E-13	1.27E-12	0	4.57E-11	0	3.551E-11	6
5.69E-13	9.25E-13	1.3E-14	6.14E-11	0	4.825E-11	4
6.53E-13	4.61E-13	3.33E-13	8.26E-11	0	6.552E-11	2
6.66E-13	1.17E-13	3.1E-12	1.04E-10	0	7.563E-11	0
3.28E-13	1.57E-14	5.89E-12	1.34E-10	0	7.099E-11	-2
7.47E-14	0	7.61E-13	1.28E-10	0	6.045E-11	-4
0	0	9.74E-13	1.12E-10	1.07E-13	4.84E-11	-6
0	0	2.03E-12	9E-11	2.11E-13	3.522E-11	-8
0	0	1.88E-12	6.83E-11	2.44E-13	2.374E-11	-10
0	0	1.74E-12	5.59E-11	2.57E-13	1.363E-11	-12
0	0	1.98E-12	4.34E-11	3.46E-13	8.459E-12	-14
0	0	1.96E-12	3.1E-11	4.45E-13	4.795E-12	-16
0	0	1.5E-12	2.26E-11	5.71E-13	2.918E-12	-18
0	0	1.05E-12	1.48E-11	6.99E-13	1.617E-12	-20
0	0	6.42E-13	9.73E-12	5.51E-13	1.061E-12	-22
0	0	3.35E-13	4.99E-12	3.7E-13	6.689E-13	-24
0	0	2.53E-13	3.18E-12	2.86E-13	4.719E-13	-26
0	0	1.7E-13	1.94E-12	1.76E-13	3.071E-13	-28
0	0	1.13E-13	7.08E-13	8.63E-14	1.738E-13	-29.999
1.5E-08	1.15E-08	5.1E-08	2.22E-06	8.57E-09	1.123E-06	

Table 45 (cont.). Interpolated cast data

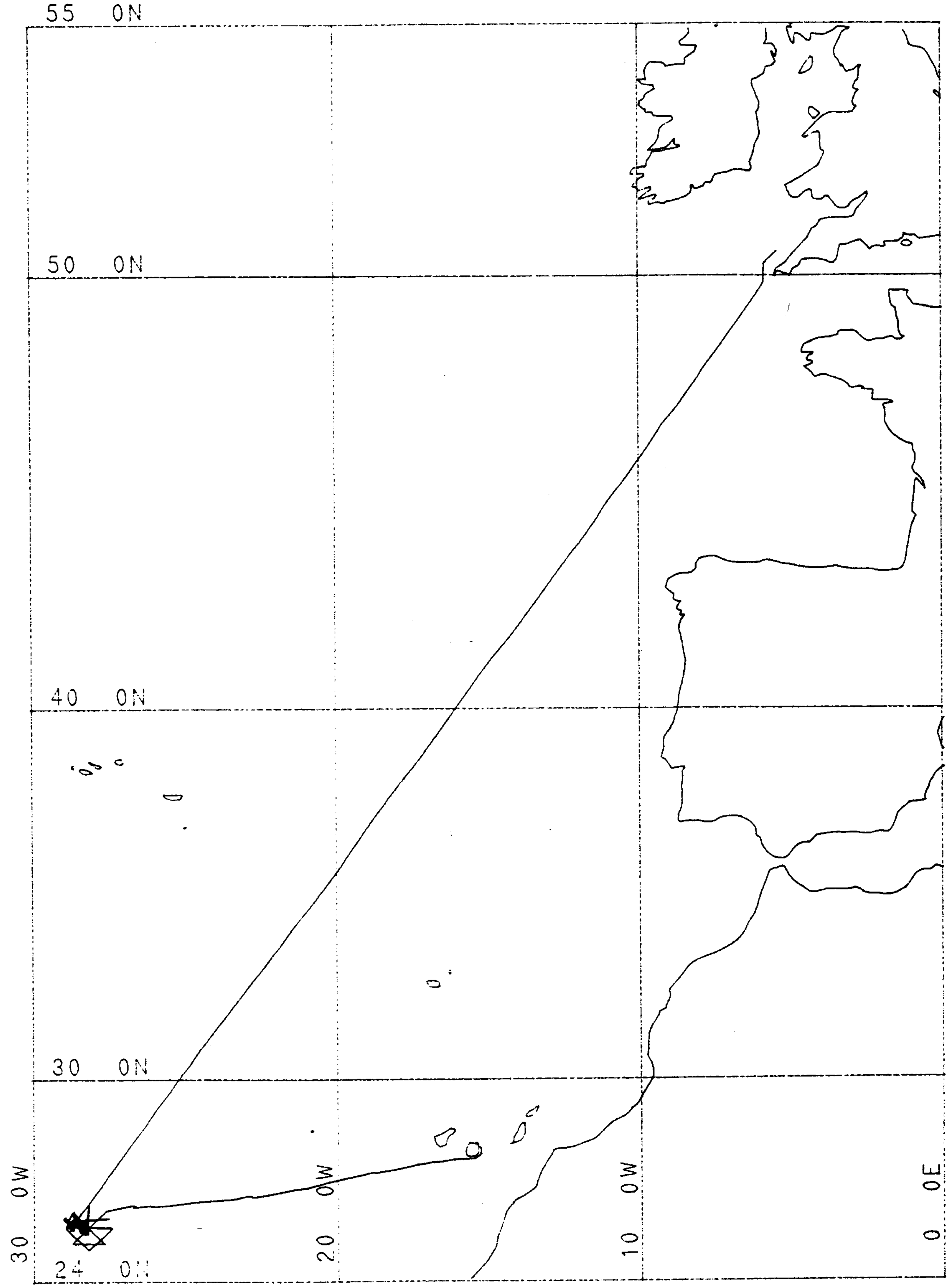
Mean profile

CRUISE CD 68: AVERAGE PROFILE CASTS 16-58			
Average (moles/liter)	Height (m)	Ht*conc	(ht-centre_of_mass)^2*conc
1.47702E-13	30	4.43E-12	1.4E-10
1.89858E-13	28	5.32E-12	1.58E-10
2.34778E-13	26	6.1E-12	1.69E-10
3.23506E-13	24	7.76E-12	2E-10
6.4845E-13	22	1.43E-11	3.38E-10
1.066E-12	20	2.13E-11	4.63E-10
1.68626E-12	18	3.04E-11	5.99E-10
2.713E-12	16	4.34E-11	7.69E-10
5.32622E-12	14	7.46E-11	1.17E-09
9.80004E-12	12	1.18E-10	1.62E-09
1.66175E-11	10	1.66E-10	1.95E-09
2.52659E-11	8	2.02E-10	1.97E-09
3.55054E-11	6	2.13E-10	1.66E-09
4.8251E-11	4	1.93E-10	1.13E-09
6.55155E-11	2	1.31E-10	5.28E-10
7.56345E-11	0	0	5.34E-11
7.0992E-11	-2	-1.4E-10	9.55E-11
6.04505E-11	-4	-2.4E-10	6.04E-10
4.84045E-11	-6	-2.9E-10	1.29E-09
3.52204E-11	-8	-2.8E-10	1.81E-09
2.37385E-11	-10	-2.4E-10	1.99E-09
1.36326E-11	-12	-1.6E-10	1.7E-09
8.45885E-12	-14	-1.2E-10	1.46E-09
4.79548E-12	-16	-7.7E-11	1.1E-09
2.91827E-12	-18	-5.3E-11	8.59E-10
1.61702E-12	-20	-3.2E-11	5.94E-10
1.06115E-12	-22	-2.3E-11	4.75E-10
6.68908E-13	-24	-1.6E-11	3.59E-10
4.71926E-13	-26	-1.2E-11	2.99E-10
3.07069E-13	-28	-8.6E-12	2.27E-10
1.73771E-13	-29.999	-5.2E-12	1.48E-10



Sum_of_concs		Centre of mass(m)	
5.6184E-10		-0.84002	
		Root mean width (m)	
		6.794252	
Integrated amount			
1.1234E-06	moles/m^2		

Table 46: Average Profile Cast.

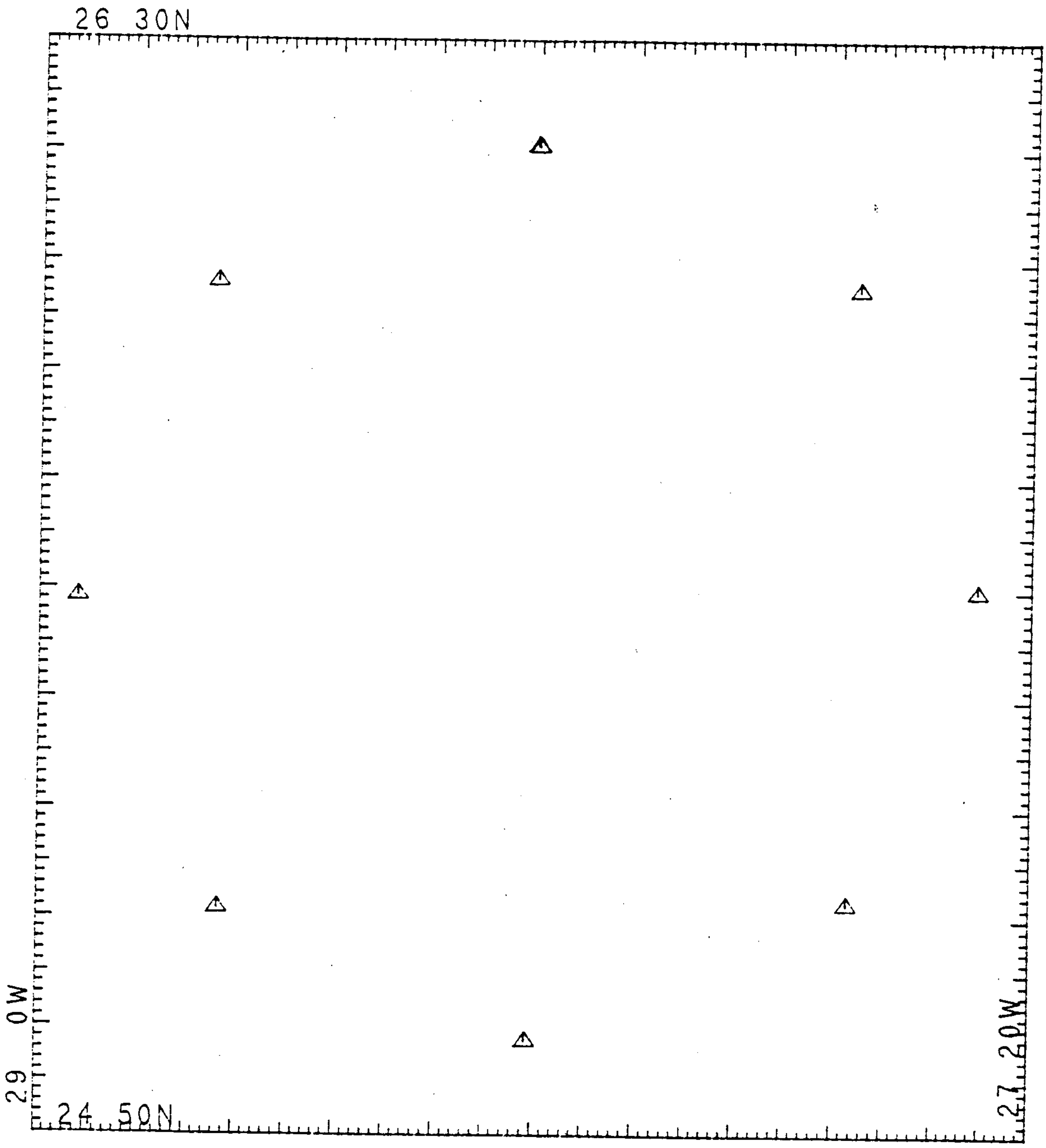


RVS MERCATOR PROJECTION GRID NO. 1

SCALE 1 TO 20000000 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

Fig. 1. Cruise track.



MERCATOR PROJECTION

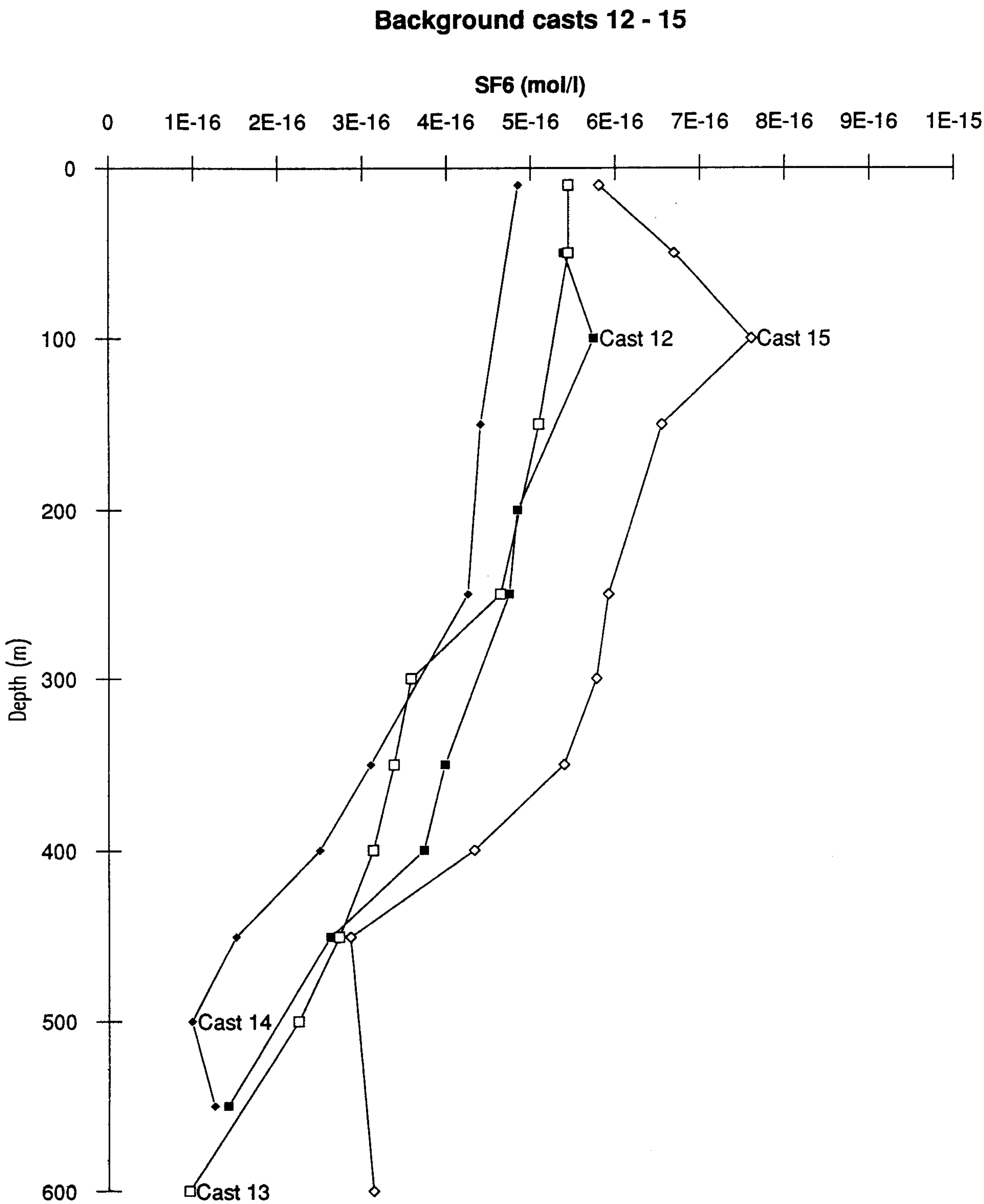
SCALE 1 TO 1250000 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

GRID NO. 1

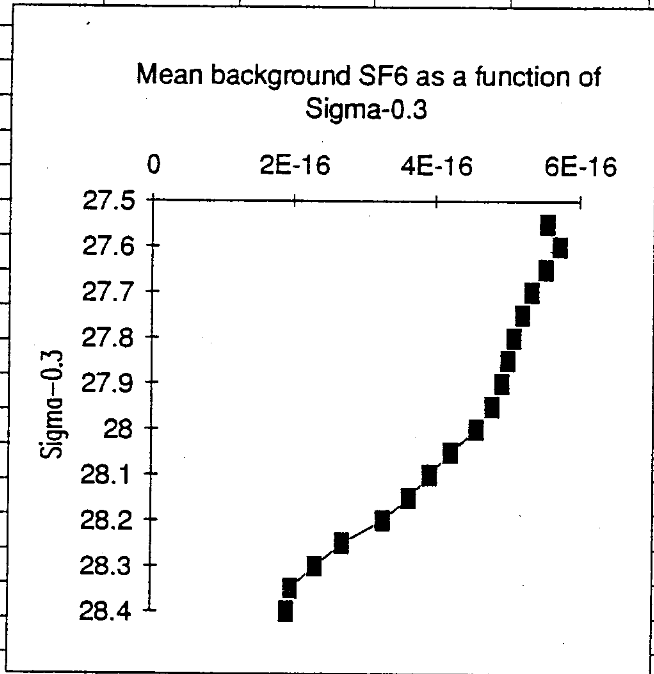
Fig. 2. Background Cast Stations

Fig. 3. Background casts from niskin bottles



Average of background casts interpolated to Sigma-0.3

SF6	Sigma0.3
5.56E-16	27.55
5.73E-16	27.6
5.54E-16	27.65
5.35E-16	27.7
5.22E-16	27.75
5.1E-16	27.8
5.02E-16	27.85
4.94E-16	27.9
4.8E-16	27.95
4.58E-16	28
4.23E-16	28.05
3.94E-16	28.1
3.65E-16	28.15
3.29E-16	28.2
2.71E-16	28.25
2.32E-16	28.3
1.98E-16	28.35
1.93E-16	28.4



CAST DATA

Cast 12		Cast 13		Cast 14		Cast 15	
Depth	SF6-mol l	Depth	SF6-mol l	Depth	SF6-mol l	Depth	SF6-mol l
50	5.4E-16	10	5.45E-16	10	4.85E-16	10	5.81E-16
100	5.75E-16	50	5.45E-16	150	4.4E-16	50	6.7E-16
200	4.84E-16	150	5.09E-16	250	4.25E-16	100	7.61E-16
250	4.74E-16	250	4.64E-16	350	3.1E-16	150	6.55E-16
350	3.98E-16	300	3.58E-16	400	2.5E-16	250	5.92E-16
350	3.98E-16	300	3.58E-16	450	1.5E-16	300	5.78E-16
400	3.73E-16	350	3.38E-16	500	9.8E-17	300	5.78E-16
450	2.62E-16	400	3.13E-16	550	1.25E-16	350	5.39E-16
550	1.41E-16	450	2.72E-16			400	4.33E-16
		500	2.24E-16			450	2.86E-16
		600	9.58E-17			500	#N/A
						600	3.13E-16

Fig. 4.

Diagram of sampler array

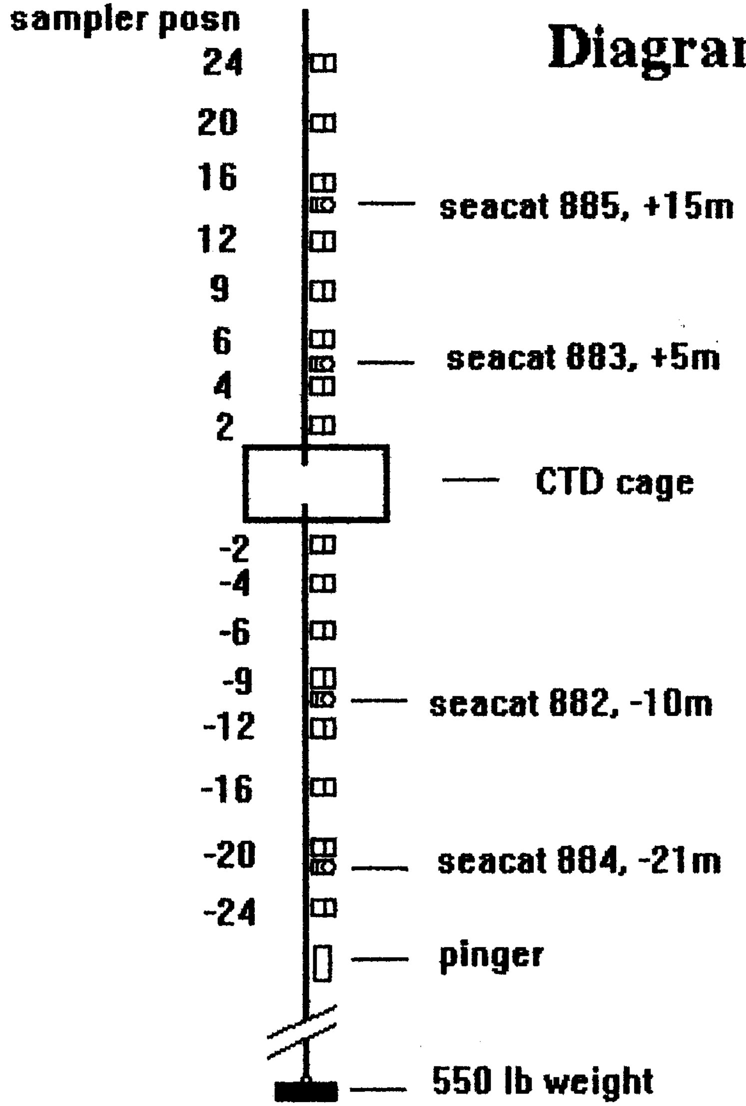
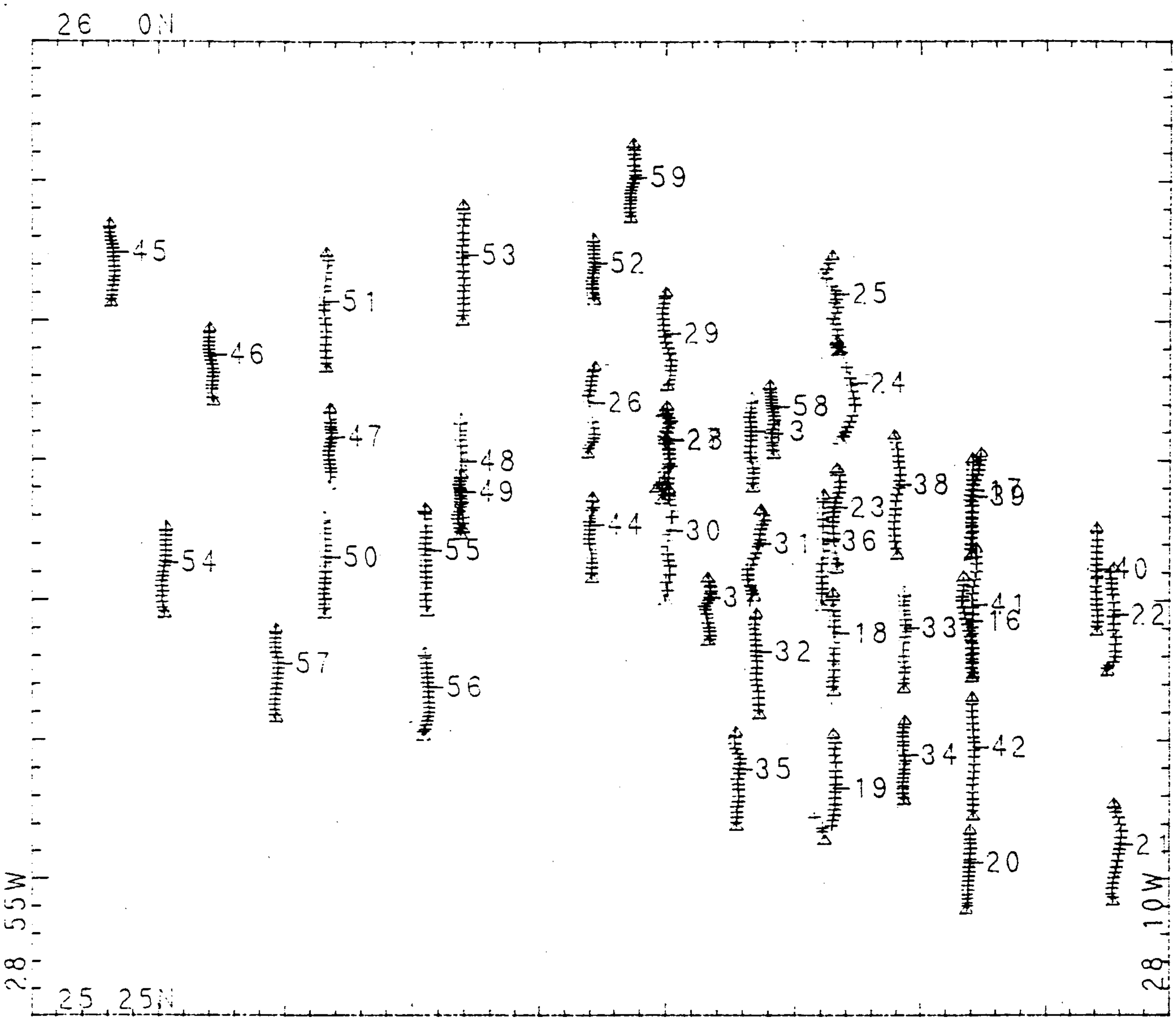


Fig. 5.



RVS MERCATOR PROJECTION GRID NO. 1

SCALE 1 TO 493233 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

Fig. 6. Tracer Cast Positions

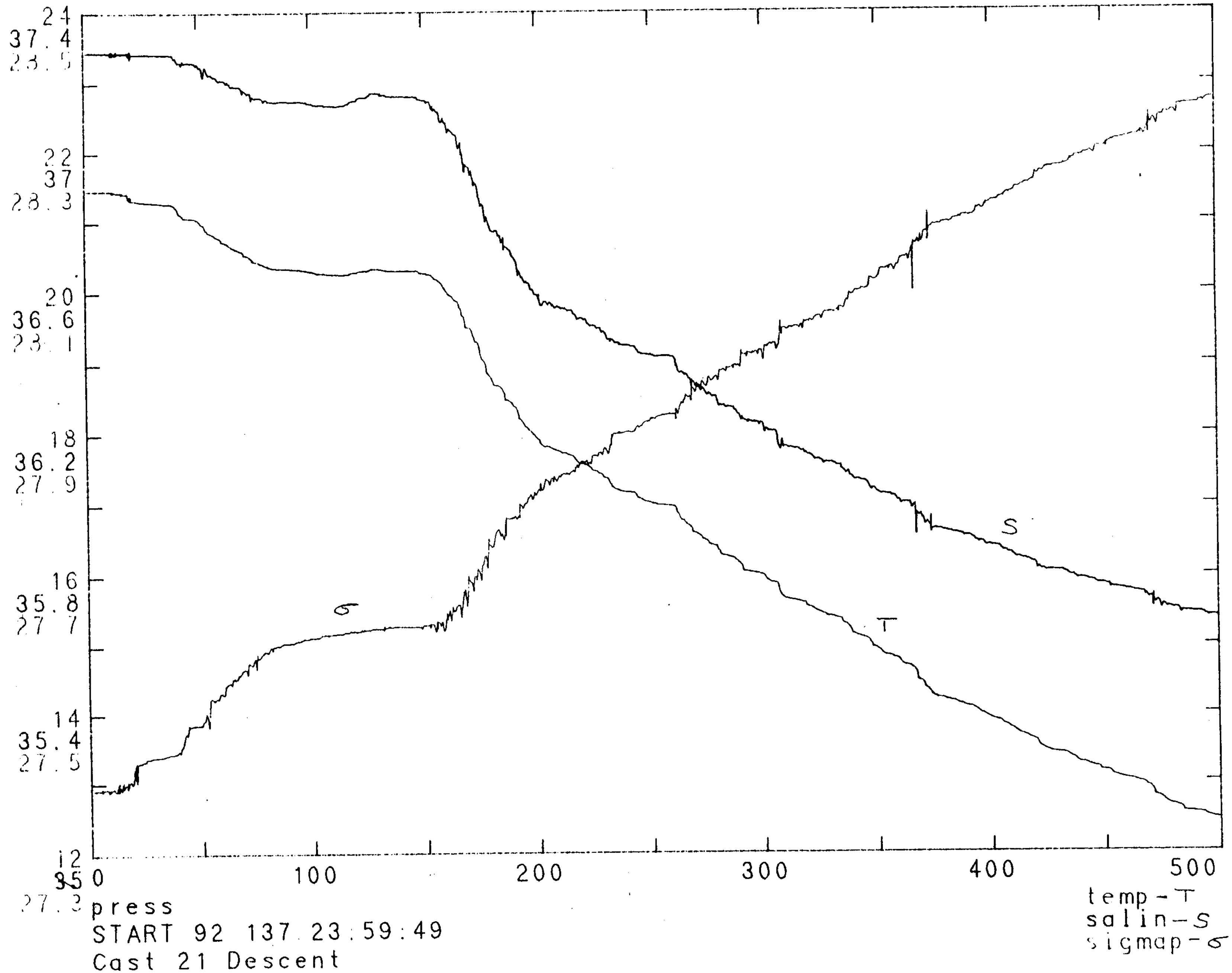


Fig. 7. CTD Data - Cast 21

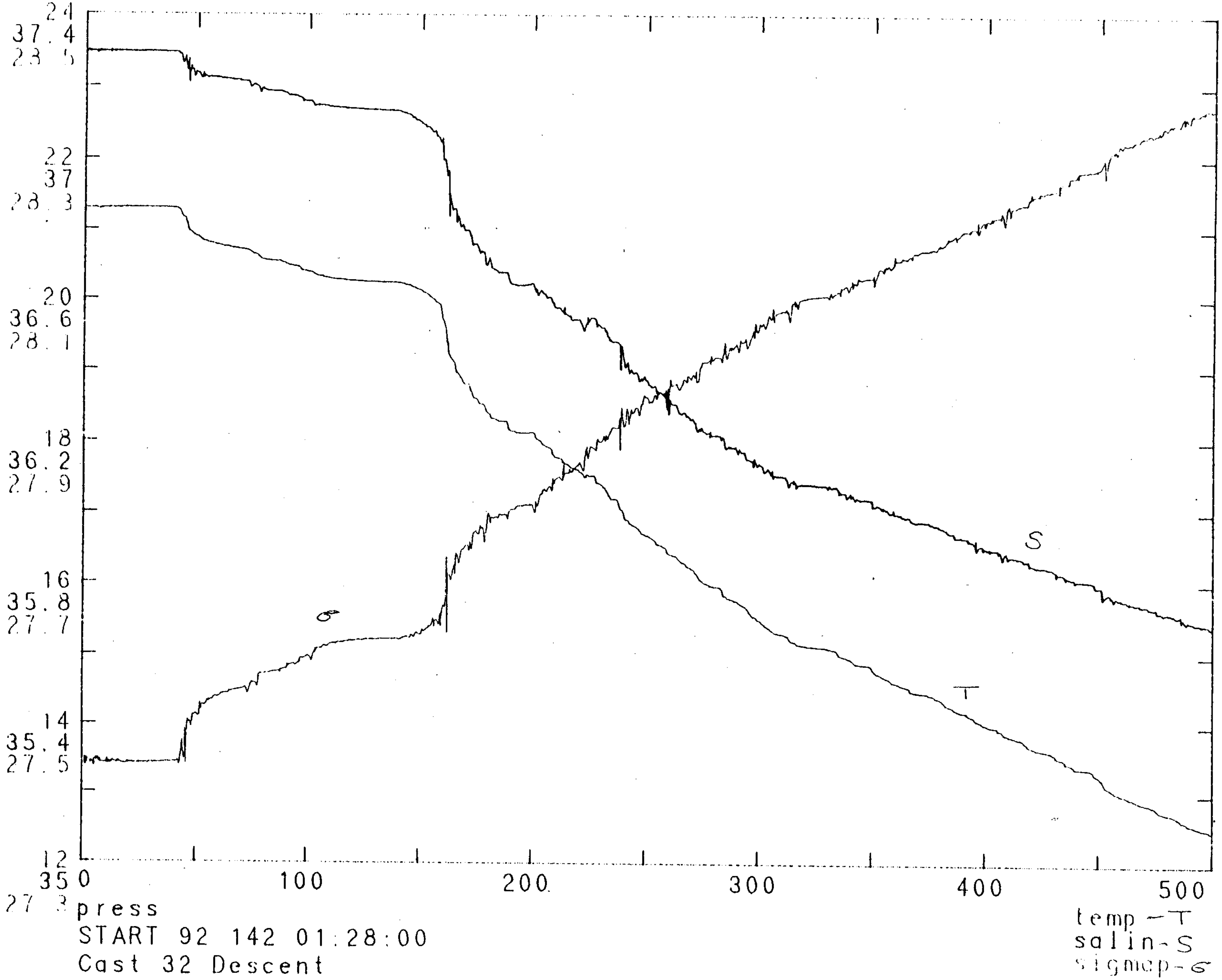


Fig. 8 CTD Data - Cast 32

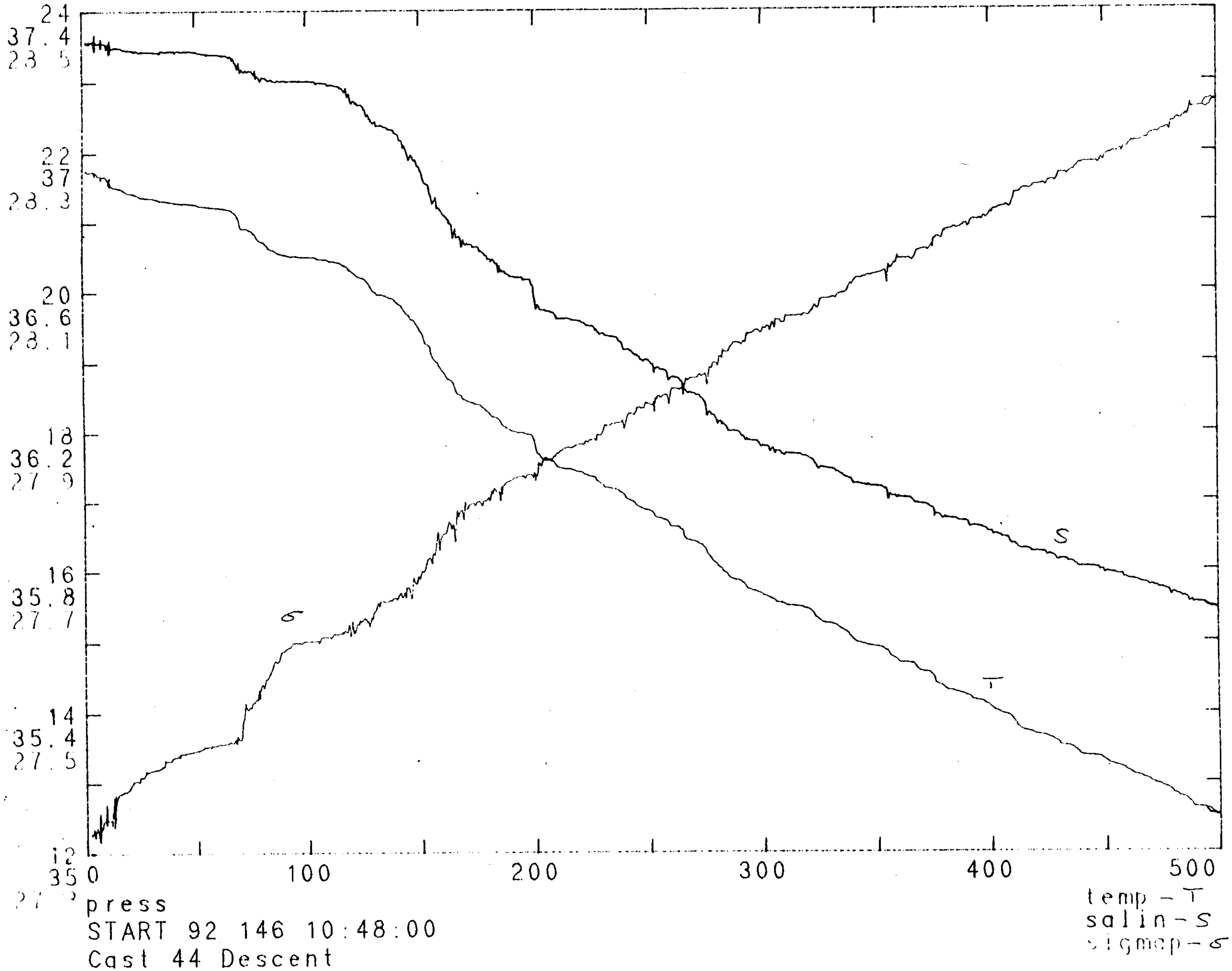


Fig. 9. CTD Data - Cast 44

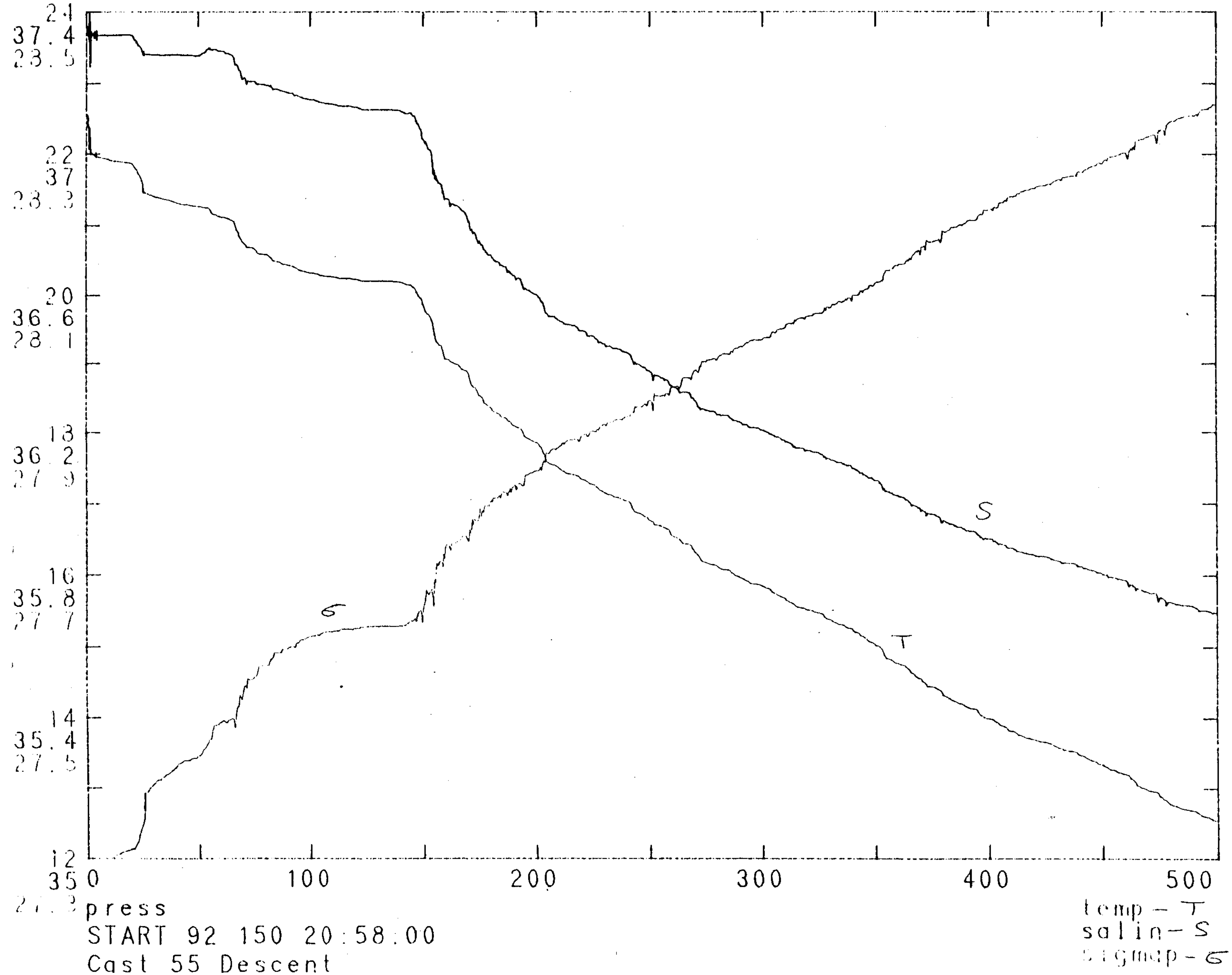


Fig. 10. CTD Data – Cast 55

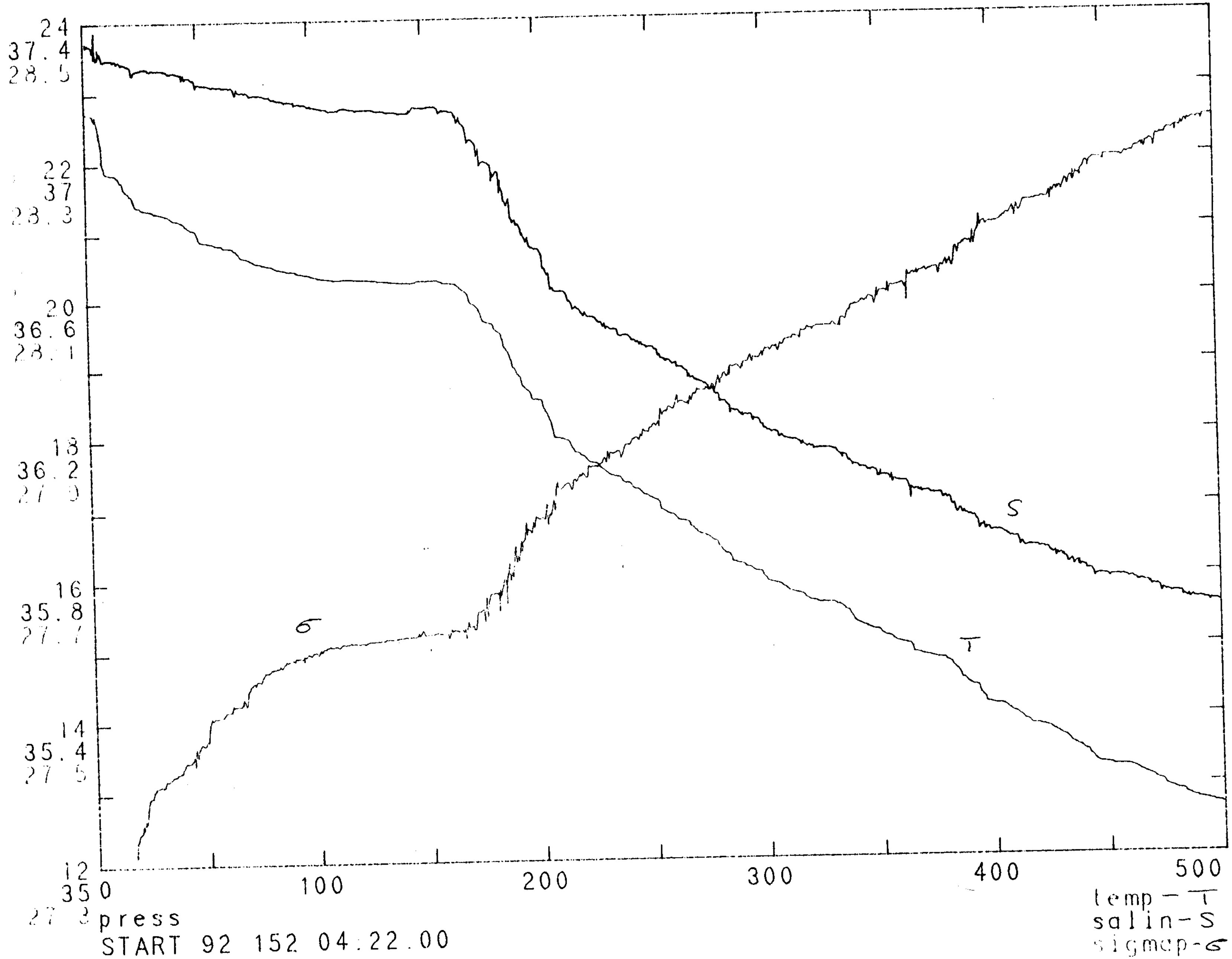


Fig. 11. CTD Data - Cast 59

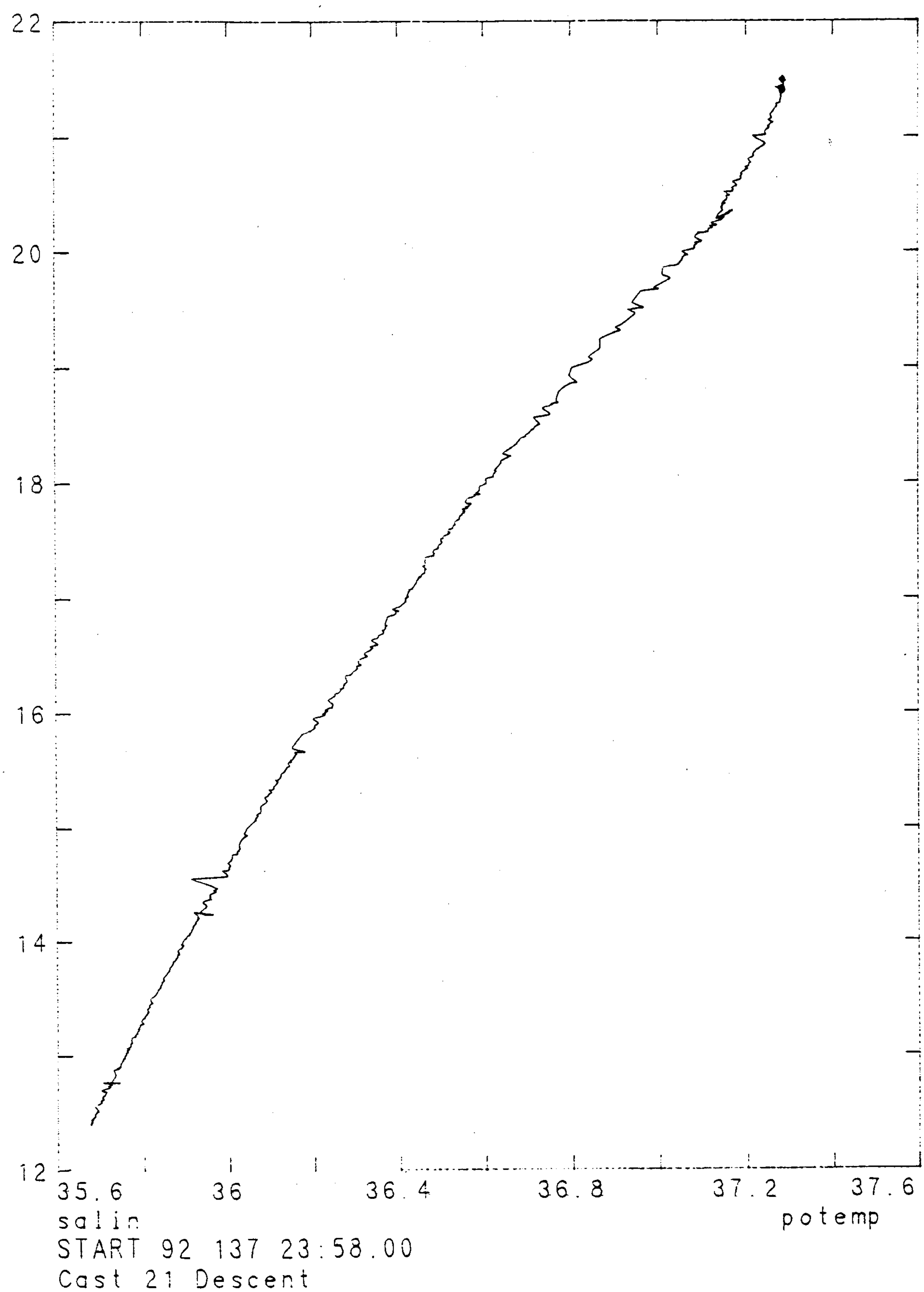


Fig. 12. Cast 21 – Potential temperature – salinity relationship

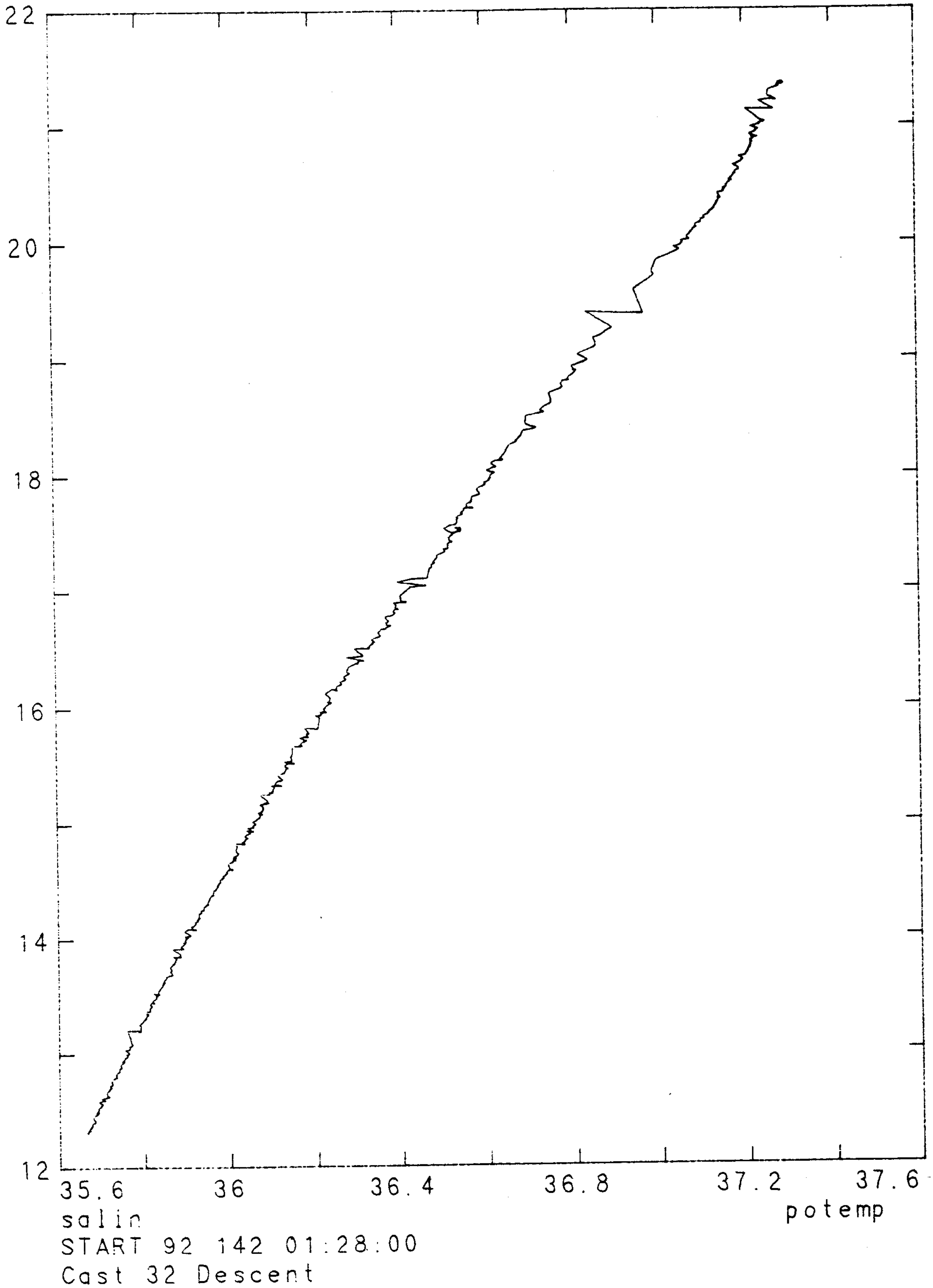


Fig. 13. Cast 32 – Potential temperature – salinity relationship

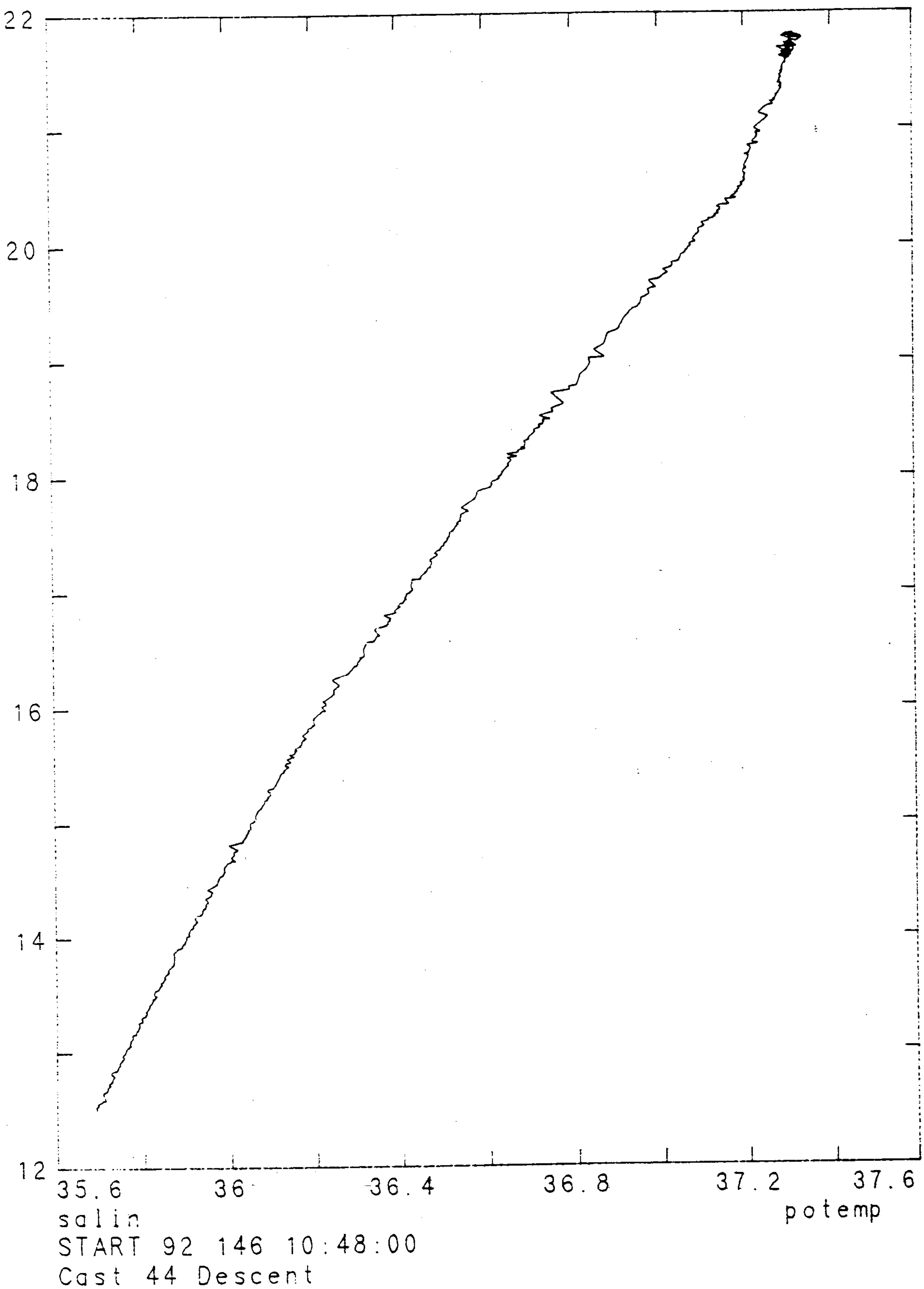


Fig. 14. Cast 44 Potential temperature – salinity relationship

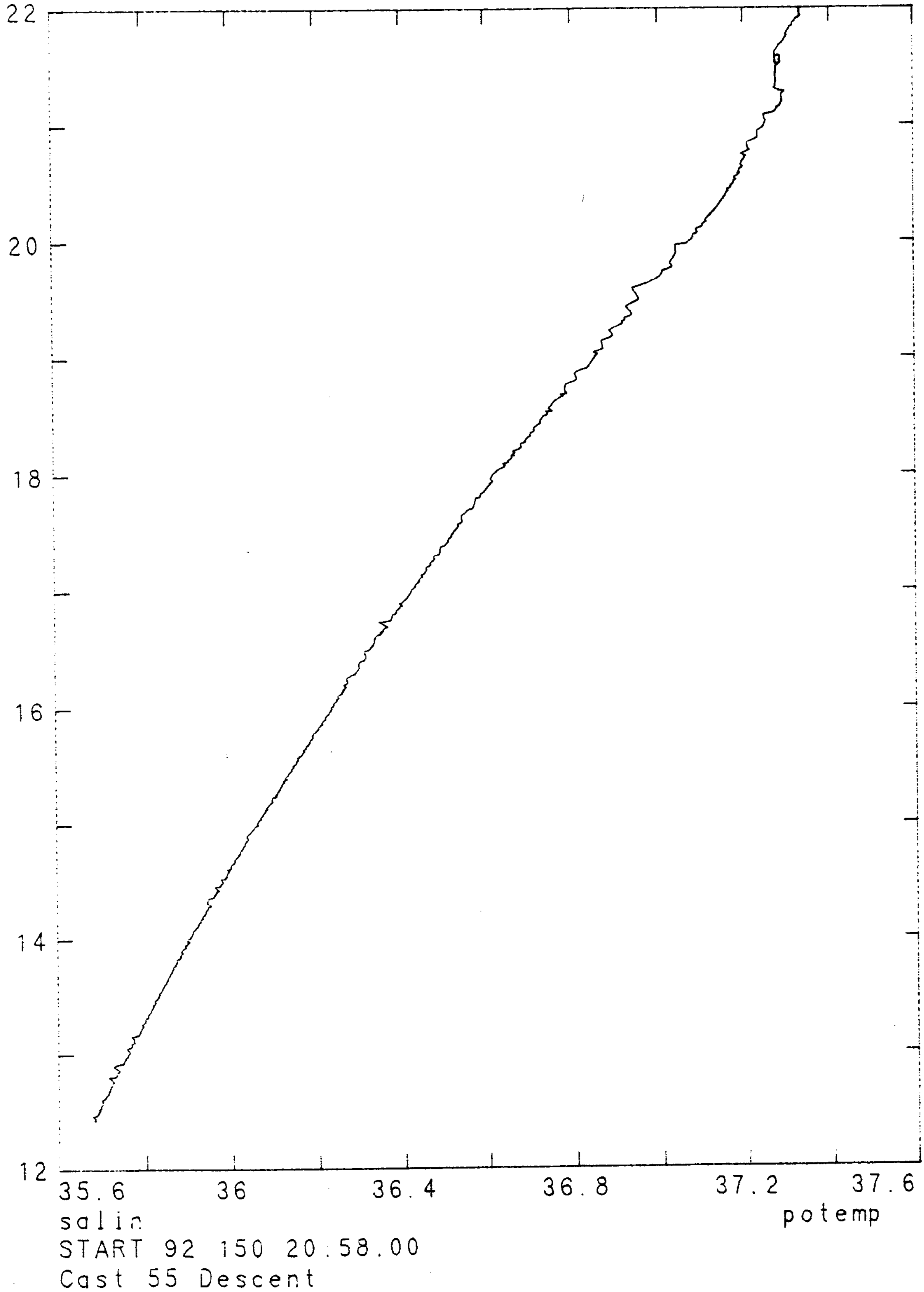


Fig. 15. Cast 55 Potential temperature - salinity relationship

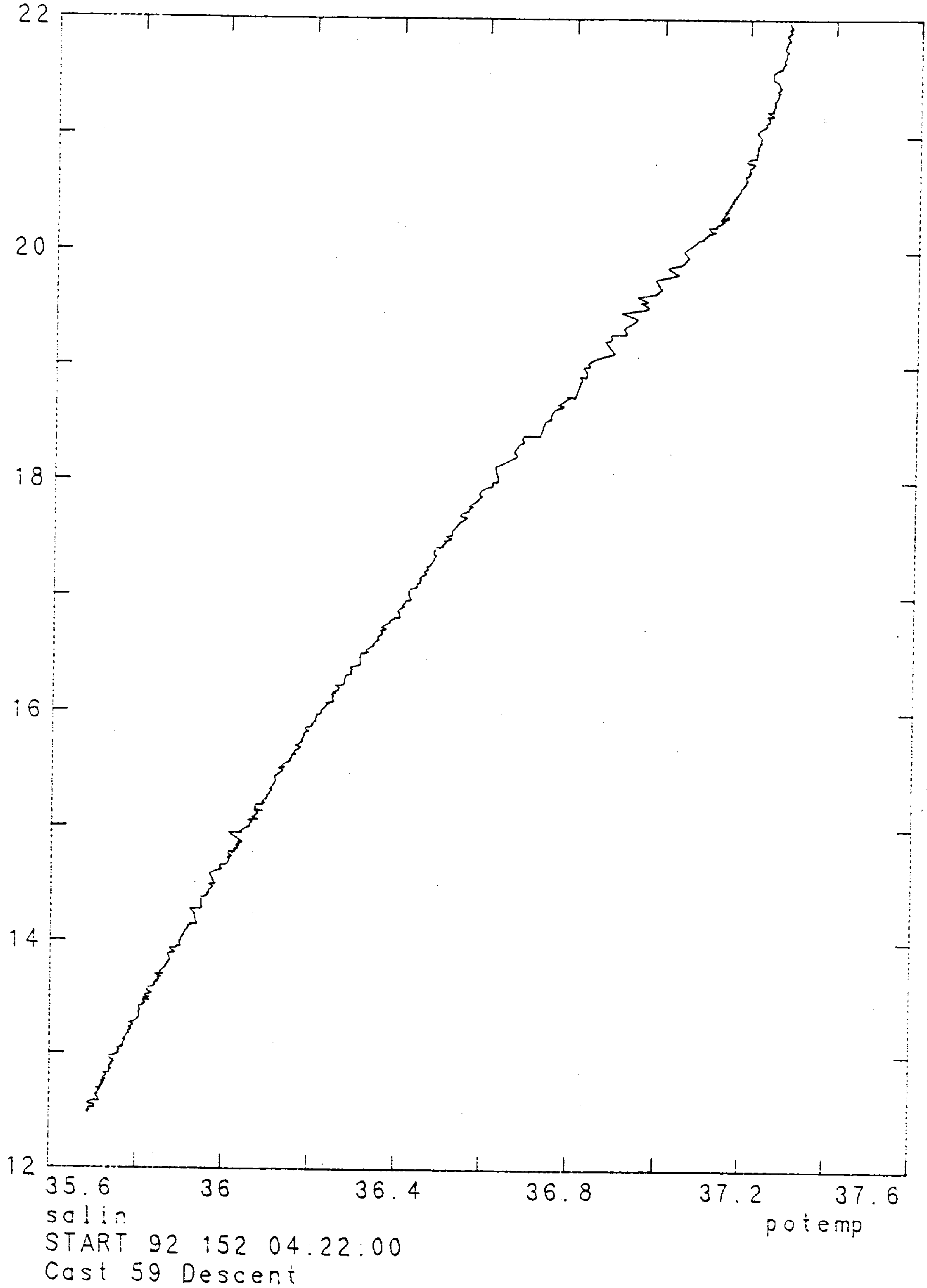


Fig. 16. Cast 59. Potential temperature – salinity relationship

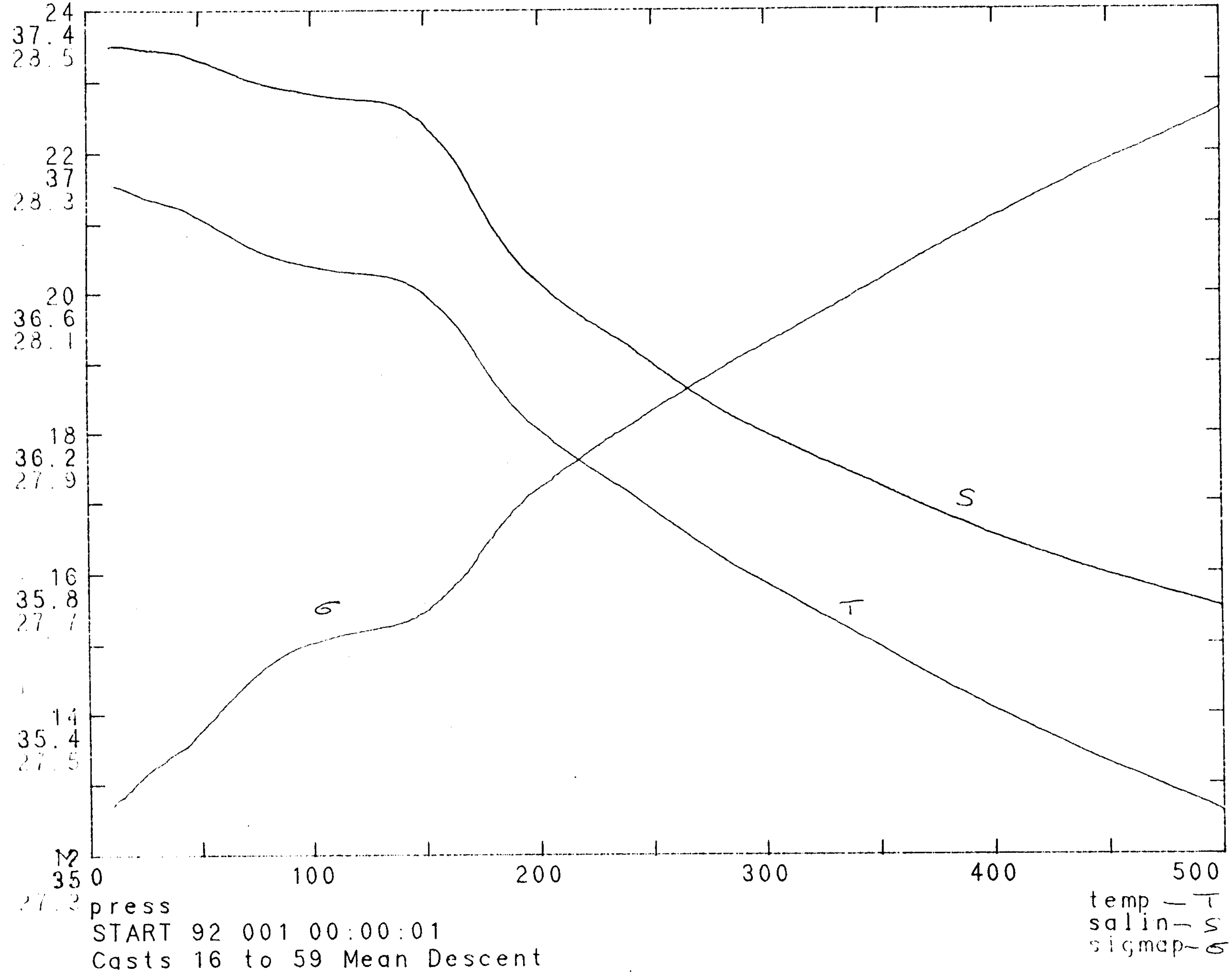


Fig. 17. Mean Descent Profiles: Cast 16-59

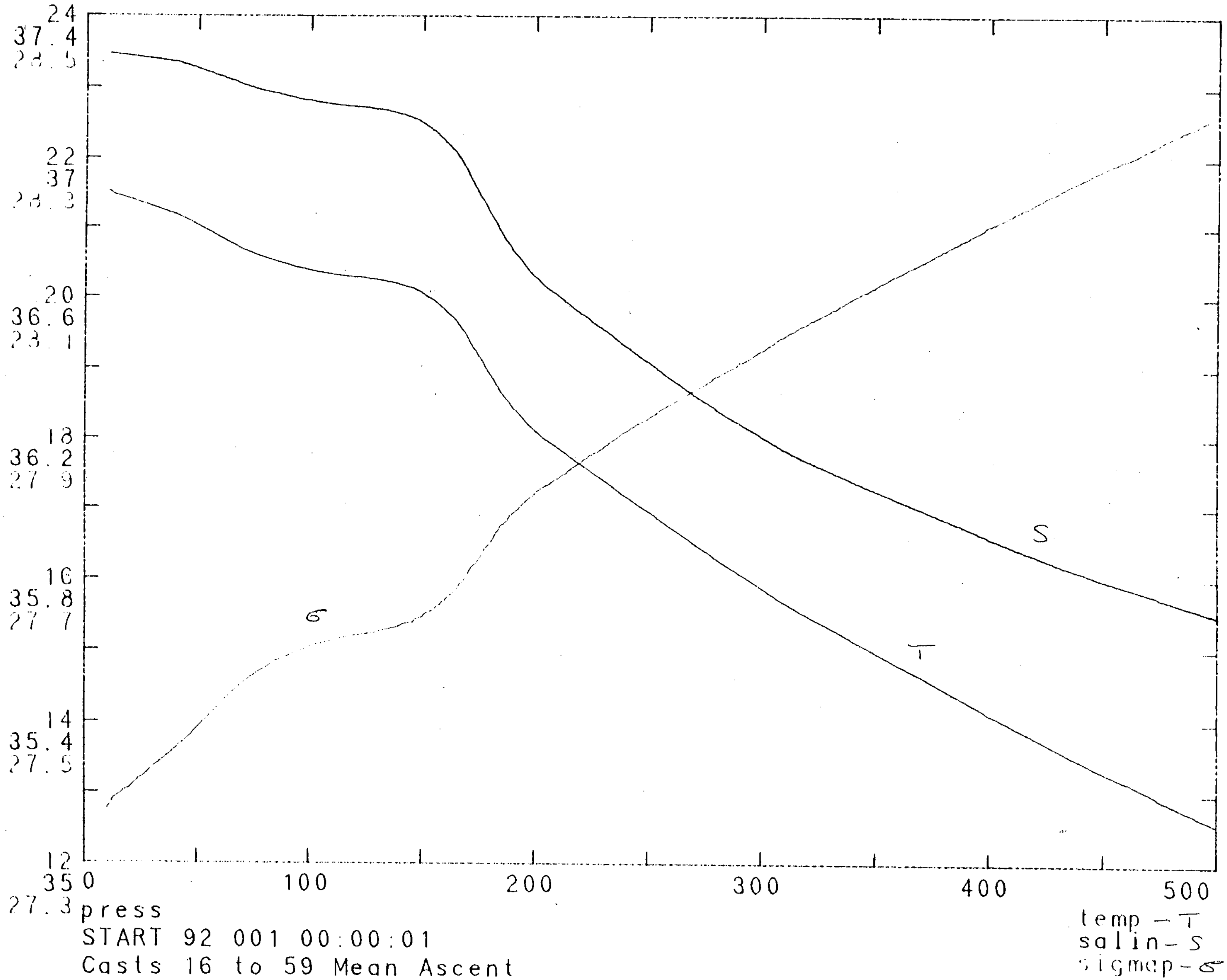


Fig. 18. Cast 16 – 59. Mean Ascent Profiles

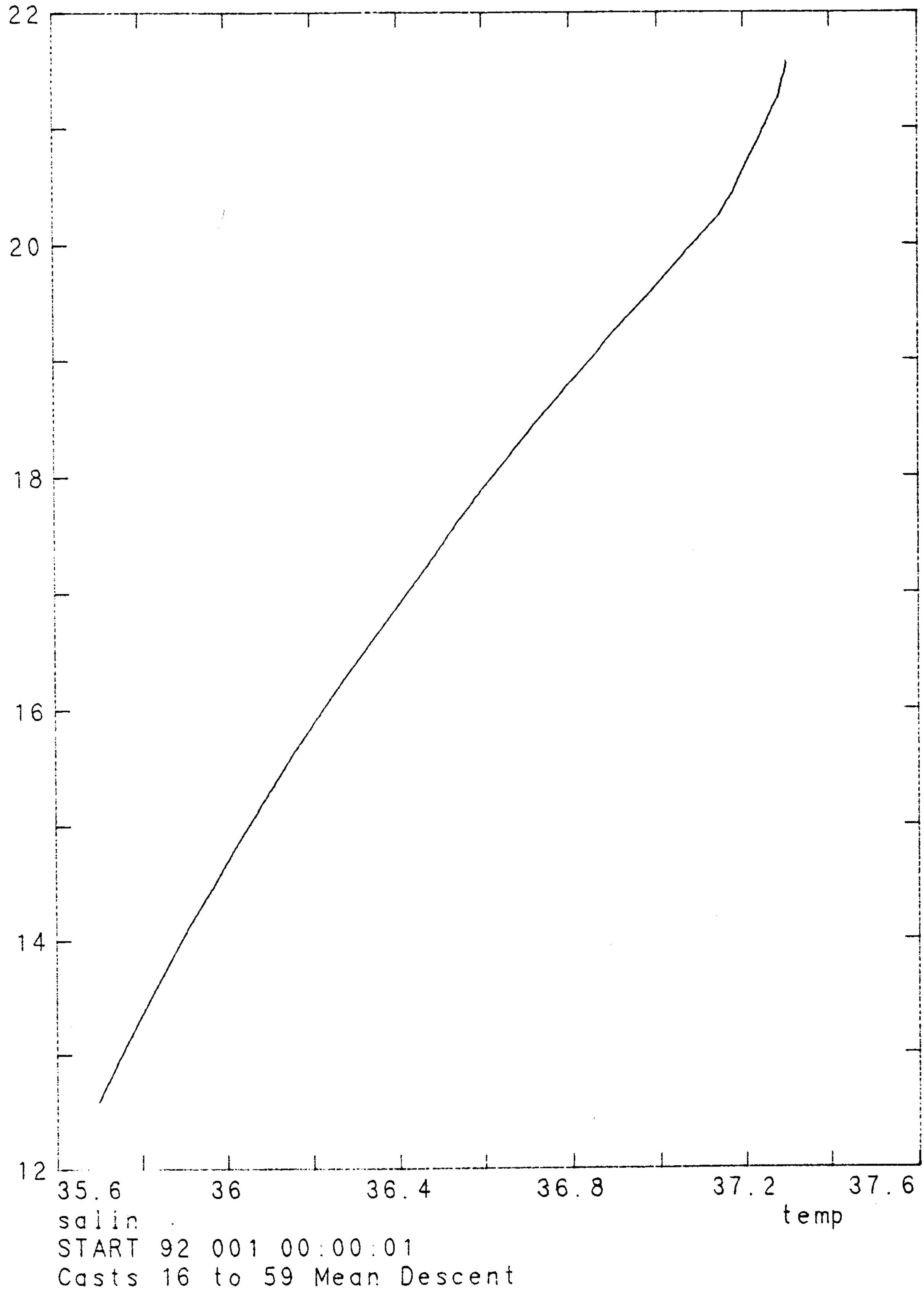


Fig. 19. Mean Descent Potential Temperature - Salinity relationship

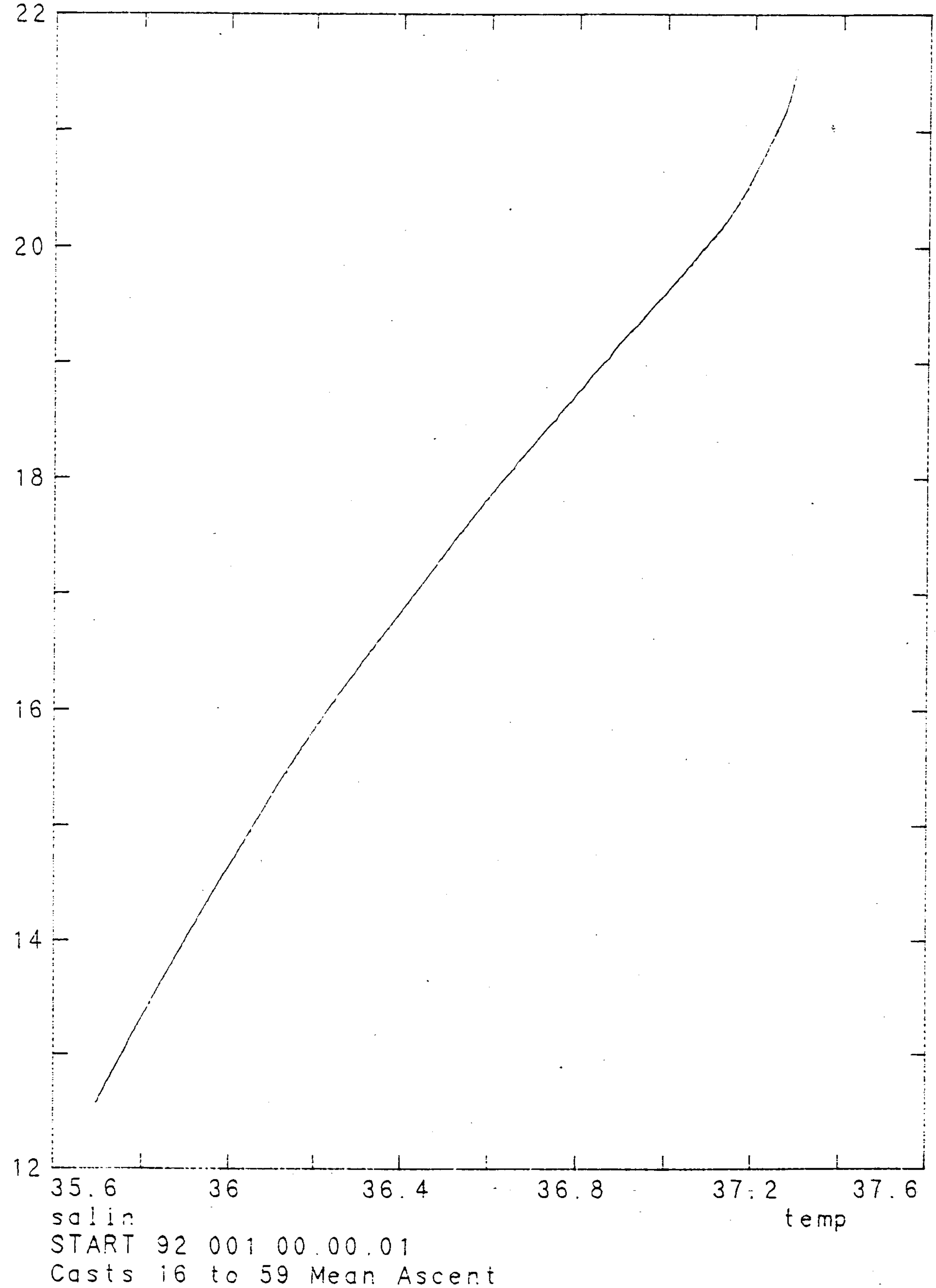


Fig. 20. Mean Ascent Potential temperature - salinity relationship

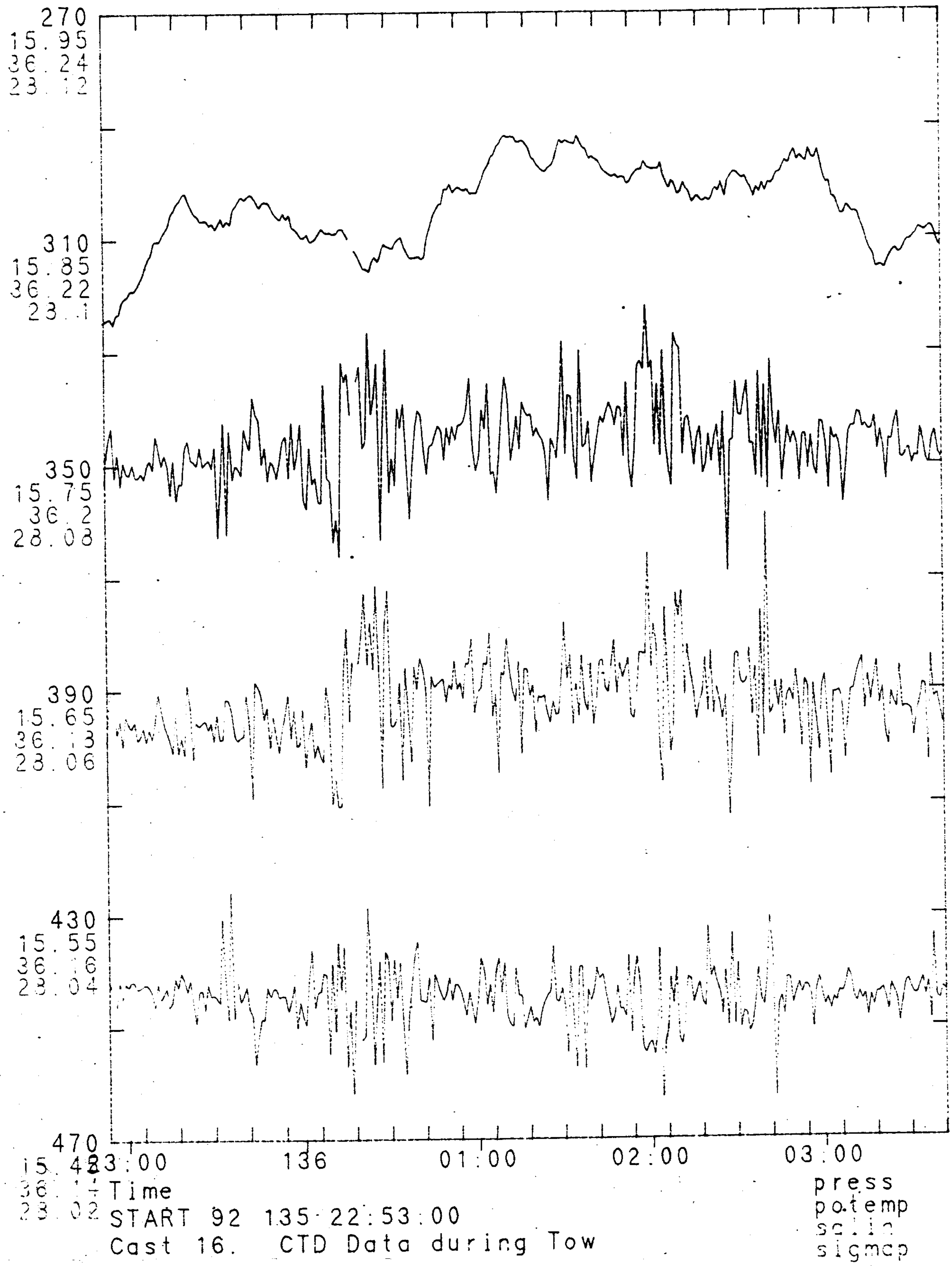


Fig. 21 Cast 16 : CTD Data during tow

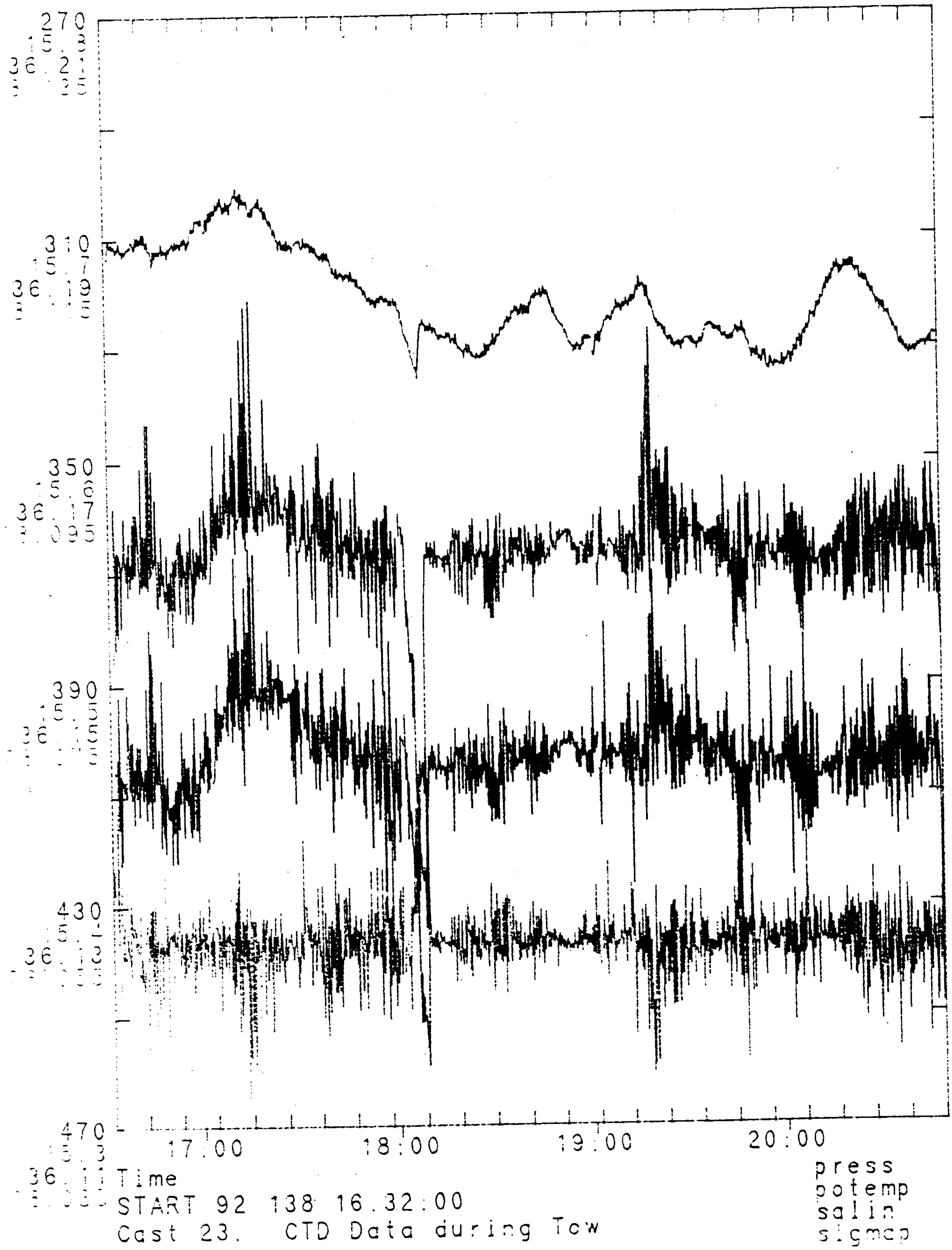


Fig 22. Cast 23 CTD Data during tow

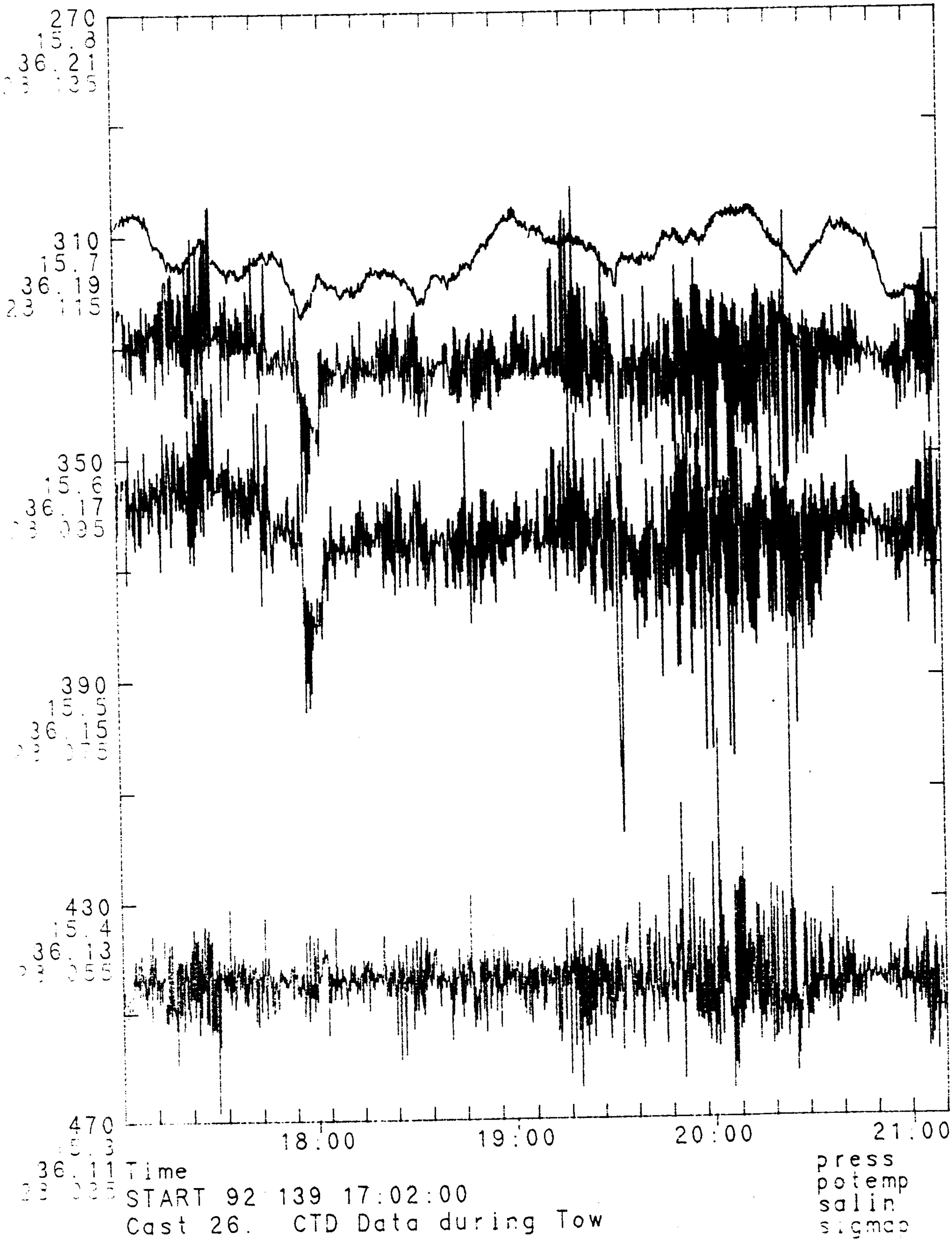


Fig 23. Cast 26. CTD Data during tow

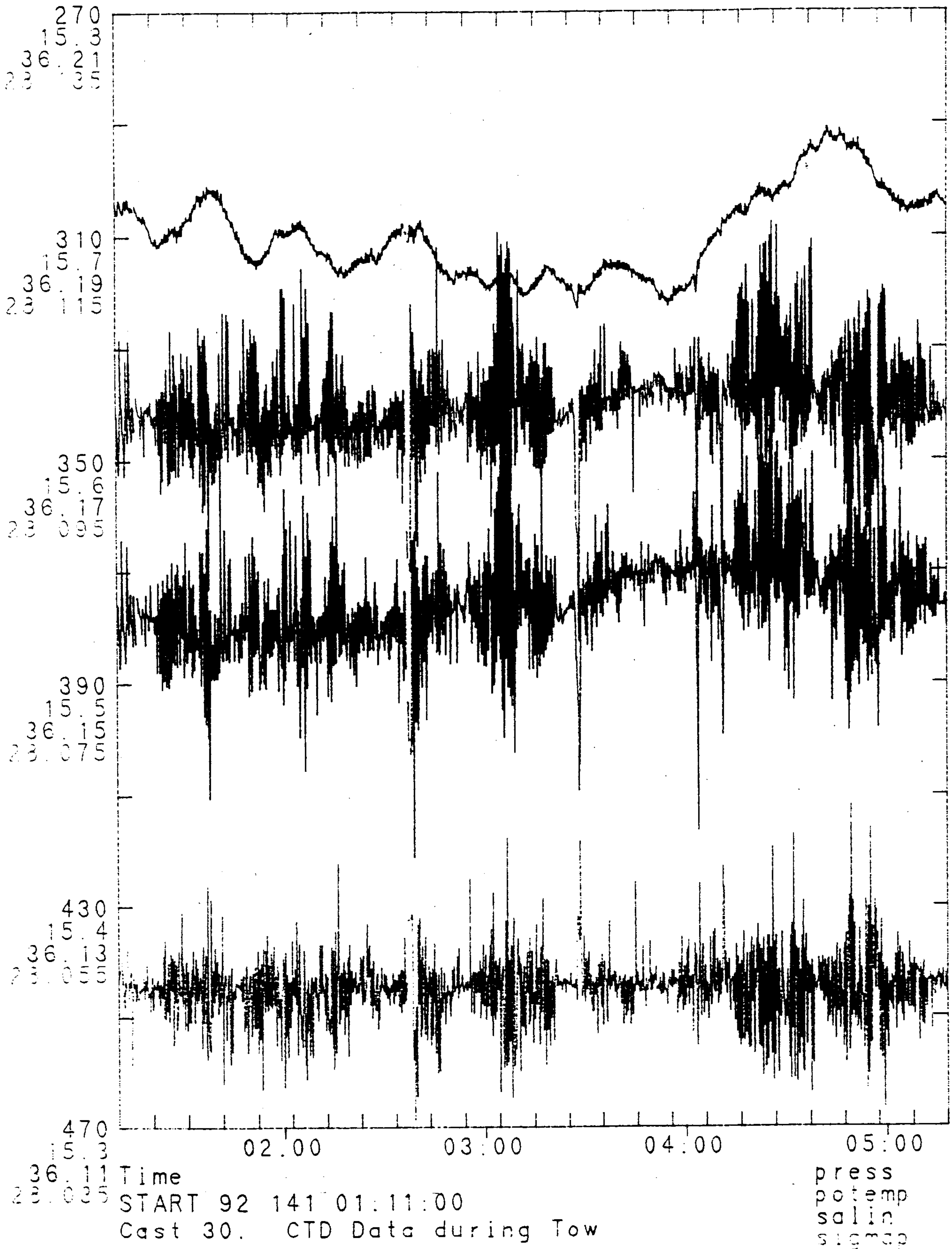


Fig. 24. Cast 30. CTD Data during tow

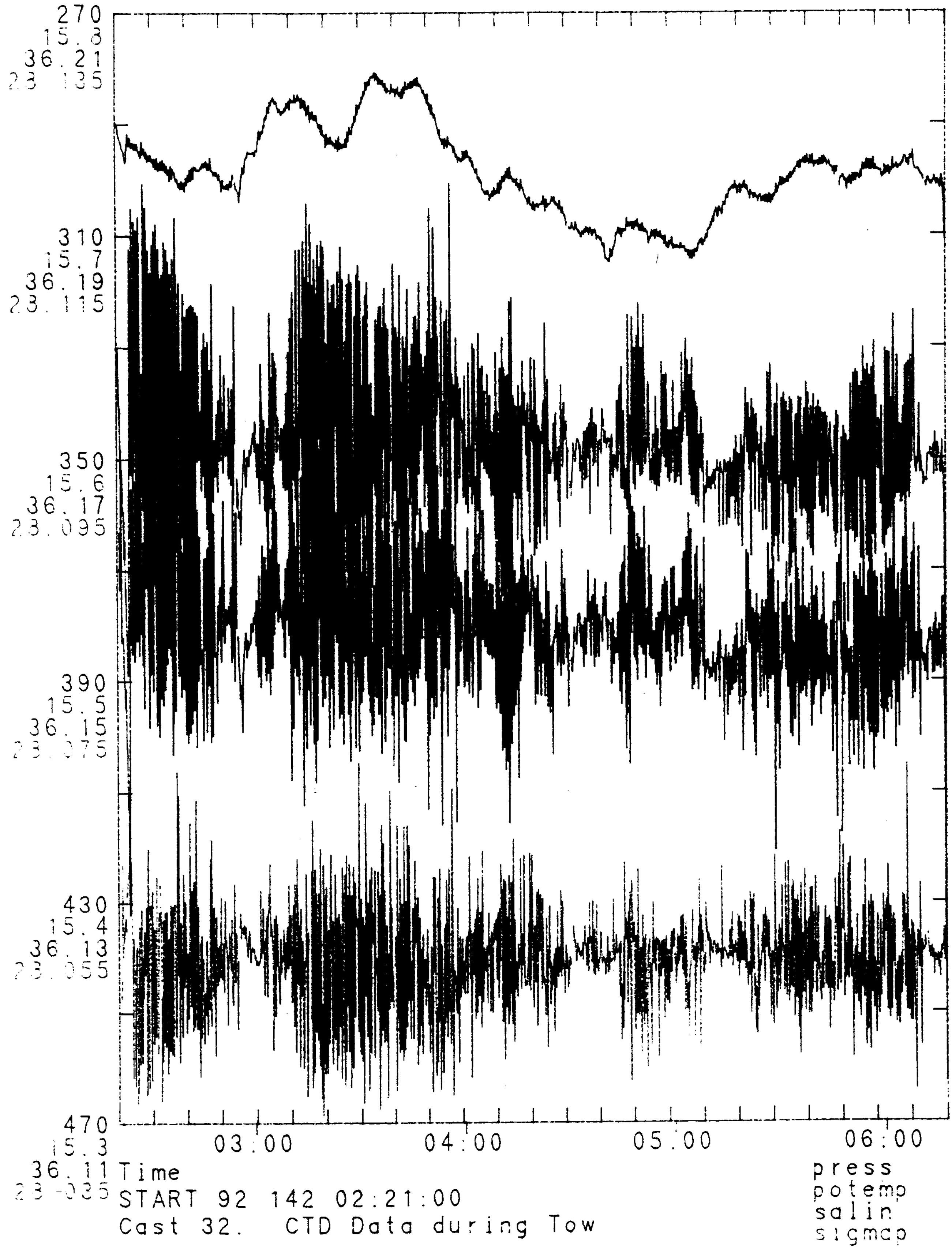


Fig 25. Cast 32. CTD Data during tow

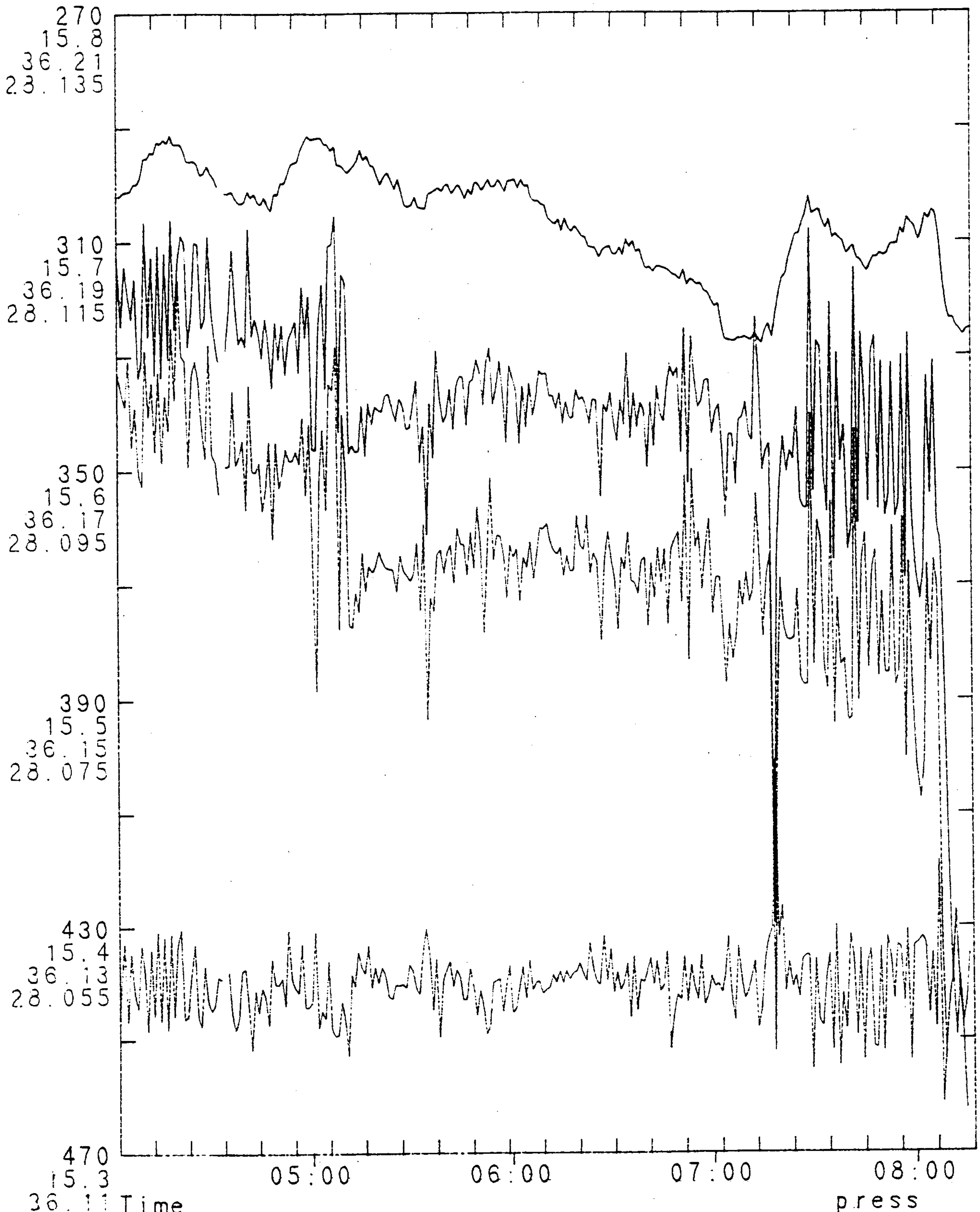


Fig. 26. Cast 40. CTD Data during tow

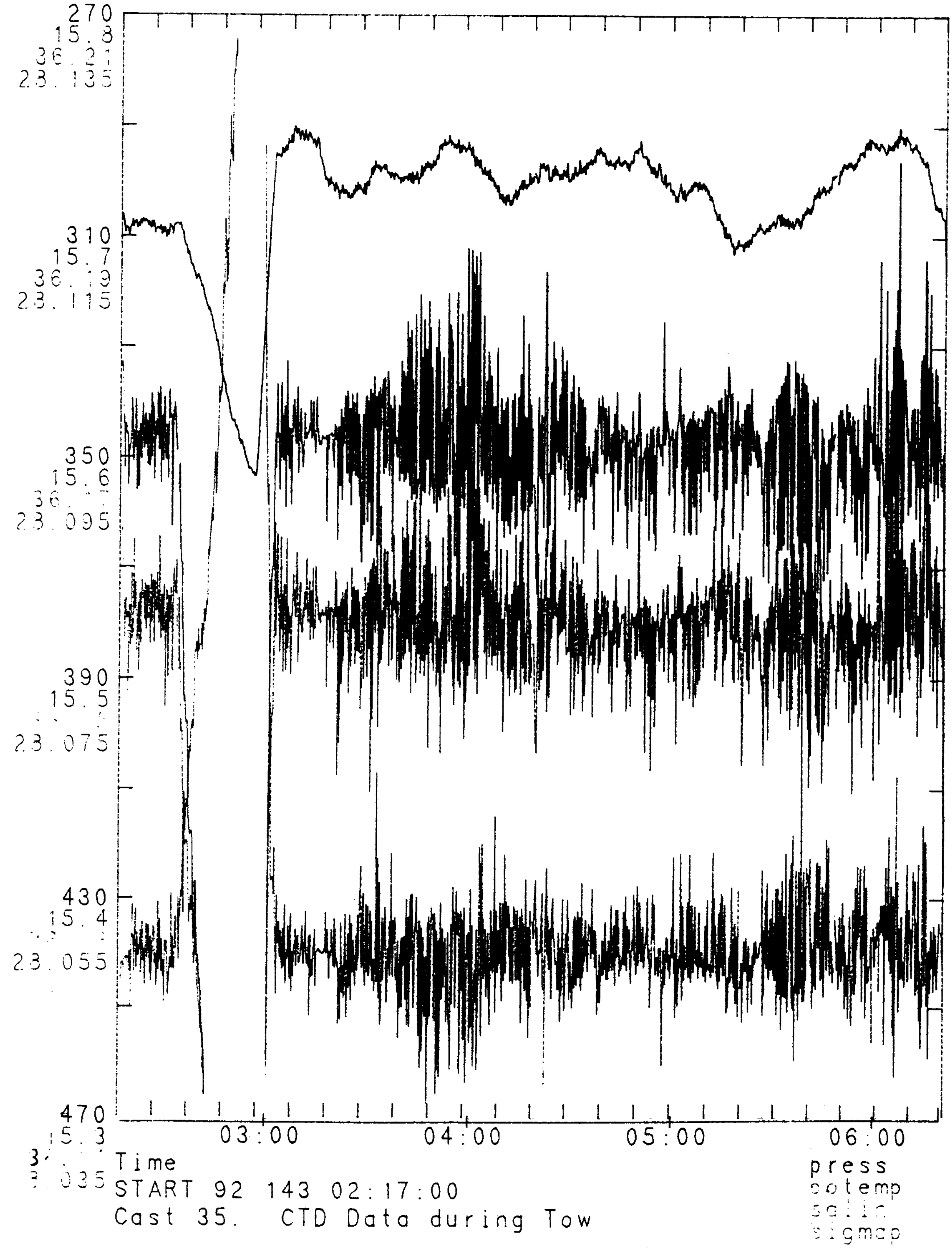


Fig. 27. Cast 35. CTD Data during tow

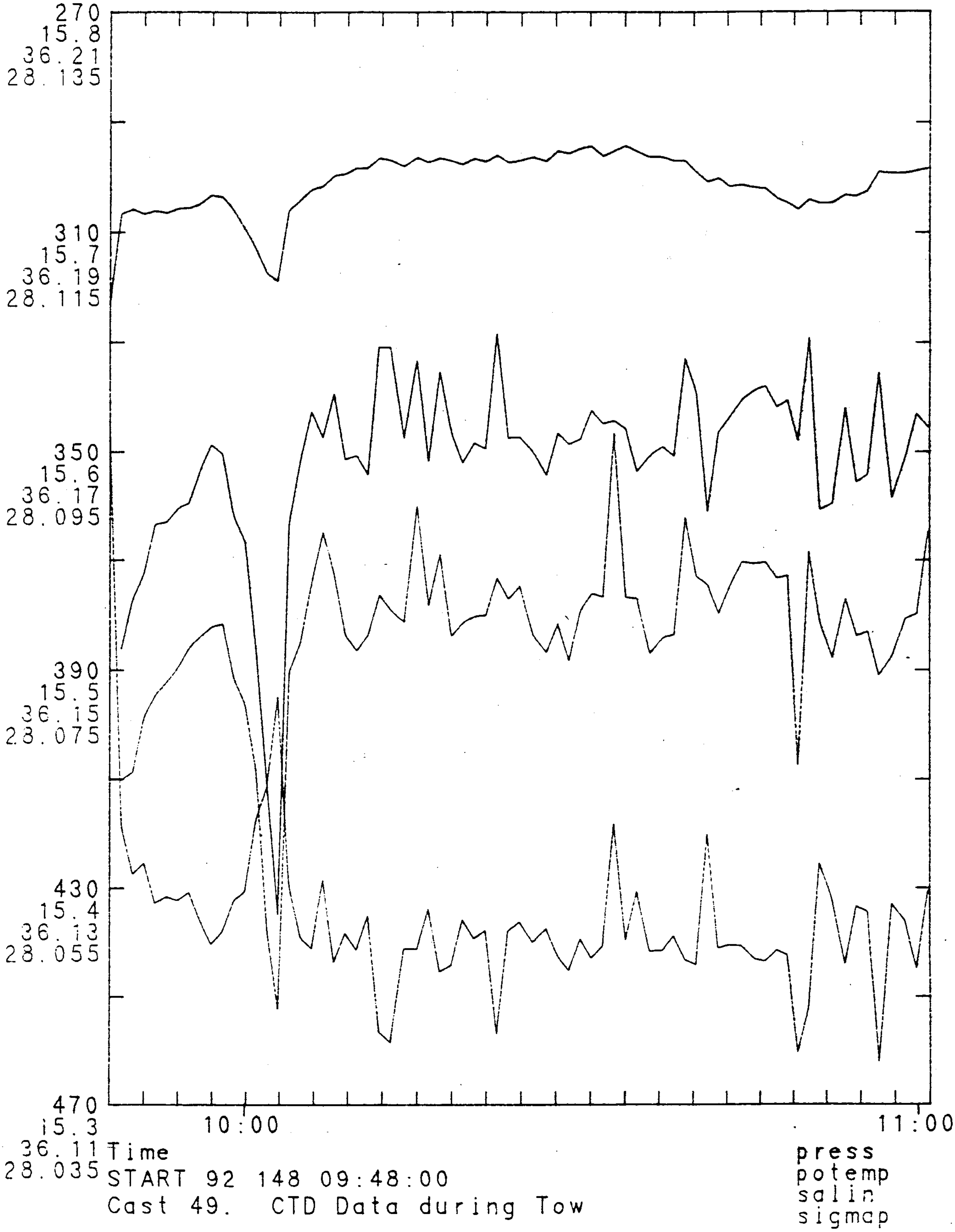


Fig. 28. Cast 49. CTD Data during tow

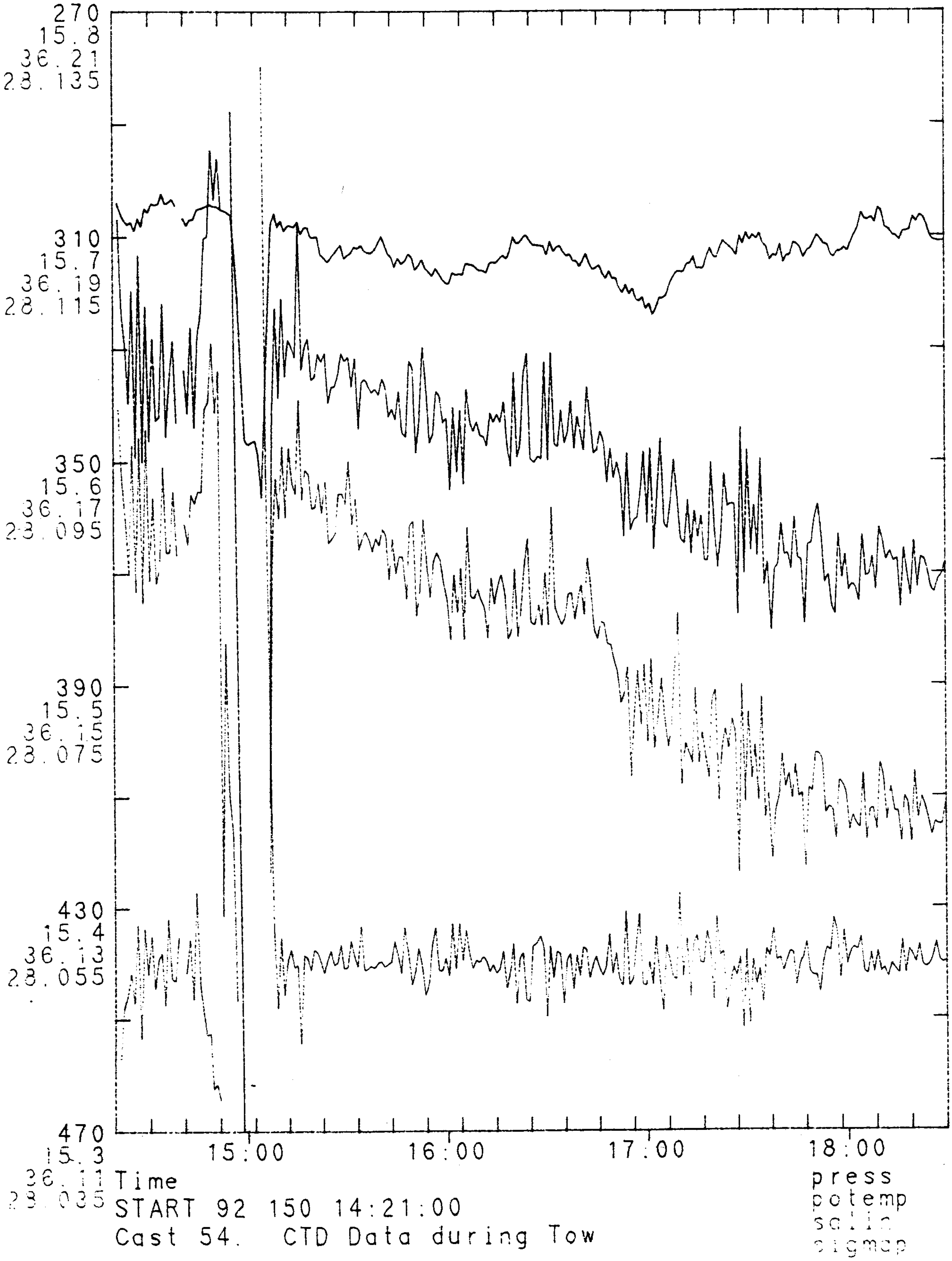


Fig. 29. Cast 54. CTD Data during tow

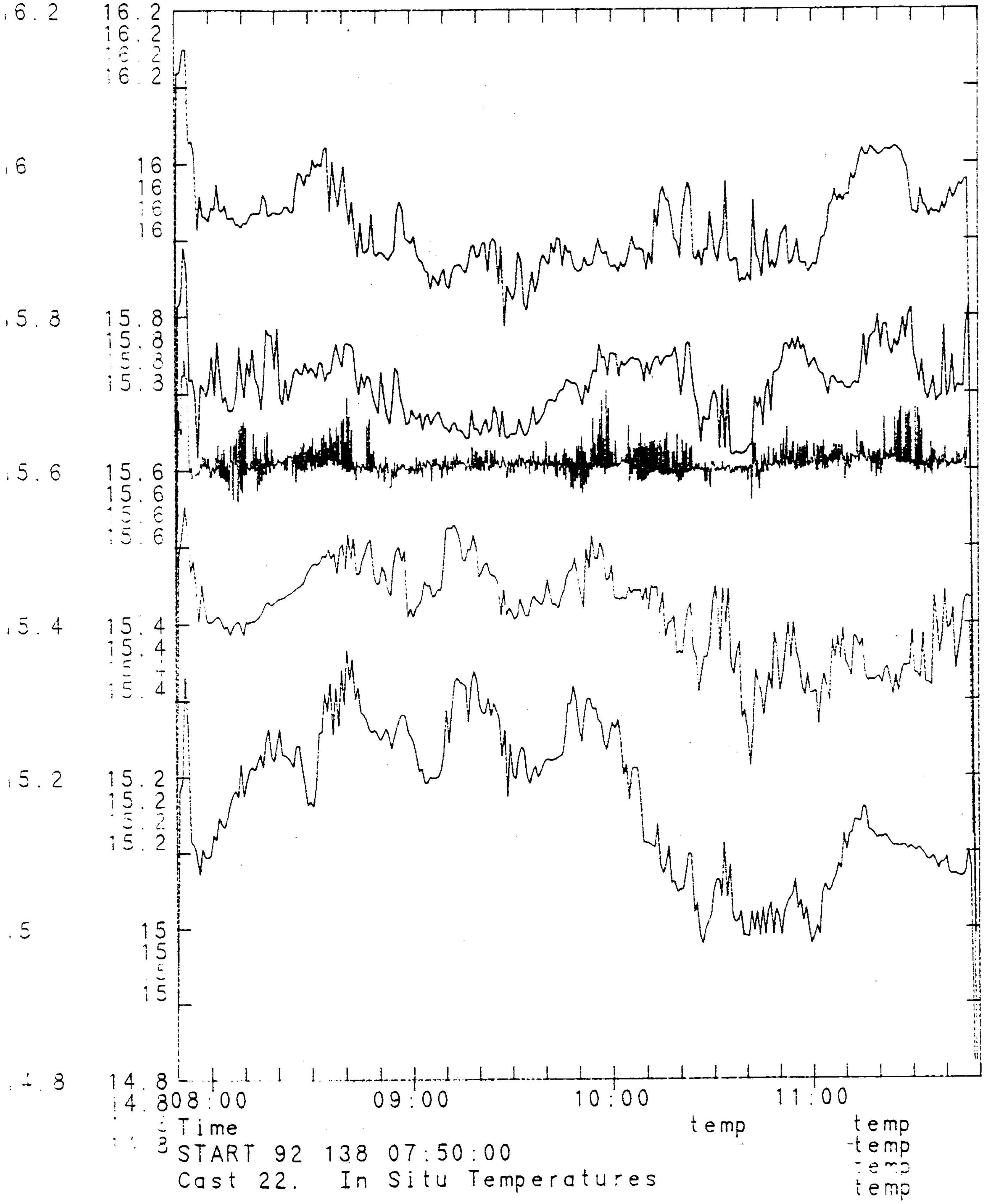


Fig. 30. Cast 22. In Situ temperatures

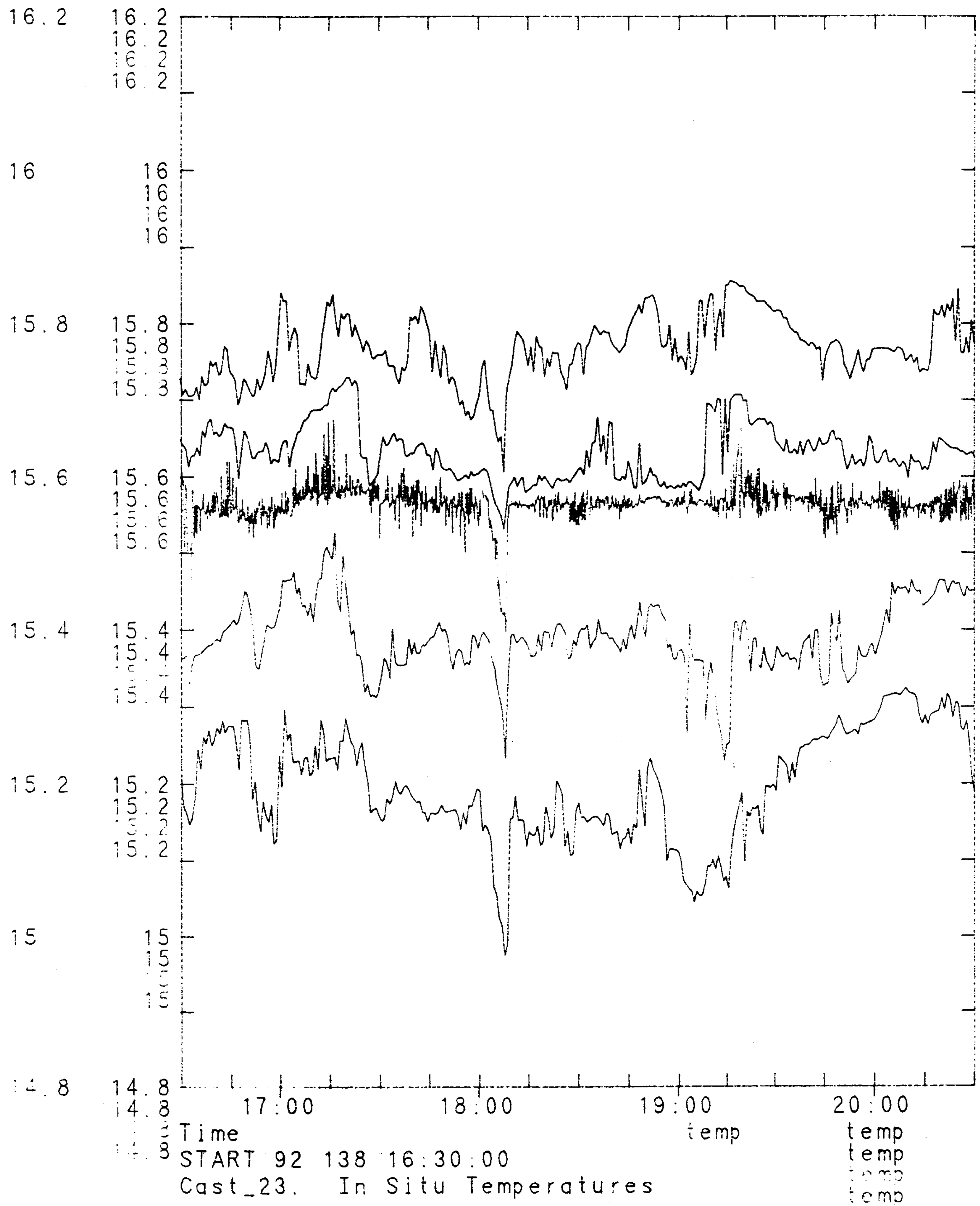


Fig. 31 Cast 23. In Situ Temperatures

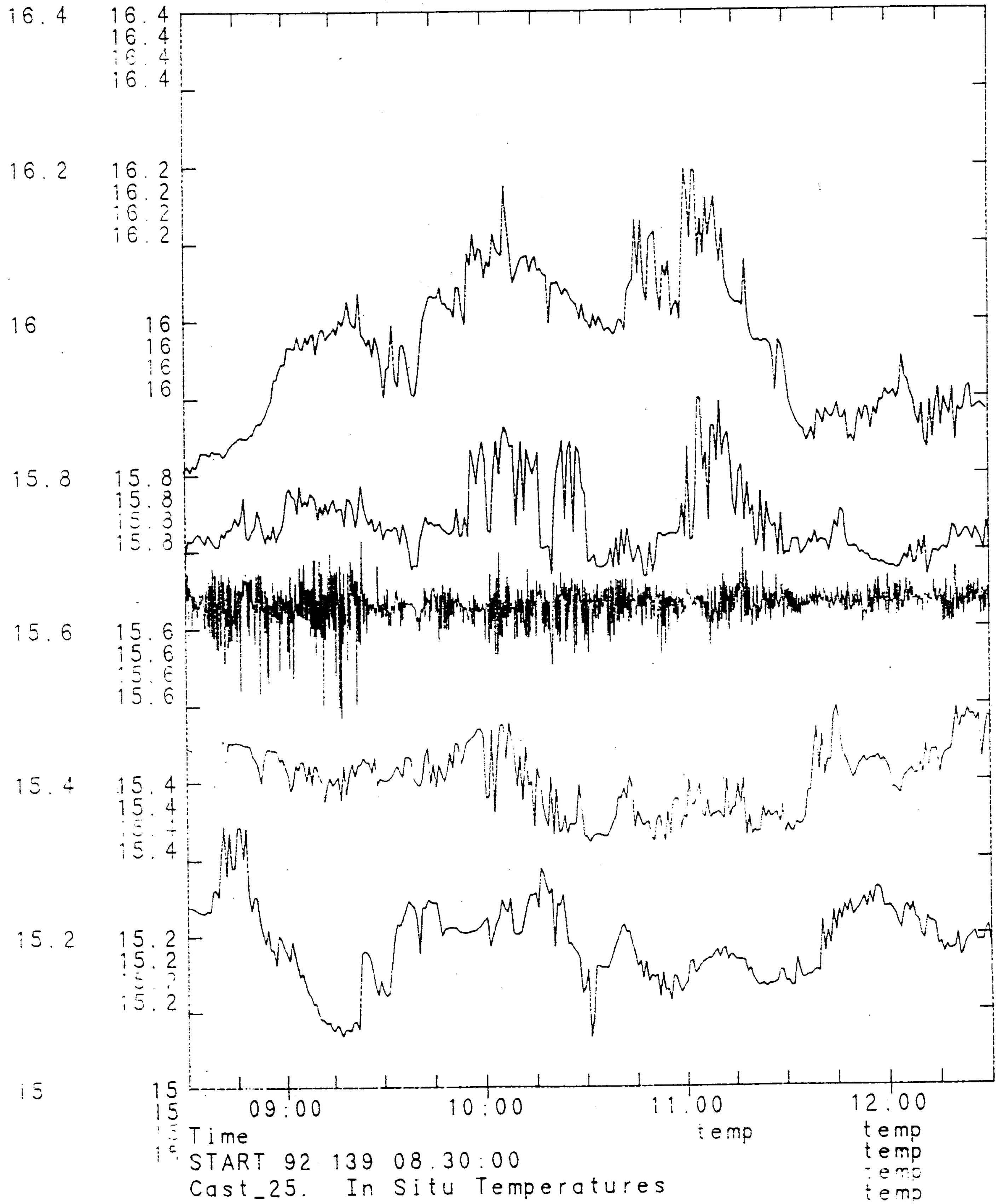


Fig. 32. Cast 25. In Situ Temperatures

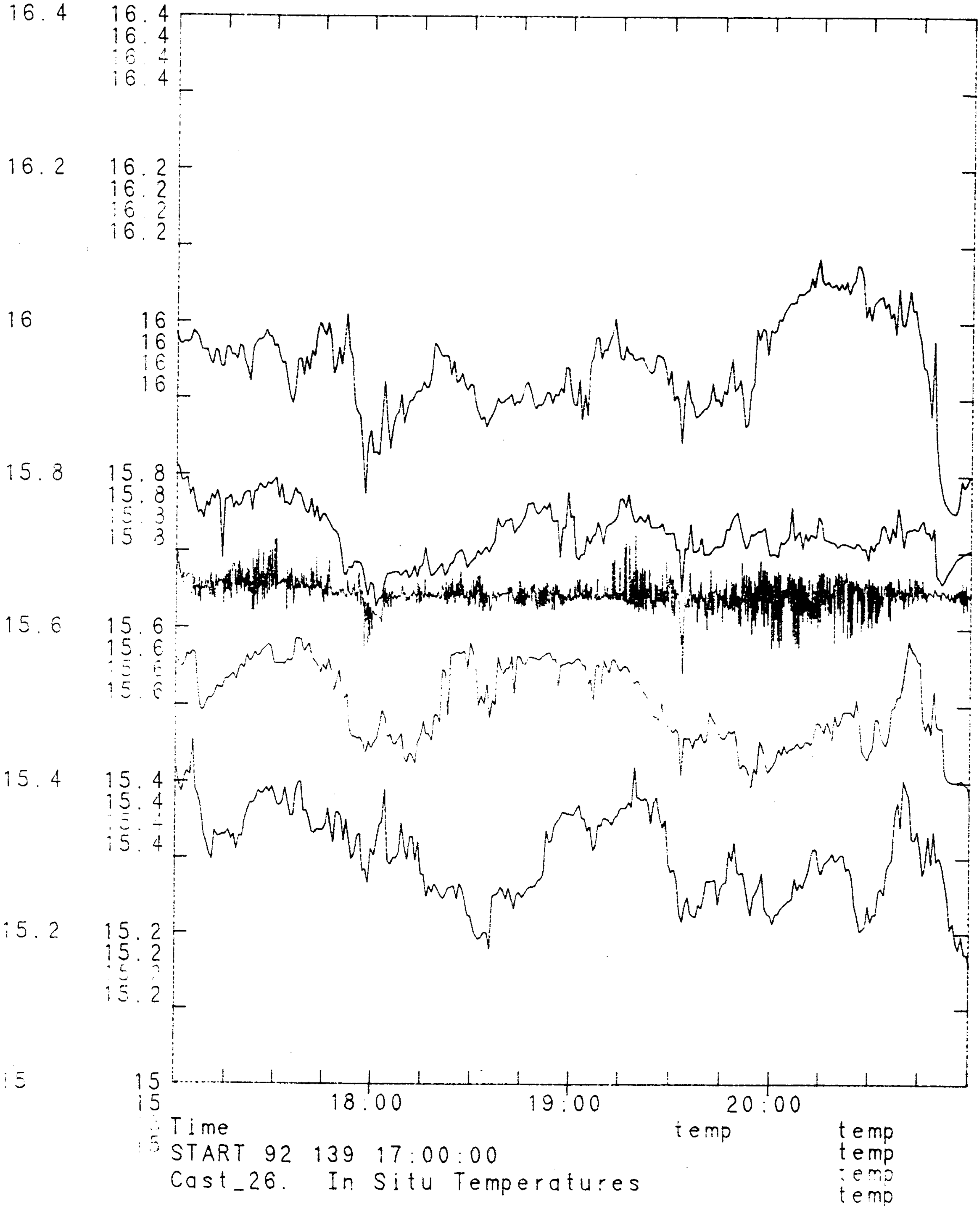


Fig. 33. Cast 26. In Situ temperatures

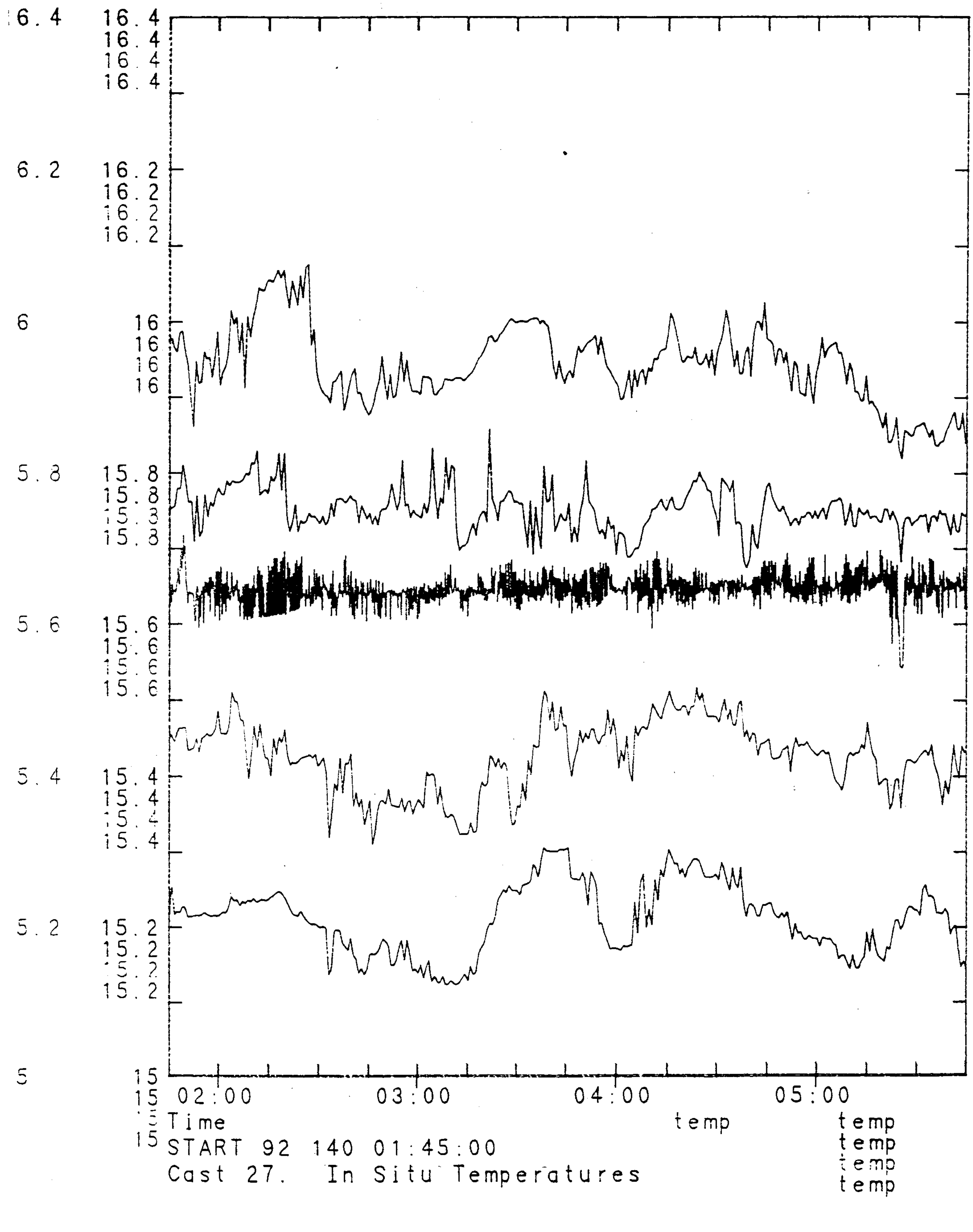
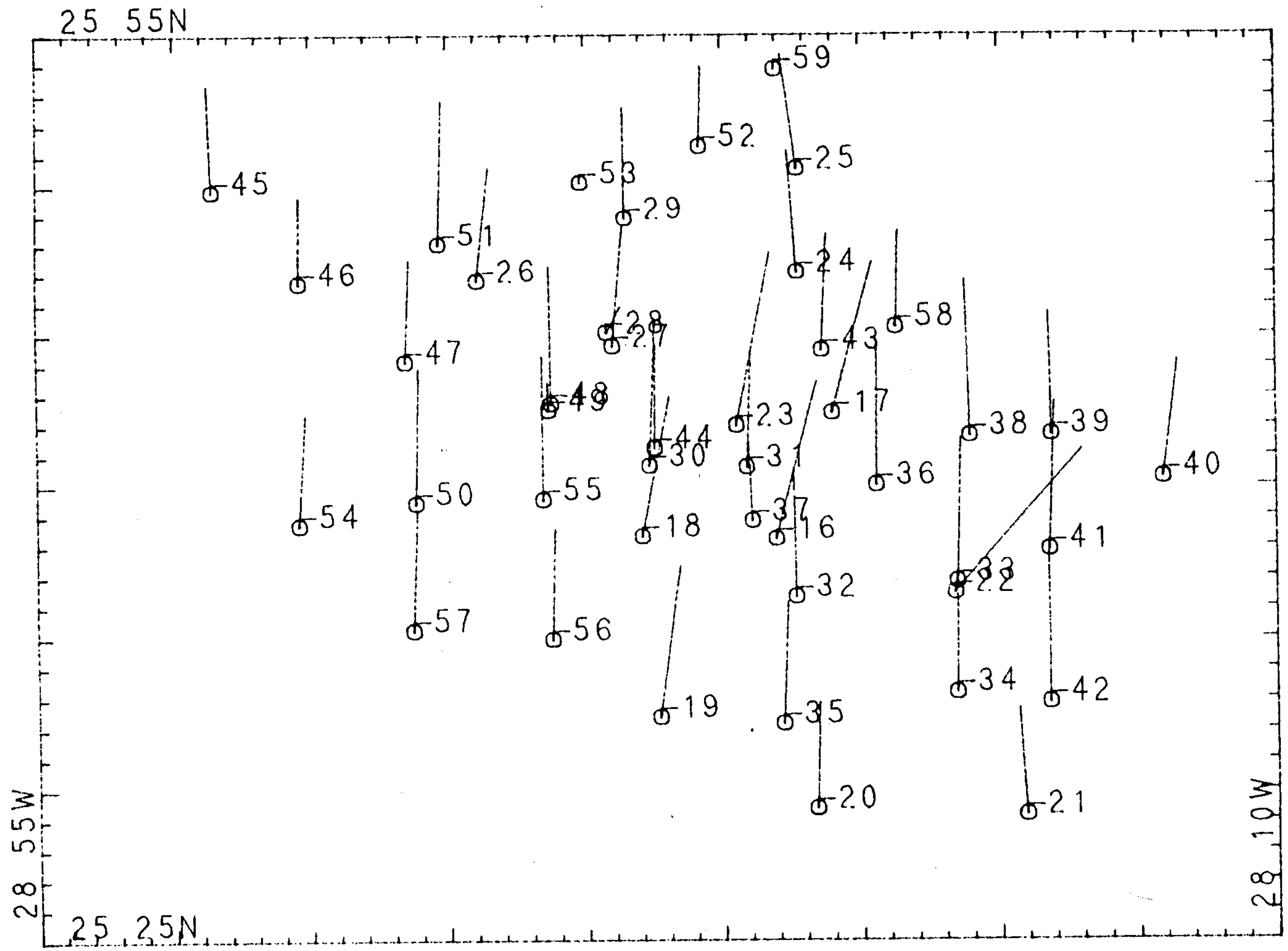


Fig. 34. Cast 27. In Situ temperatures.



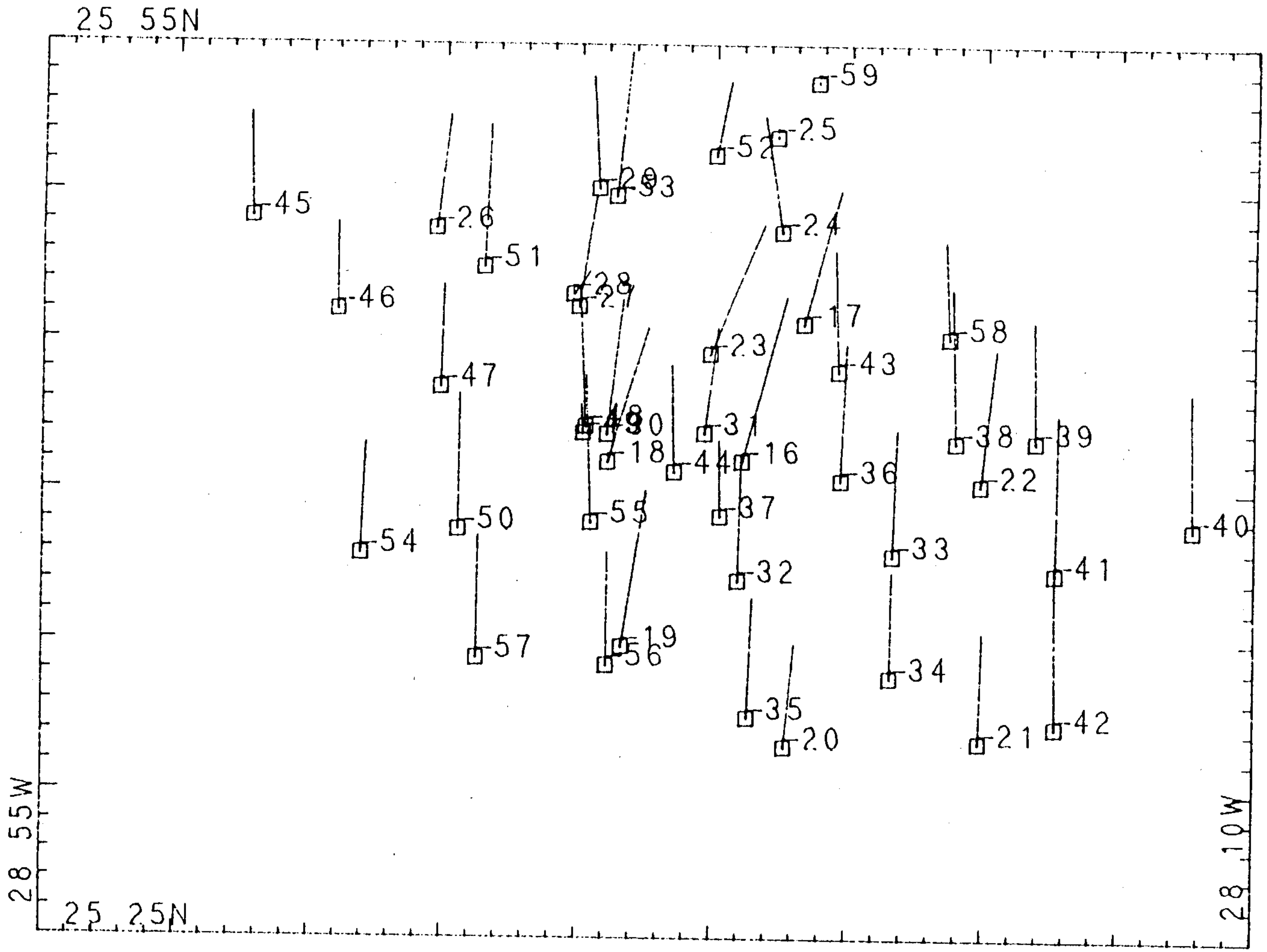
MERCATOR PROJECTION

GRID NO. 1

SCALE 1 TO 493238 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

Fig. 35. Conservative estimate of track positions



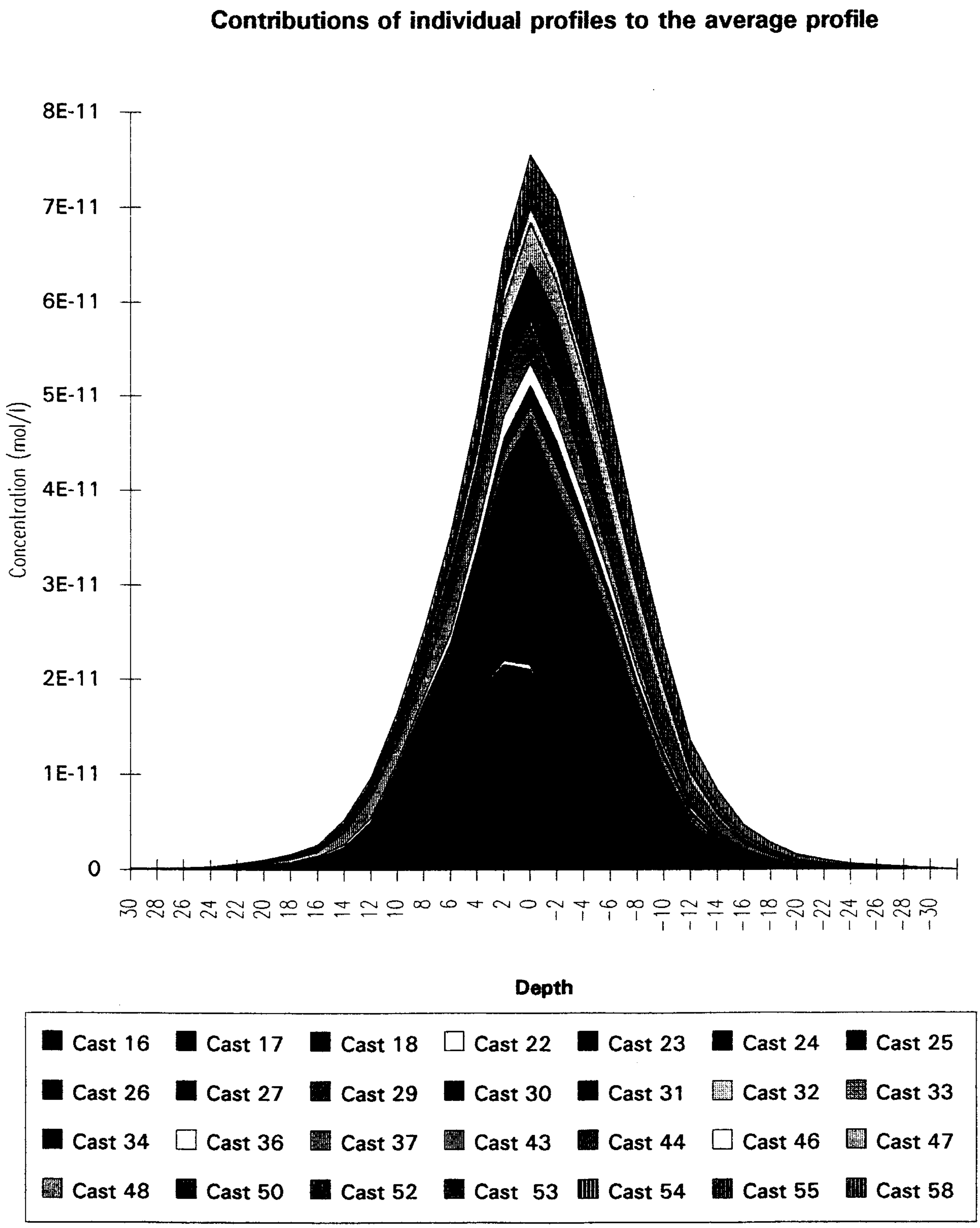
MERCATOR PROJECTION

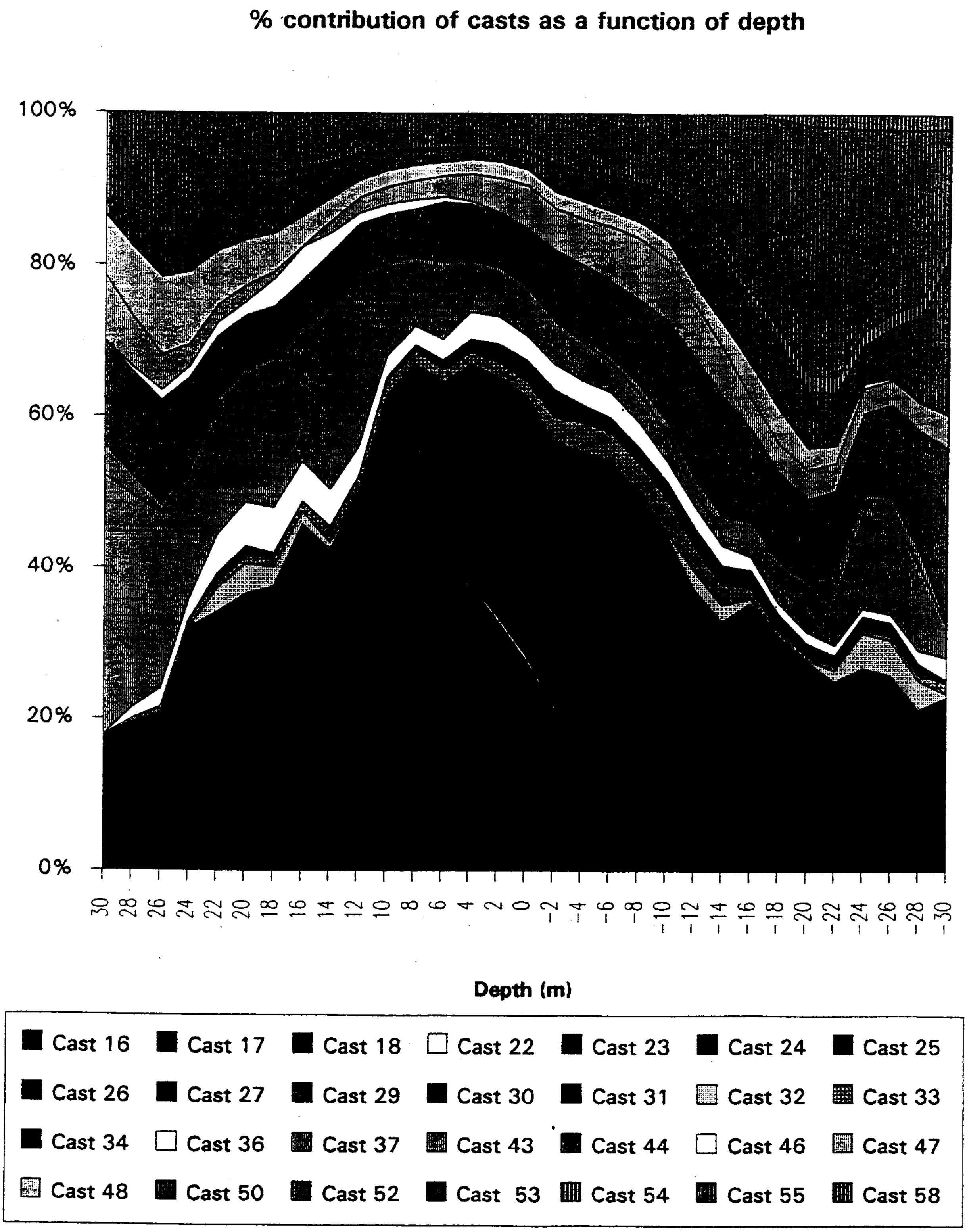
SCALE 1 TO 493238 (NATURAL SCALE AT LAT. 0)

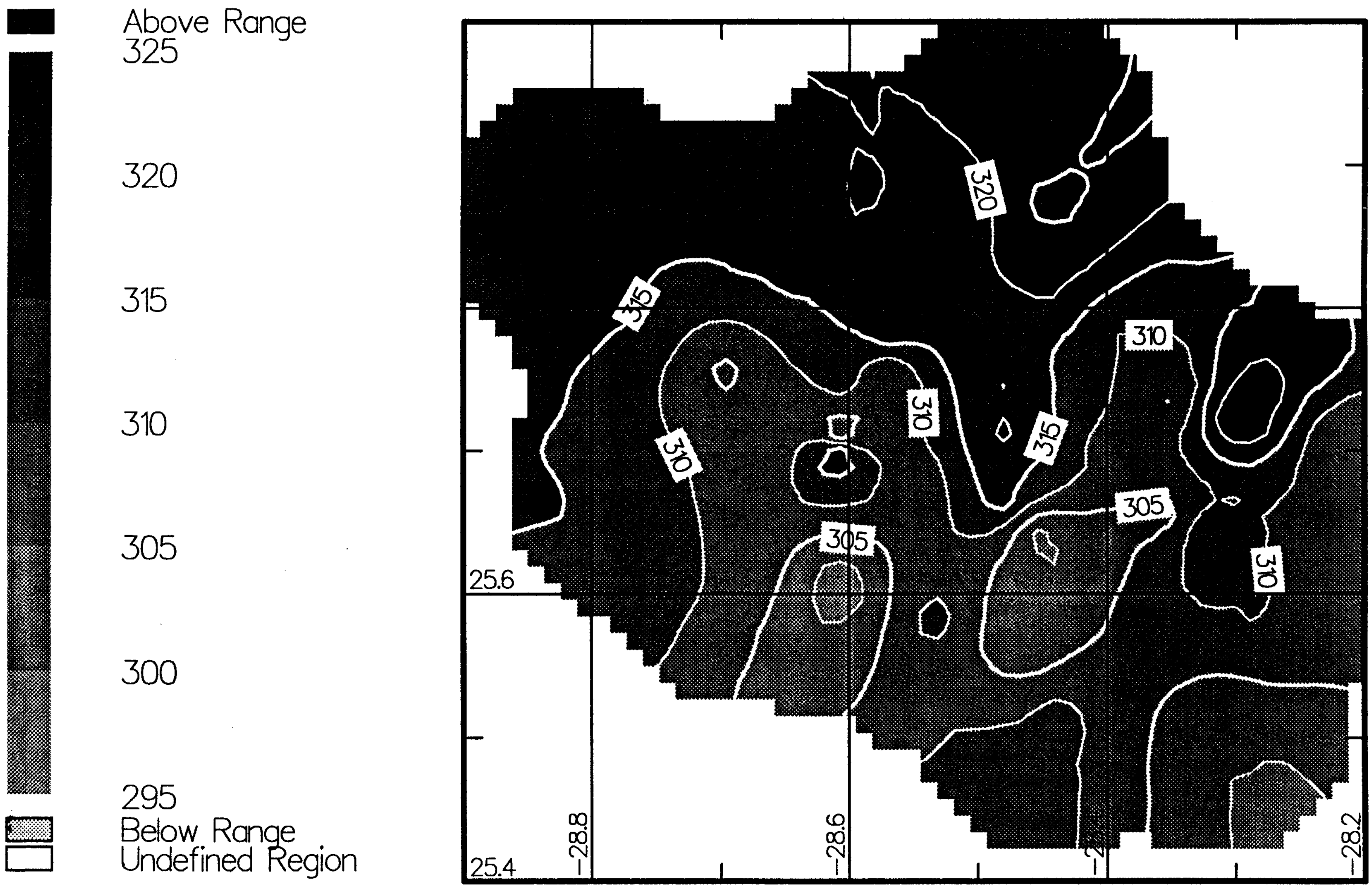
INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

GRID NO. 1

Fig. 36. Liberal estimate of track positions

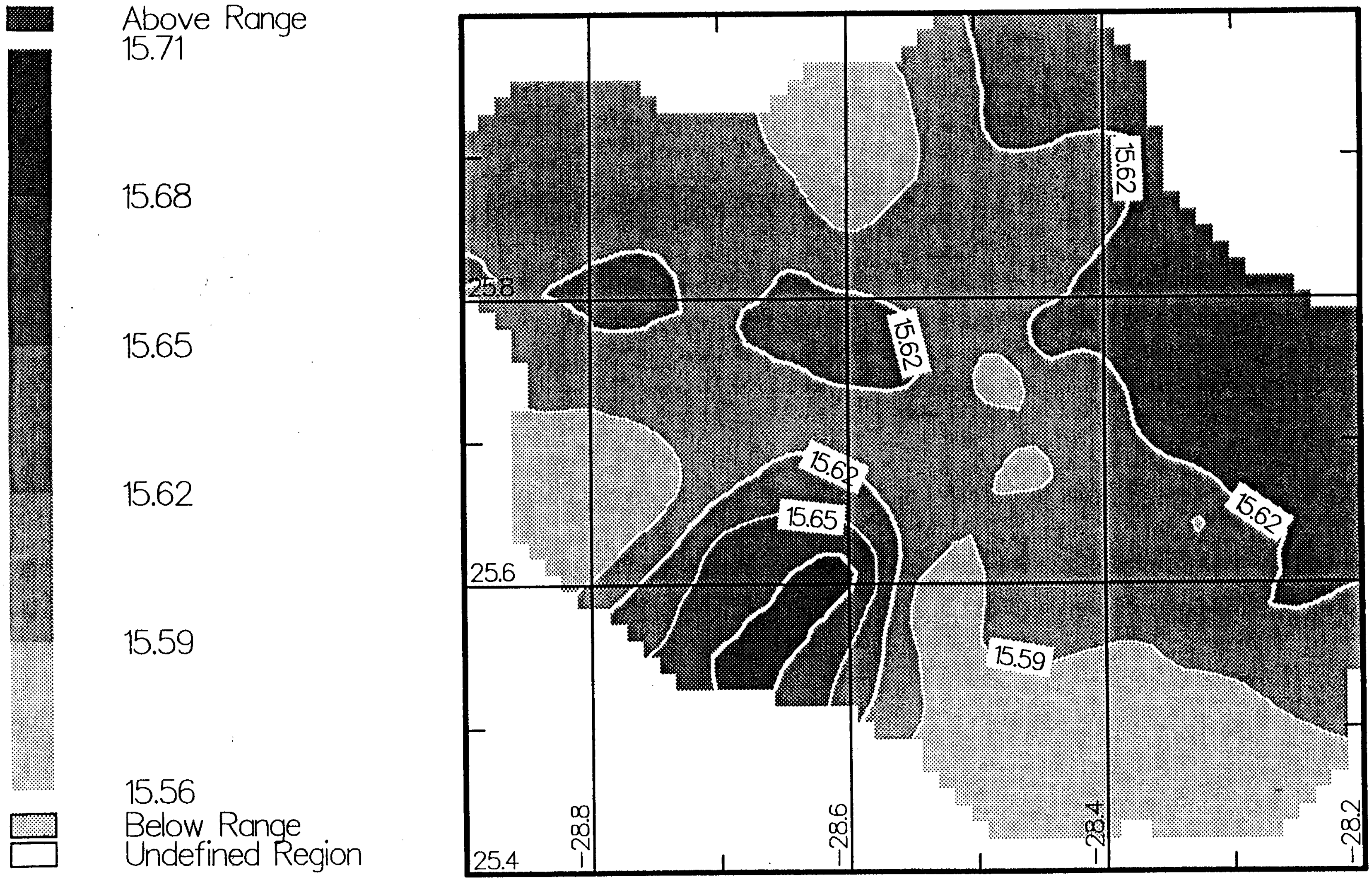

Contributions of individual profiles to the average profile
8E-11
7E-11
6E-11
5E-11
4E-11
3E-11
2E-11
1E-11
0
Concentration (mol/l)
30 28 26 24 22 20 18 16 14 12 10 8 6 4 2 0 -2 -4 -6 -8 -10 -12 -14 -16 -18 -20 -22 -24 -26 -28 -30
Depth
Cast 16
Cast 17
Cast 18
Cast 22
Cast 23
Cast 24
Cast 25
Cast 26
Cast 27
Cast 29
Cast 30
Cast 31
Cast 32
Cast 33
Cast 34
Cast 36
Cast 37
Cast 43
Cast 44
Cast 46
Cast 47
Cast 48
Cast 50
Cast 52
Cast 53
Cast 54
Cast 55
Cast 58


% contribution of casts as a function of depth
100%
80%
60%
40%
20%
0%
30 28 26 24 22 20 18 16 14 12 10 8 6 4 2 0 -2 -4 -6 -8 -10 -12 -14 -16 -18 -20 -22 -24 -26 -28 -30
Depth (m)
Cast 16 Cast 17 Cast 18 Cast 22 Cast 23 Cast 24 Cast 25
Cast 26 Cast 27 Cast 29 Cast 30 Cast 31 Cast 32 Cast 33
Cast 34 Cast 36 Cast 37 Cast 43 Cast 44 Cast 46 Cast 47
Cast 48 Cast 50 Cast 52 Cast 53 Cast 54 Cast 55 Cast 58



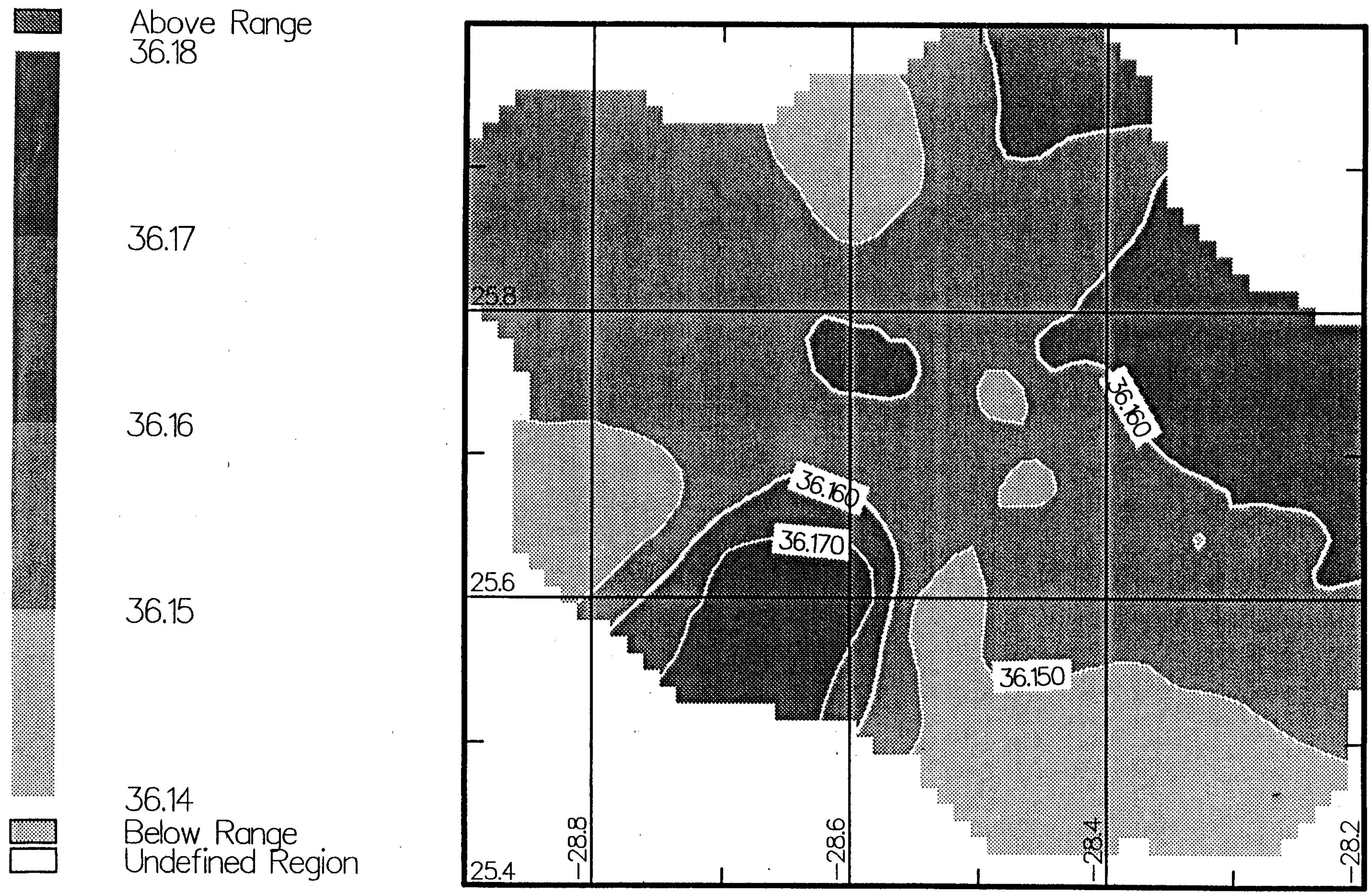
TITLE:– "Pressure at Sigma–p = 28.050 "
VARIABLE:–

Map 1.



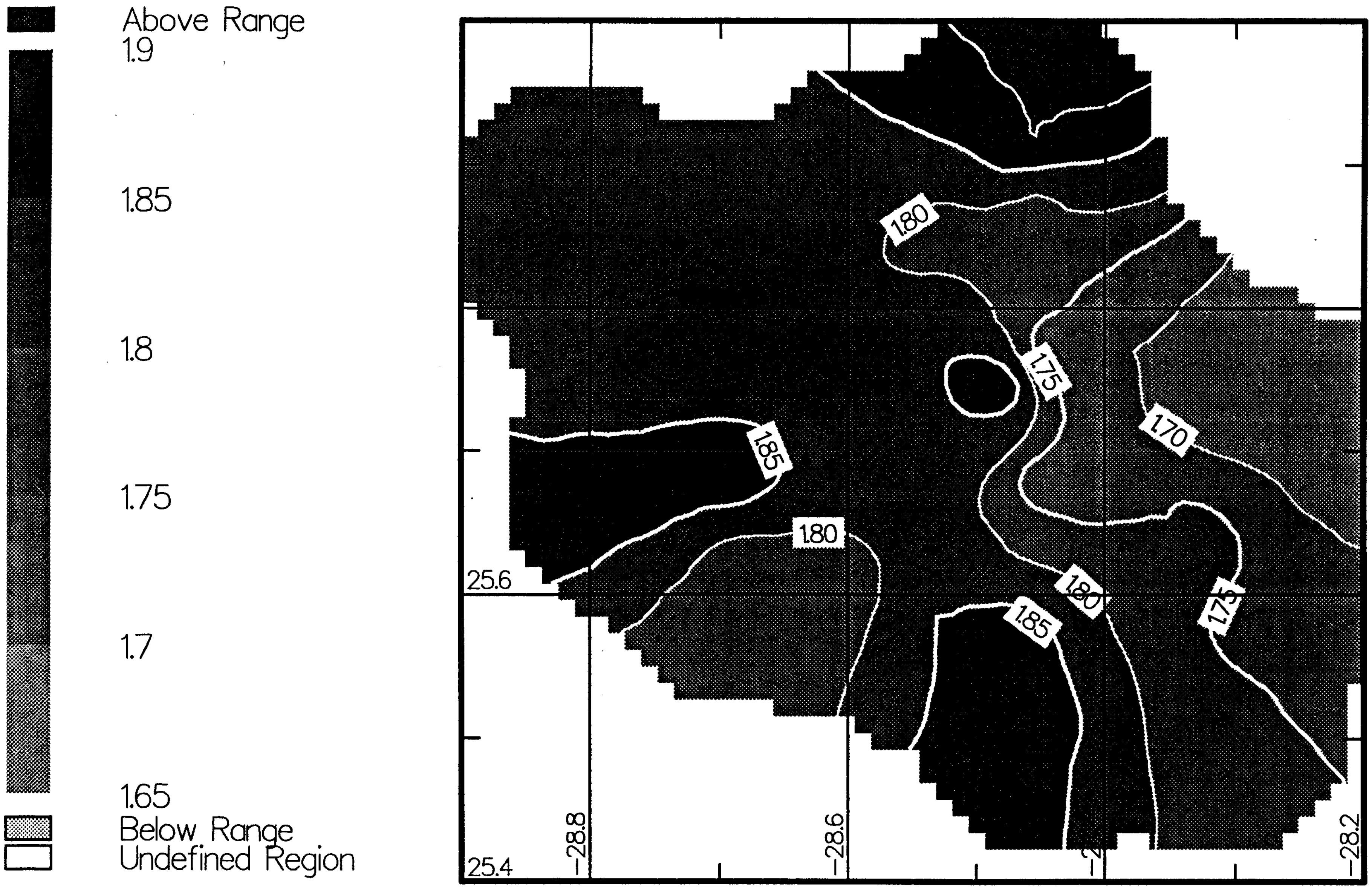
Map 2.

TITLE:— "Potential Temperature at Sigma—p = 28.050 "
VARIABLE:—



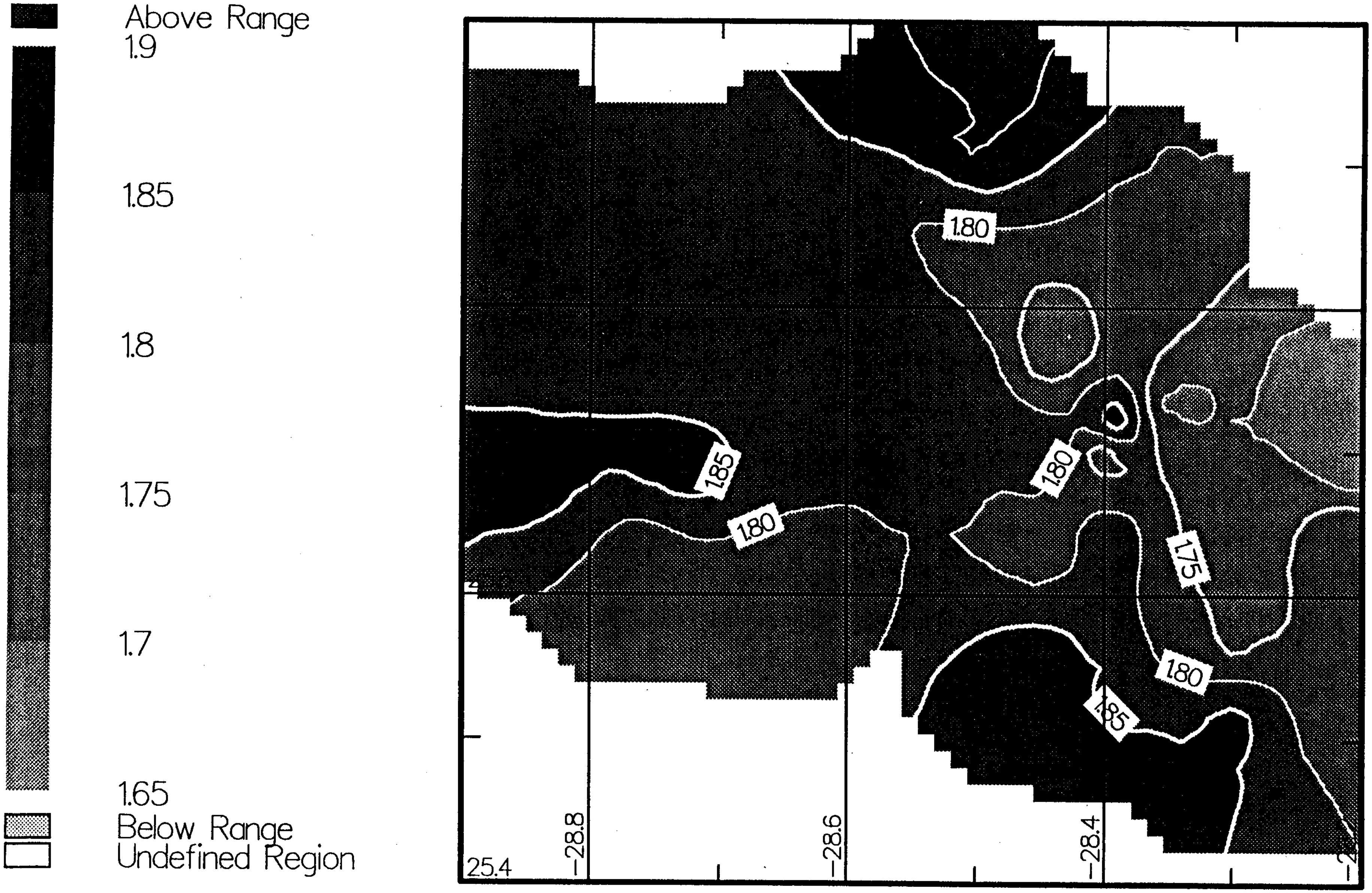
RVS TITLE:— "Salinity at Sigma—p = 28.050 "
VARIABLE:—

Map 3



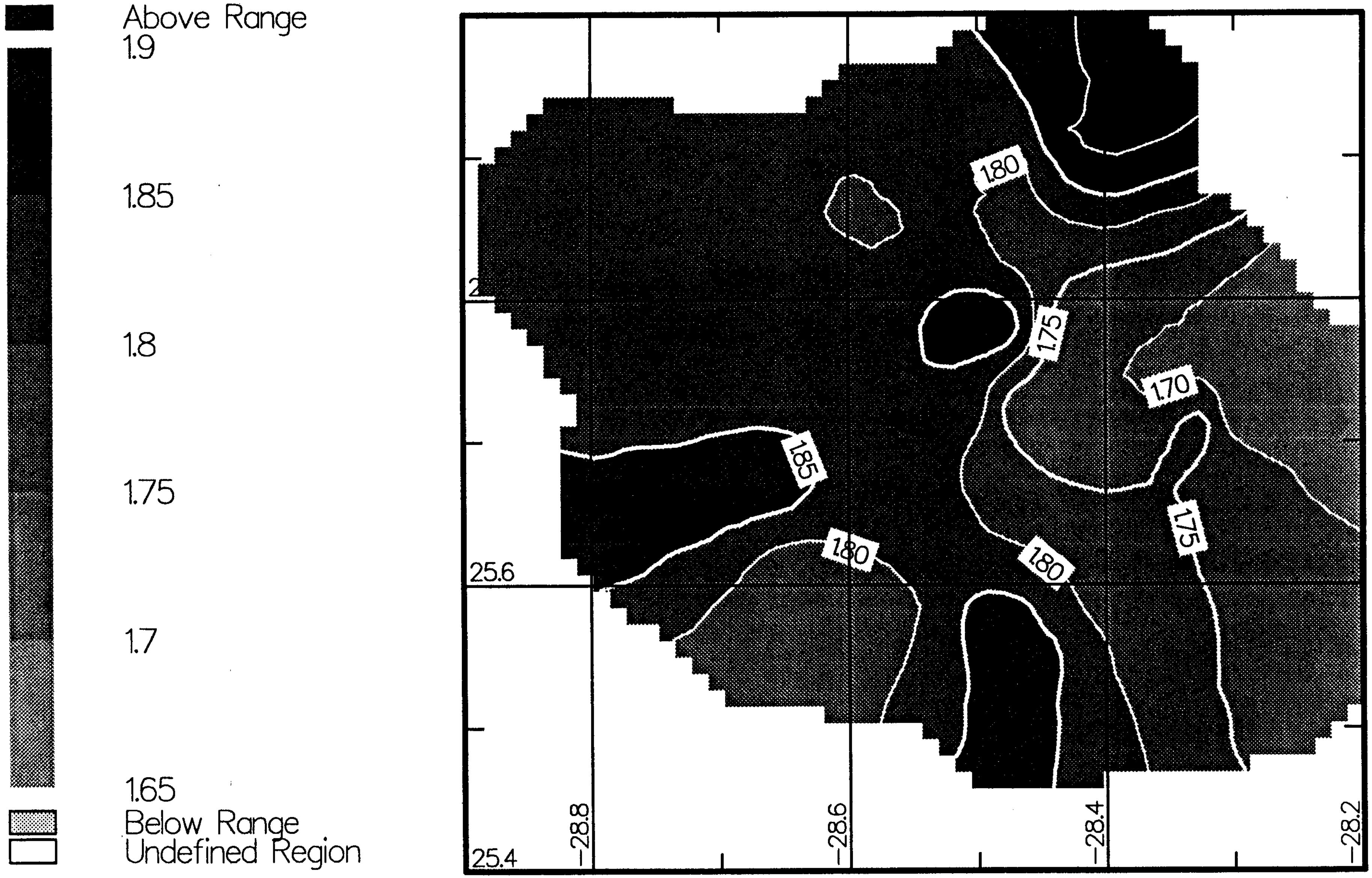
Map 4

TITLE:— "Density Ratio at Sigma-p = 28.050 "
VARIARI F·— Original positions



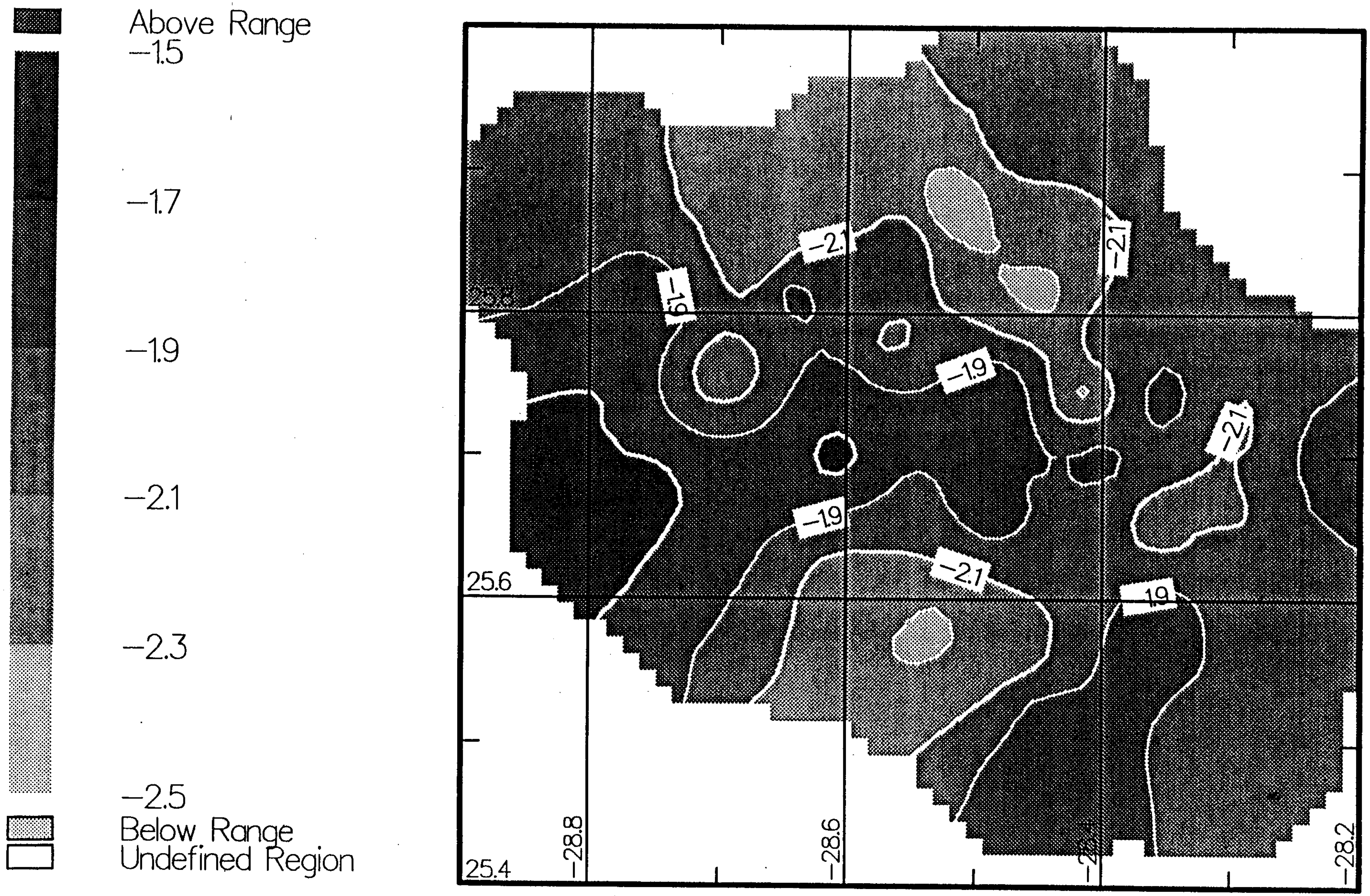
TITLE:— "Density Ratio at Sigma—p = 28.050 "
VARIABLE:—absolute coordinates

Map 5



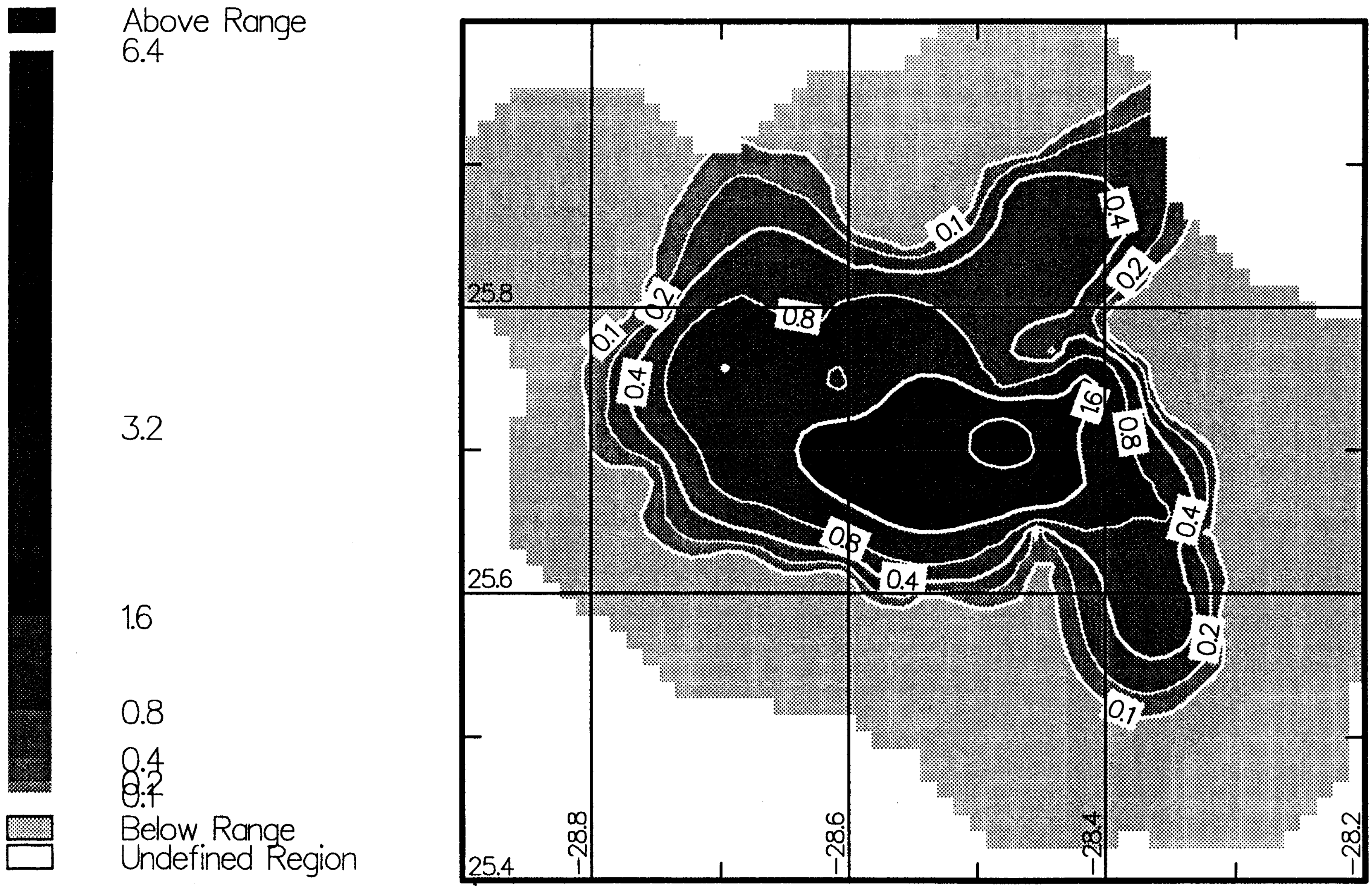
Map 6.

TITLE:- "Density Ratio at Sigma-p = 28.050 "
VARIABLE:-liberal coordinates



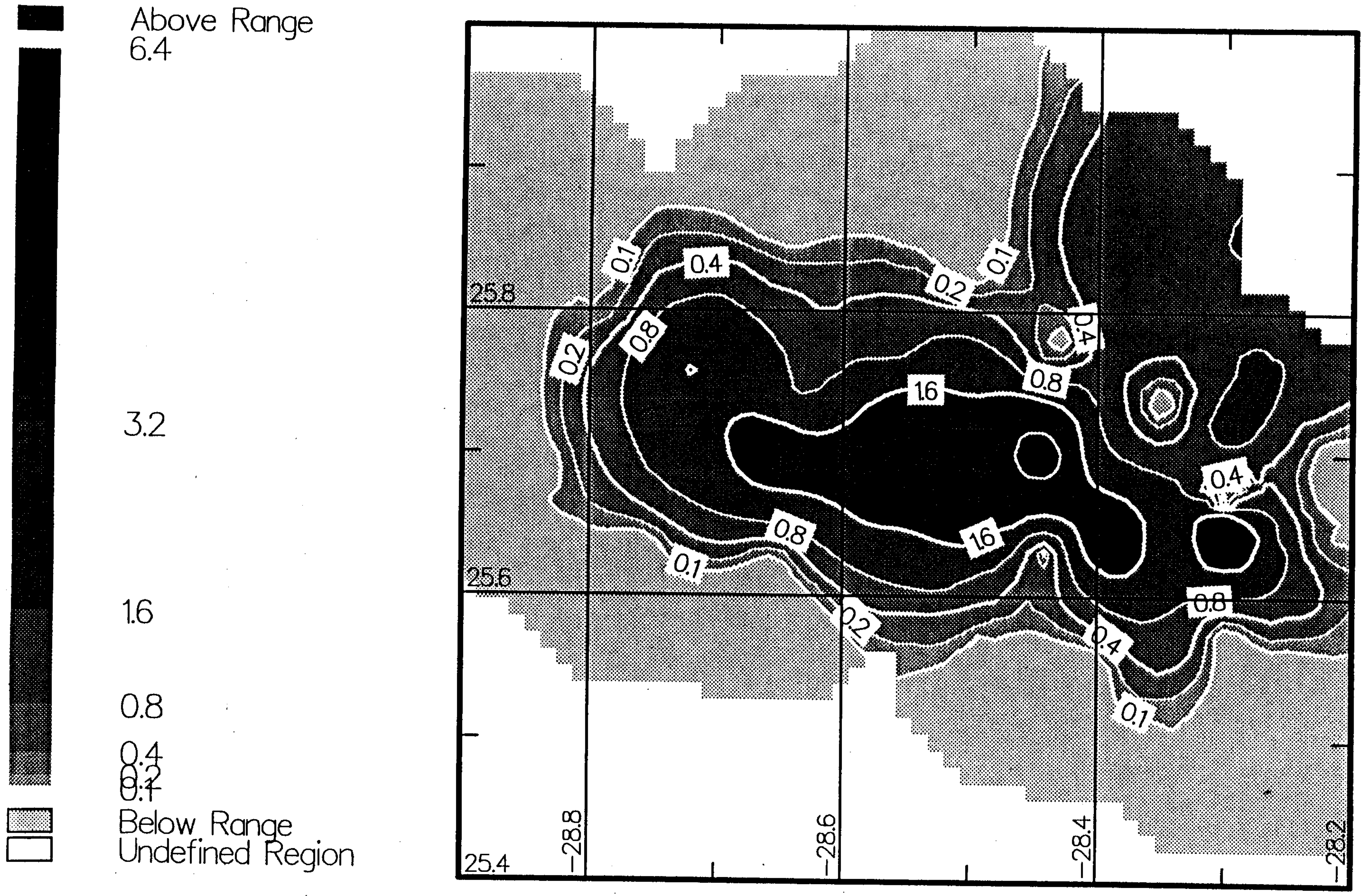
TITLE:— "d Sigma/dZ at Sigma—p = 28.050 "
VARIABLE:—

Map 7



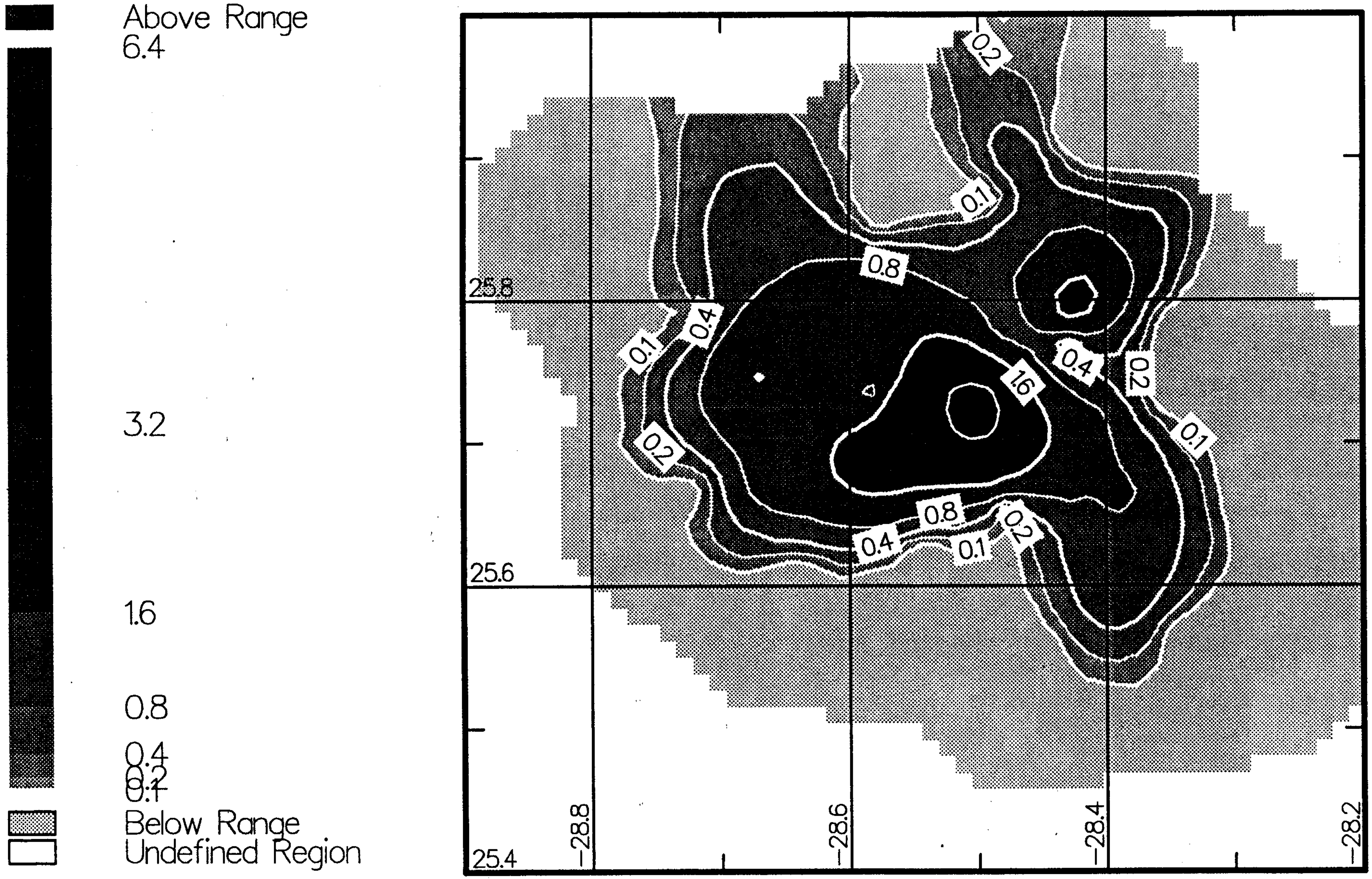
Map 8

TITLE:- "Column Integral of SF6 (e-06 mol/m2) "
VARIABLE:-conservative positions



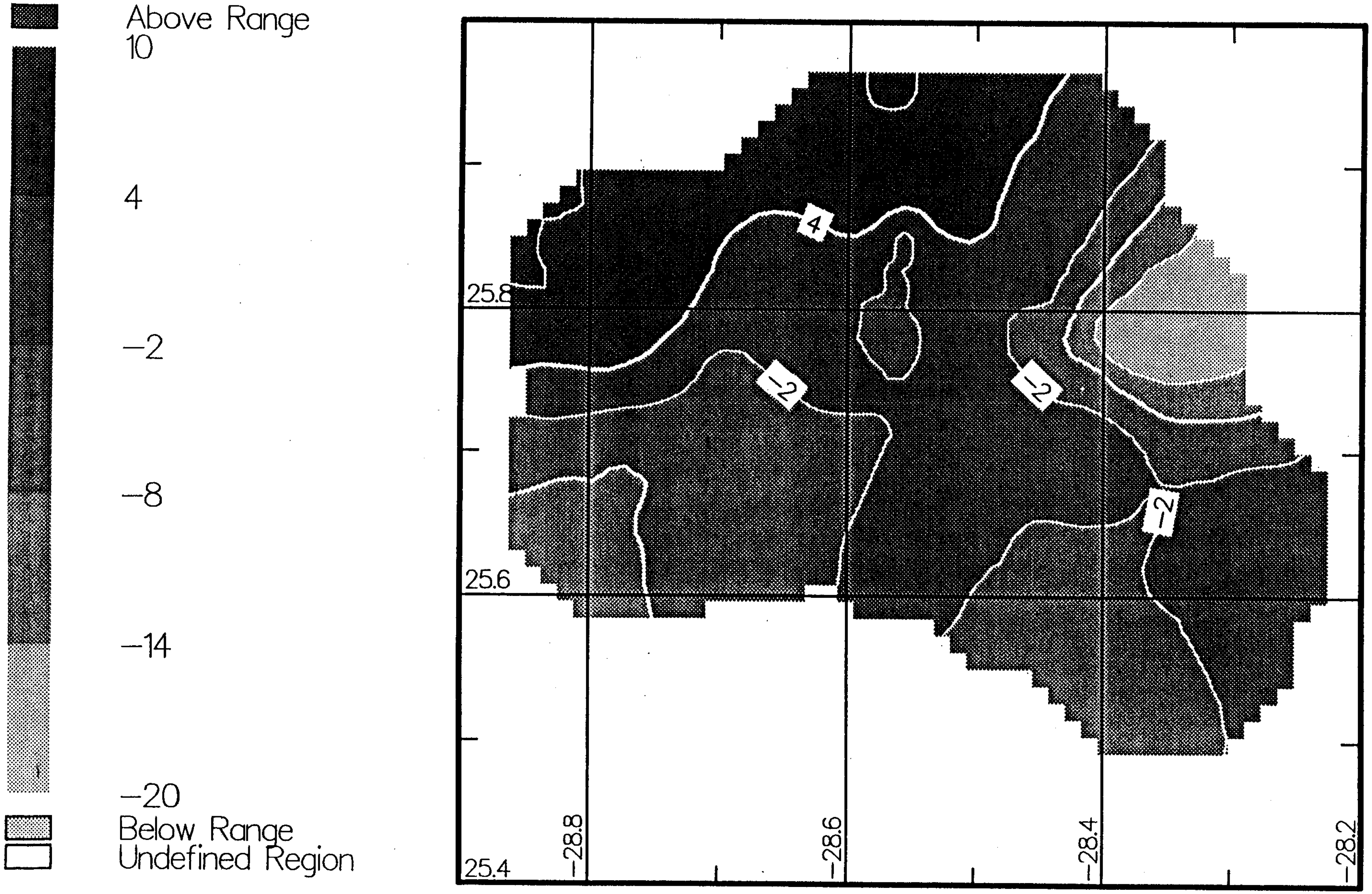
TITLE:— "Column Integral of SF6 (e—06 mol/m2)"
VARIABLE:—absolute positions

Map 9



TITLE:— "Column Integral of SF6 (e—06 mol/m2)"
VARIABLE:— liberal positions

Map 10



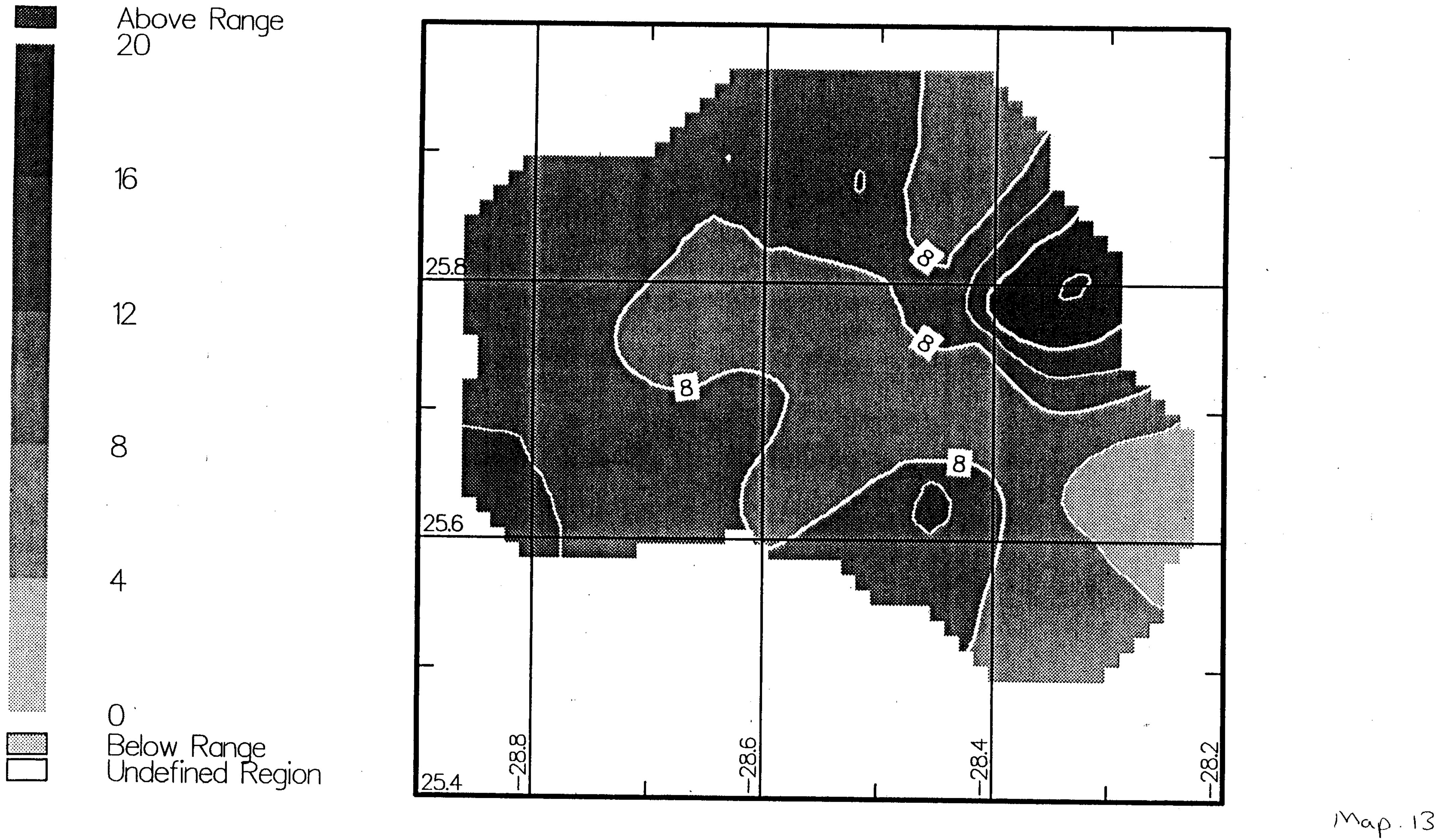
Map 11

TITLE:— "First Moment of SF6 Profiles (m)"
VARIARI F·—

Map 12

TITLE:— "Second Moment of SF6 Profiles Rel. to CM (m2) "
VARIABLE:—

117 RVS



TITLE:— "Second Moment of SF6 Profiles Rel. to h=0 (m2)
VARIABLE:—

Appendix I: Scientific Personnel

Embarked at Las Palmas:

Dr Andrew Watson	(Plymouth Marine Laboratory) Principal Scientist
Ms Susan Becker	(Woods Hole Oceanographic Institution)
Mr Terry Donaghue	(Woods Hole Oceanographic Institution)
Ms Cecelia Fernandez	(Woods Hole Oceanographic Institution)
Dr Clifford Law	(Plymouth Marine Laboratory)
Mr Malcolm Liddicoat	(Plymouth Marine Laboratory)
Mr Kay Lubcke	(Plymouth Marine Laboratory)
Mr Craig Marquette	(Woods Hole Oceanographic Institution)
Dr Phillip Nightingale	(University of East Anglia)
Ms Rachel Oxburgh	(Lamont-Doherty Geological Observatory)
Mr Martin Beney	(RVS)
Mr Darrell Phillips	(RVS)
Mr Simon Watts	(RVS)
Mr Chris Rymer	(RVS)
Mr David Dunster	(RVS)

Transferred at sea from R/V *Oceanus*:

Dr James Ledwell	(Woods Hole Oceanographic Institution)
Dr Brian Guest	(Woods Hole Oceanographic Institution)
Mr Chris Kinkade	(Woods Hole Oceanographic Institution)

Appendix II:CTD Calibration

Temperature and pressure channels of the RVS Neil Brown Mk 3 instrument (S/N 01-1195) were both calibrated at RVS against known standards. However the conductivity (salinity) channel had to be calibrated at sea using samples drawn from Niskin bottles on the sled.

In total 168 samples were taken from 59 casts and then analysed on a Guildline autosal (S/N 52395) which was calibrated against Standard Sea Water ampoules from batch P118 (see Table AII.1). The results from the comparison of (autosal-CTD) data showed an average offset of +0.022 ppm with a standard deviation of 0.006 (see Table AII.2).

Also to insure that there was no offset between the salinity measurements taken on Oceanus and Charles Darwin an inter-calibration exercise was carried out. This involved measuring 28 duplicate samples from the Oceanus. The results (see Table AII.3) show a mean error of less than 1ppm. Numerous calibration checks were made on the autosal throughout the cruise, all of which were within 1ppm of the standard. (Standard Sea Water from batches 118 and 119 were used, see Table AII.4). Four reversing thermometers were also placed on the sled but the results (see Table A1.1) proved to very noisy and unreliable.

<u>Suggestions for future cruises</u>

The Neil Brown CTD (S/N 01-1195) proved to be very reliable throughout the cruise but to insure the success of future cruises, the following suggestions could be followed:

a) Incorporate redundant sensors (temperature and conductivity) onto the sled.

b) To reduce the error in the salinity samples the EG&G automatic bottle firing system should be bought for the RVS rosette sampler.

c) The CTD conductivity channel should be calibrated in the lab, either at IOSDL or RVS thus making the salinity samples a calibration check rather than an absolute calibration.

Simon Watts,
Ocean Science group,
RVS Barry

Table AII.1: Salinity Corrections and reversing thermometer readings

Sample #	Autosal Sal	CTD Sal	Auto-CTD Sal	Therm #	Therm °C	CTD °C	CTD-Therm °C
Cast 2							
1	36.815	36.794	0.021				
2	36.815	36.794	0.021				
3	36.812	36.794	0.018				
4	36.814	36.794	0.020				
5	36.811	36.794	0.017				
6	36.833	36.794	0.039				
Cast 3							
7	37.024	37.006	0.018				
8	37.025	37.006	0.019				
9	37.024	37.006	0.018				
10	37.024	37.006	0.018				
11	37.026	37.006	0.020				
12	37.025	37.006	0.019				
Cast 6							
13	35.698	35.674	0.023	219	12.550		
14	35.904	35.882	0.022	264	20.420		
15	36.169	36.145	0.024				
16	36.551	36.531	0.020				
17	37.052	37.026	0.026				
18	37.161	37.139	0.022				
Cast 7							
19	36.219	36.198	0.021	179	15.906		
20	36.228	36.209	0.019	264	15.905		
21	36.233	36.213	0.020	219	15.931		
22	36.228	36.210	0.018				
23	36.234	36.210	0.024				
24	36.235	36.215	0.020				
Cast 16							
5	36.186	36.166	0.020	179	15.752	15.763	0.011
6	36.183	36.163	0.020				
7	36.210	36.166	0.044	363	15.775	15.757	-0.018
8	36.184	36.164	0.020	359	15.774	15.757	-0.017
9	36.181	36.164	0.017	365	15.749	15.747	-0.002
10	36.184	36.164	0.020	355	15.744	15.747	0.003

Sample #	Autosal Sal	CTD Sal	Auto-CTD Sal	Therm #	Therm °C	CTD °C	CTD-Therm °C
Cast 17							
11	36.184	36.166	0.018	359	15.763	15.761	-0.002
12	36.184	36.176	0.008	363	15.753	15.761	0.008
13	36.191	36.165	0.026	264	15.734	15.732	-0.002
14	36.182	36.167	0.015	179	15.726	15.732	0.00
15	36.189	36.189	0.000	355	15.984	15.886	-0.098
16	36.209	36.190	0.019	365	15.898	15.886	-0.012
Cast 18							
17	36.190	36.167	0.023	359	15.777	15.768	-0.009
18	36.191	36.166	0.025	363	15.769	15.768	-0.001
19	36.197	36.173	0.024	179	15.719	15.771	0.052
20	36.172	36.151	0.021	260	15.727	15.771	0.044
21	36.177	36.162	0.015	355	15.754	15.750	-0.004
22	36.185	36.170	0.015	365	15.760	15.750	-0.010
Cast 19							
23	36.172	36.157	0.015	359	15.711	15.721	0.010
24	36.180	36.161	0.019	363	15.708	15.721	0.013
25	36.187	36.165	0.022	264	15.771	15.791	0.020
26	36.200	36.169	0.031	179	15.789	15.791	0.002
27	36.176	36.151	0.025	355	15.735	15.722	-0.013
28	36.181	36.152	0.029	365	15.742	15.722	-0.020
Cast 20							
29	36.153	36.132	0.021	359	15.578	15.699	0.121
30	36.162	36.137	0.025	363	15.561	15.699	0.138
31	36.163	36.133	0.030	264	15.562	15.769	0.207
32	36.151	36.129	0.022	179	15.562	15.769	0.207
33	36.158	36.136	0.022	355	15.588	15.722	0.134
34	36.155	36.136	0.019	365	15.592	15.722	0.130
Cast 23							
1	36.148	36.131	0.017	359	15.556	15.558	0.002
2	36.152	36.132	0.020	363	15.553	15.558	0.005
3	36.152	36.128	0.024	264	15.572	15.568	-0.004
				179	15.579	15.568	-0.011
				355	15.579	15.568	-0.011
				365	15.583	15.568	-0.015
Cast 24							
4	36.177	36.149	0.028	359	15.636	15.629	-0.007
5	36.168	36.148	0.020	363	15.635	15.629	-0.006
6	36.166	36.149	0.017	355	15.652	15.639	-0.013
				365	16.660	15.639	-1.021
Cast 25							
1	36.168	36.128	0.040	359	15.670	15.666	-0.004
2	36.161	36.138	0.023	363	15.673	15.666	-0.007
3	36.166	36.138	0.028	355	15.627	15.652	0.025
				365	15.630	15.652	0.022

Sample	Autosal	CTD	Auto-CTD	Therm	THerm	CTD	CTD-Therm
Cast 26							
4	36.168	36.149	0.019	359	15.672	15.666	-0.006
5	36.161	36.139	0.022	363	15.659	15.666	0.007
6	36.168	36.146	0.022	355	15.641	15.641	0.000
				365	15.645	15.641	-0.004
Cast 27							
7	36.163	36.144	0.019	359	15.644	15.640	-0.004
8	36.169	36.148	0.021	363	15.644	15.640	-0.004
9	36.153	36.137	0.016	355	15.550	15.551	0.001
				365	15.554	15.551	-0.003
Cast 28							
10	36.164	36.142	0.022	359	15.638	15.635	-0.003
11	36.158	36.135	0.023	363	15.634	15.635	0.001
12	36.167	36.144	0.023	355	15.627	15.629	0.002
13	36.166	36.140	0.026	365	15.631	15.629	-0.002
14	36.164	36.142	0.022				
15	36.163	36.143	0.020				
Cast 29							
16	36.169	36.143	0.026	359	15.591	15.600	0.009
17	36.175	36.152	0.023	363	15.586	15.600	0.014
18	36.164	36.143	0.021	355	15.625	15.701	0.076
				365	15.636	15.701	0.065
Cast 30							
1	0.000	36.138		359	15.363	15.621	0.258
2	36.154	36.133	0.021	363	15.630	15.621	-0.009
3	36.164	36.133	0.031	355	15.540	15.590	0.050
				365	15.602	15.590	-0.012
Cast 31							
4	36.167	36.149	0.018	359			
5	36.158	36.140	0.018	363			
6	36.161	36.155	0.006	355			
				365			
Cast 32							
7	36.155	36.139	0.016	359	15.592	15.569	-0.023
8	36.159	36.137	0.022	363	15.597	15.569	-0.028
9	36.160	36.134	0.026	355	15.593	15.590	-0.003
				365	15.597	15.590	-0.007
Cast 33							
10	36.161	36.135	0.026	359	15.593	15.596	0.003
11	36.162	36.143	0.019	363	15.585	15.596	0.011
12	36.156	36.150	0.006	355	15.566	15.621	0.0
				365	15.574	15.621	0.047

Sample #	Autosal Sal	CTD Sal	Auto-CTD Sal	Therm #	Therm °C	CTD °C	CTD-Therm °C
Cast 34							
13	36.154	36.146	0.008	359	15.593	15.584	-0.009
14	36.159	36.133	0.026	363	15.585	15.584	-0.001
15	36.161	36.128	0.033	355	15.566	15.592	0.026
				365	15.577	15.592	0.015
Cast 35							
16	36.159	36.136	0.023	359	15.622	15.623	0.001
17	36.157	36.136	0.021	363	15.609	15.623	0.014
18	36.168	36.141	0.027	355	15.596	15.609	0.013
				365	15.602	15.609	0.007
Cast 36							
19	36.158	36.135	0.023	359	15.604	15.608	0.004
20	36.180	36.147	0.033	363	15.589	15.608	0.019
21	36.163	36.143	0.020	355	15.602	15.608	0.006
				365	15.607	15.608	0.001
Cast 37							
22	36.157	36.131	0.026	359	15.570	15.587	0.017
23	36.152	36.132	0.020	363	15.565	15.587	0.022
24	36.150	36.125	0.025	355	15.554	15.550	-0.004
				365	15.559	15.550	-0.009
Cast 38							
25	36.176	36.145	0.031	359	15.613	15.638	0.025
26	36.179	36.148	0.031	363	15.619	15.638	0.019
27	36.165	36.145	0.020	355	15.546	15.592	0.046
				365	15.557	15.592	0.035
Cast 39							
28	36.171	36.144	0.027				
29	36.173	36.155	0.018	363	15.627	15.624	-0.003
30	36.162	36.145	0.017	355	15.646	15.646	0.000
				365	15.651	15.646	-0.005
Cast 40							
31	36.178	36.154	0.024	359	15.676	15.681	0.005
32	36.168	36.144	0.024	363	15.668	15.681	0.013
33	36.158	36.130	0.028	355	15.555	15.551	-0.004
				365	15.559	15.551	-0.008
Cast 41							
34	36.173	36.138	0.035	359	15.580	15.675	0.095
35	36.162	36.144	0.018	363	15.574	15.675	0.101
36	36.155	36.131	0.024	355	15.562	15.540	-0.022
				365	15.575	15.540	-0.035

Sample #	Autosal Sal	CTD Sal	Auto-CTD Sal	Therm #	Therm °C	CTD °C	CTD-Therm °C
Cast 42							
37	36.164	36.137	0.027	359	15.621	15.623	0.002
38	36.190	36.137	0.053	363	15.616	15.623	0.007
39	36.169	36.142	0.027	355	15.628	15.633	0.005
				365	15.635	15.633	-0.002
Cast 43							
40	36.163	36.144	0.019	359	15.650	15.621	-0.029
41	36.178	36.163	0.015	363	15.627	15.621	-0.006
42	36.158	36.140	0.018	355	15.597	15.590	-0.007
				365	15.601	15.590	-0.011
Cast 44							
43	36.163	36.148	0.015	359	15.634	15.617	-0.017
44	36.162	36.137	0.025	363	15.622	15.617	-0.005
45	35.945	36.142		355	15.651	15.660	0.009
				365	15.658	15.660	0.002
Cast 45							
46	36.160	36.136	0.024	359	15.594	15.605	0.011
47	36.164	36.138	0.026	363	15.610	15.605	-0.005
48	36.161	36.139	0.022	355	15.650	15.638	-0.012
				365	15.652	15.638	-0.014
Cast 46							
48	36.166	36.141	0.025	359	15.572	15.621	0.049
50	36.173	36.141	0.032	363	15.607	15.621	0.014
				355	15.600	15.626	0.026
				365	15.615	15.626	0.011
Cast 47							
51	36.161	36.139	0.022	359	15.608	15.626	0.018
52	36.165	36.142	0.023	363	15.602	15.626	0.024
53	36.171	36.134	0.037	355	15.548	15.604	0.056
				365	15.556	15.604	0.048
Cast 48							
54	36.174	36.146	0.028	359	15.631	15.623	-0.008
55	36.163	36.138	0.025	363	15.631	15.623	-0.008
56	36.161	36.147	0.014	355	15.657	15.640	-0.017
				365	15.663	15.640	-0.023
Cast 49							
1	36.162	36.137	0.025	359	15.594	15.611	0.017
2	36.158	36.138	0.020	363	15.603	15.611	0.008
3	36.161	36.138	0.023	355	15.605	15.598	-0.007
4	36.164	36.143	0.021	365	15.610	15.598	-0.012
5	36.155	36.138	0.017				
6	36.164	36.138	0.026				

Sample #	Autosal Sal	CTD Sal	Auto-CTD Sal	Therm #	Therm °C	CTD °C	CTD-Therm °C
Cast 50							
1	36.169	36.149	0.020	359	15.635	15.642	0.007
2	36.147	36.132	0.015	363	15.632	15.642	0.010
3	36.154	36.136	0.018	355	15.612	15.621	0.009
				365	15.614	15.621	0.007
Cast 51							
4	36.177	36.152	0.025	359	15.650	15.633	-0.017
5	36.163	36.139	0.024	363	15.640	15.633	-0.007
6	36.156	36.134	0.022	355	15.694	15.590	-0.104
				365	15.600	15.590	-0.010
Cast 52							
7	36.165	36.134	0.031	359	15.601	15.584	-0.017
8	36.159	36.136	0.023	363	15.608	15.584	-0.024
9	36.162	36.142	0.020	355	15.604	15.590	-0.014
				365	15.608	15.590	-0.018
Cast 53							
10	36.147	36.120	0.027	359	15.601	15.538	-0.063
11	36.151	36.126	0.025	363	15.608	15.538	-0.070
12	36.152	36.138	0.014	355	15.604	15.575	-0.029
				365	15.608	15.575	-0.033
Cast 54							
13	36.176	36.145	0.031	359	15.654	15.631	-0.023
14	36.168	36.137	0.031	363	15.646	15.631	-0.015
15	36.149	36.121	0.028	355	15.567	15.560	-0.007
				365	15.573	15.560	-0.013
Cast 55							
16	36.156	36.139	0.017	359	15.645	15.643	-0.002
17	36.169	36.149	0.020	363	15.565	15.643	0.078
18	36.161	36.138	0.023	355	15.592	15.624	0.032
				365	15.591	15.624	0.033
Cast 56							
19	36.182	36.162	0.020	359	15.693	15.688	-0.005
20	36.185	36.163	0.022	363	15.681	15.688	0.007
21	36.186	36.163	0.023	355	15.666	15.693	0.027
				365	15.672	15.693	0.021
Cast 57							
22	36.181	36.158	0.023	359	15.684	15.697	0.013
23	36.184	36.161	0.023	363	15.678	15.697	0.019
24	36.165	36.155	0.010	355	15.602	15.698	0.096
				365	15.606	15.698	0.092

Sample	Autosal	CTD	Auto-CTD	Therm	THerm	CTD	CTD-Therm
Cast 58							
25	36.172	36.151	0.021	359	15.641	15.640	-0.001
26	36.167	36.145	0.022	363	15.636	15.640	0.004
27	36.160	36.140	0.020	355	15.552	15.606	0.054
				365	15.551	15.606	0.055
Cast 59							
28	36.153	36.147	0.006	359	15.650	15.647	-0.003
29	36.165	36.137	0.028	363	15.646	15.647	0.001
30	36.169	36.142	0.027	355	15.639	15.656	0.017
				365	15.644	15.656	0.012

Average salin Err	0.022	Average temp Err	0.006
Stan. Dev.	0.006	Stan. Dev.	0.090
No. of Samples	168	No. of Samples	174

Table AII.2. Comparison of autosal-CTD data

cast	no. samples	av	STD
2	6	0.023	0.007
3	6	0.019	0.001
6	6	0.023	0.002
7	6	0.02	0.002
16	6	0.023	0.009
17	5	0.017	0.006
18	6	0.02	0.004
19	6	0.023	0.006
20	3	0.023	0.004
23	3	0.02	0.003
24	3	0.022	0.004
25	3	0.03	0.007
26	3	0.021	0.001
27	3	0.019	0.002
28	6	0.023	0.002
29	3	0.023	0.002
30	2	0.026	0.005
31	3	0.014	0.006
32	3	0.021	0.004
33	3	0.017	0.008
34	3	0.022	0.011
35	3	0.024	0.002
36	3	0.025	0.006
37	3	0.024	0.003
38	3	0.027	0.005
39	3	0.021	0.004
40	3	0.025	0.002
41	3	0.026	0.007
42	3	0.036	0.012
43	3	0.017	0.002
44	2	0.02	0.005
45	3	0.024	0.002
46	2	0.028	0.004
47	3	0.027	0.007
48	3	0.022	0.006
49	6	0.022	0.003
50	3	0.018	0.002
51	3	0.024	0.001
52	3	0.025	0.005
53	3	0.022	0.006
54	3	0.03	0.001
55	3	0.02	0.002
56	3	0.022	0.001
57	3	0.019	0.006
58	3	0.021	0.001
59	3	0.02	0.01

TABLE AII.3 intercomparison of salinities between *Oceanus* and *Darwin*

BOTTLE	CC SAL .	AZ SAL.	ΔS
1	36.1650	36.1630	0.0020
2	36.1635	36.1640	-0.0005
3	36.1695	36.1630	0.0065
4	36.1654	36.1650	0.0004
5	36.1655	36.1650	0.0005
6	36.1669	36.1660	0.0009
7	36.1651	36.1650	0.0001
8	36.1641	36.1622	0.0019
9	36.1640	36.1622	0.0018
10	36.1655	36.1668	-0.0013
11	36.1660	36.1668	-0.0008
12	36.1671	36.1664	0.0007
13	36.1666	36.1664	0.0002
14	36.1687	36.1668	0.0019
15	36.1678	36.1668	0.0010
16	36.1715	36.1737	-0.0022
17	36.1713	36.1737	-0.0024
18	36.1711	36.1731	-0.0020
19	36.1715	36.1731	-0.0016
20	36.1717	36.1713	0.0004
21	36.1710	36.1713	-0.0003
22	36.1614	36.1610	0.0004
23	36.1604	36.1600	0.0004
24	36.1605	36.1610	-0.0005
25	36.1625	36.1630	-0.0005
26	36.1623	36.1630	-0.0007
27	36.1634	36.1620	0.0014
28	36.1610	36.1620	-0.0010

AVERAGE ERROR 0.0002

STD 0.0017

TABLE AII.4: Standard seawater calibration checks

BATCH P118 STANDARD SALINTY 34.998 K15 0.99994

CAL CHECK	SALINITY
1	34.999
2	34.998
3	34.998
4	34.997
5	34.997
6	34.998

BATCH P119 STANDARD SALINTY 34.995. K15 0.99990

CAL CHECK	SALINITY
1	34.995
2	34.996
3	34.995
4	34.996

Appendix III: Seacat autonomous CTDs

Mechanical Configuration

There were four Seabird Seacats used during the tracer sampling casts. Their serial numbers were 882,883,884 and 885. These Seacats were of the profiling type and were modified by Seabird to be started by computer rather than switch. The conductivity cells were mounted horizontally to be more effective while being towed. They also came from the factory with a mount to which a swivel clamp and flotation in the form of a syntactic foam footballs have been attached. The swivel and flotation were to allow the Seacats to keep the conductivity cell pointed into the flow as they were being towed.

Each of the Seacats measures conductivity and temperature and numbers 884 and 885 measure pressure as well. The Seacats with pressure were put near the top and bottom of the array of integrating samplers.

The Seacats were also equipped with optional battery packs, due to the vibrations the Seacats were expected to experience while being towed, which could cause the standard battery configuration to open and cause data recording problems.

The Seacats have a protective piece of tubing on the conductivity cells, usually filled with distilled water during storage. When shipped there was a danger of the water in these cells freezing, thus destroying the cell, so they were shipped dry. Shipping dry requires flushing with Triton X to wet the surfaces inside the cell, prior to deployment, for proper functioning of the cell. See manual for proper procedure.

The Seacats were held in place on the wire by stopper clamps above and below the swivel clamp. These slid down the wire a few centimeters, occasionally, when the Seacat was allowed to rotate around the wire out of the water. This problem can be solved by making bigger clamps for the next cruise.

The Seacats were mounted under 5-liter Niskin bottles with integrating samplers, and messengers with long lanyards were attached under the Seacats, with the lanyards passing through Tygon tubing to a standard Niskin bottle messenger release mechanism to prevent fouling on the Seacats. This worked well; there was only one fouled lanyard for the entire criuse and this was on a Niskin bottle.

The Seacats were mounted on the sled three times during the cruise to get comparisons and do calibrations with the N.E.R.C. Neil Brown CTD.

Battery Capacity

The Seacats are powered by 6 alkaline D-cells wired in series. The factory gives a nominal battery end of life of 48 hours. It has been demonstrated on this cruise that a battery pack will reliably run a Seacat for 68 hours. This time is independent of the record rate. A new battery pack will read about 9.3 volts, and when installed in a Seacat the Seacat will show the main battery voltage, Vmain, to be about 8.6 volts. When Vmain gets down to 6.5 volts, there will be a battery failure soon. This is a good point at which to change the batteries. This voltage would occur after about 10 casts of around 7 hours each.

Data collection and format

The record rate for the Seacats on this cruise was 1 scan every 5 seconds. This gives about 14.5 hours of data collection.

The data was saved from each cast in the following manner. The data is dumped from the Seacat by calling up PROTERM, and hitting F9 to dump data in SEASOFT compatable form. It is labeled with the cast number and instrument number and puts .DAT after it. F5 is then entered to capture header data andsetup data, from the current dump to the data file. This is done by entering F5, and calling it cast number Seacat number.hdr, CSTXXXXX.HDR, and typing DH to capture the header data for the header file and F5 CSTXXXXX.SET, DS for the setup file. This information was saved on the SUN computer on the Darwin and on 3.5 inch disk. The data, .DAT, is also saved in ASCII form by using BINAVG from the SEASOFT software. It writes time, pressure if applicable, temperature and conductivity to the file, puts a header on it, and saves it in a file labeled .AVG. It also makes a file, .SUM, which summarizes the data. This information is a summary of the cast data giving minimums and maximums of the sampled parameters. .AVG and .SUM are saved on the 3.5 inch disk as well.

Craig Marquette,
Woods Hole Oceanographic Institution

Appendix IV: Multichamber sampler

A McLane pump and valve was used run a multichamber sampler which employed cut-off glass syringes to take sequential water samples during the flight of the towed sled at the density layer of the tracer. Information on the distribution of SF_6 concentrations along the sample path was obtained in this manner.

<u>Pumping problems and solutions</u>

At the beginning of the cruise, there were a few problems with the sampler. The first problem was no pumping at all during the cast. It was determined that the sampler would not turn on using a pumping rate of 5 mL/min, the first rate tried. A rate of 6 mL/min was acceptable; the pump worked at this rate, so this was used for the duration of the cruise. The maximum pump time was 11 minutes. There was a 0.4 minute delay while the valve rotated between positions. Thus, the sampler ran for a total of about 205 minutes which was somewhat less than the duration of the tow.

The pump was started by firing a rosette position which activated a switch that shorted two pins of the pump electronics. The switch worked well except on 2 casts near the end of the cruise when the switch didn't fire until the up cast at the end of the tow. The reason for the failure is unknown. When it was set up again, there appeared to be no problems and it worked fine for the following casts. The lanyard may have fouled.

Another failure mode of the sampler was sticky syringes. The pump would pump, but there would be no sample. The cure for this was to exercise the syringe over the area it wouldn't slide well during cleaning.

Occasionally communication with the pump could not be established. The reason for this was unknown, but unplugging the battery and plugging it back in solved the problem.

<u>Pump set-up</u>

A carousel of syringes was prepared for the cast by loading syringes with about 1 ml of water in the bottom and removing any air. Any air in the pump lines was first purged by pumping water from a bucket. The lines were then connected underwater so as not to introduce air. Air in the lines will cause the syringe to start to fill prematurely as the air is compressed as pressure increases.

The pump was programmed with special menu-driven software from McLane Reasearch called PUMP145. The software was first loaded into a Tattle Tale in the pump. The Tattle Tale was then programmed for the cast. The enabling switch had to be cocked before loading the data or the pump would start right away.

<u>Data collection and format</u>

At the end of the tow, the data were dumped onto a disk using the PUMP145 program. One could then select how to view the data from a menu. The start times of the different syringe positions were also recorded in a notebook, with a note of how it performed. A summary of the performance of the multichamber sampler is shown in Table AIV.I.

Craig Marquette

Table AIV.1 Summary of carousel performance

Cast No.	Comments	No. of Samples
16	No data	
17	No samples	
18	Skipped first sample (started 1:46 after trip)	17
19	No SF6 found	
20	No SF6 found	
21	No SF6 found	
22	Skipped first sample (started 9:16 after trip)	17
23	OK	18
24	OK	18
25	Pump set at 1 minute per sample	
26	OK	18
27	OK	18
28	No pump. Calibration cast	
29	OK	18
30	OK	18
31	OK	18
32	OK	18
33	OK	18
34	OK	18
35	OK	18
36	OK	18
37	OK	18
38	Skipped first sample (started 5:42 after trip)	17
39	OK	18
40	OK	18
41	OK	18
42	OK	18
43	OK	18
44	OK	18
45	OK	18
46	OK	18
47	OK	18
48	OK	18
49	No pump. Calibration cast	
50	OK	18
51	OK	18
52	OK No data from pump	18
53	OK	18
54	No data. Pump tripped after tow	
55	OK	18
56	OK	18
57	No data. Pump tripped after tow	
58	OK	18
59	OK Last cast	18

Appendix V: Sulphur hexafluoride analysis

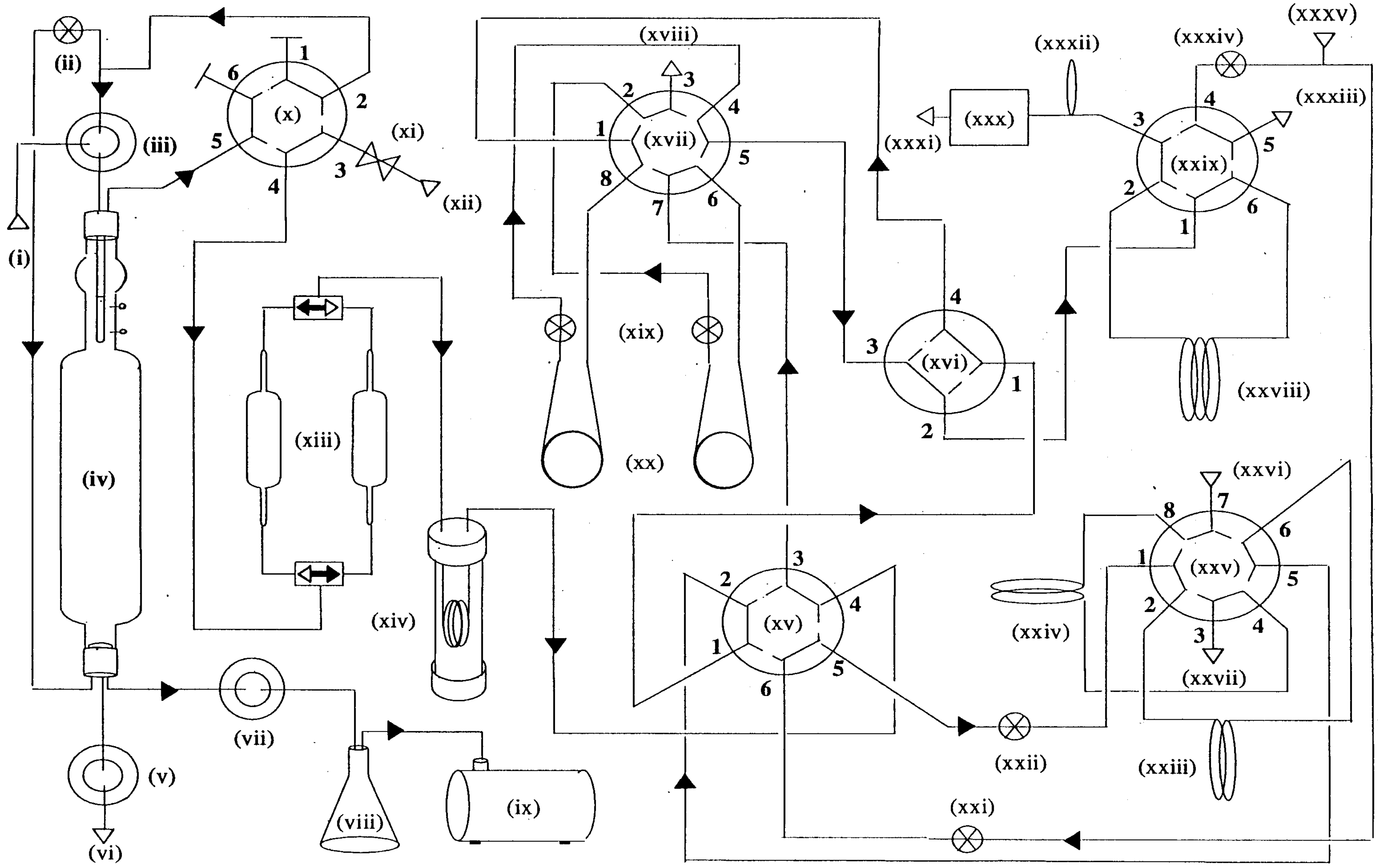
(a) Background samples (casts 8-15) were analysed using a fully automated vacuum-sparge technique (See Fig AV.1). 350ml of seawater were drawn directly from a sampling canister into a glass bulb (iv) by vacuum, and the dissolved SF_6 extracted by vacuum and sparging with nitrogen. The extracted gases were carried through driers (xiii,xiv) and then concentrated on Porapak Q traps (xx) maintained at -65°C in an Iso-Propanol bath. Raising and rapid heating of the traps mobilised the SF_6, which was transferred into the GC carrier gas line by valve xvi. onto a Molecular sieve chromatographic column (xxviii). Following resolution of the SF_6 peak by a Molecular Sieve 5A column, the column was backflushed to prevent the elution of further interferent peaks. SF_6 was detected by a Shimadzu GC8AIE, incorporating an electron capture detector. This technique facilitated a throughput of 8 samples an hour, with a reproducibility of 1.1% at background concentrations. Calibration of this system, by injection of standards into a 1 ml loop, with subsequent trapping and analysis as described above, demonstrated a minimum detectable concentration of 0.04×10^{-17}mol l^{-1}. Regular calibration of the system demonstrated that no significant drift in detector response occurred during the cruise.

(b) Tracer samples were analysed by headspace equilibrium of 50 ml of seawater and 50 ml of nitrogen. The high levels of SF_6 in the tracer samples eliminated the need for pre-concentration. Instead, the headspace was injected through a drying tube directly into either a 1 ml or 20 ul standard loop (xxiv, xxiii), and subsequently switched into the GC carrier gas line onto the chromatographic column as previously described. Standards were analysed by the same technique. A throughput of 14 samples per hour was achieved using this method, with a reproducibility of <1%. In addition, this technique was used for determining the SF_6 memories of the canister bags.

Data handling was achieved by the use of a Spectra-Physics Datajet Integrator in conjunction with Spectra-Station, a chromatographic software package. Final SF_6 concentrations were calculated by custom-written software.

The analytical system worked exceptionally well on NATRE 1, despite continual analysis for periods of up to 10 days. Some electrical problems were encountered at the start of the cruise, but these were overcome.

Cliff Law
Plymouth Marine Laboratory



A5.I. Sulphur Hexafluoride analysis system (for key see table A5.II)

(i)	water sample introduction port
(ii),(xix),(xxi),(xxii) (xxxiv)	needle valves
(iii),(v), (vii)	solenoid valve
(iiii)	vacuum - sparge tower
(vi)	waste outlet
(viii)	vacuum trap
(ix)	vacuum pump
(x),(xv),(xxix)	six-port valves
(xi)	valve
(xii)	sparge gas inlet
(xiii)	dryer (Magnesium Perchlorate)
(xiv)	Nafion dryer
(xvi)	four-port valve
(xvii)	eight-port valve
(xviii)	sparge gas outlet
(xx)	traps
(xxiii)	sample loop A
(xxiv)	sample loop B
(xxv)	standard introduction port
(xxvii)	standard outlet port
(xxviii)	chromatographic column
(xxx)	electron capture detector
(xxxi),(xxxiii)	carrier gas outlet
(xxxii)	post column
(xxxv)	carrier gas inlet

Table A5.II Key to Sulphur Hexafluoride analysis system diagram

Appendix VI: RVS Equipment reports

Simrad Echo Sounder

The echo sounder fish was deployed on the way to the work site after leaving Las Palmas. It was used during every cast to listen to a 10kHz beacon on the sampler array below the sled and therefore confirm that all samplers had fired. As usual the system performed very well and no maintenance was required. The fish was recovered on the completion of the scientific stations.

Winch Wire Out and Load Output

During the port call the load cell was repaired and calibrated. The fault seemed to be a combination of loose connections through out the junction boxes. This then worked well for a while until there were intermittent readings during several casts. Again this was found to be due to loose connections in the junction box next to the Hydrographic Winch. This rectified the fault for several days but it then returned and the casts were completed with this intermittent fault.

There were no problems with the wire out reading, except that the lab readout seemed to pick up spurious readings, and the difference in readings was as much as 50 metres after several hours.

Automatic Winch Control

The system was tested while steaming to the tracer release site using a dummy load and another computer to simulate the CTD data. It could be seen from this test that the system would work and that the instrumentation would not be put in any extra danger. After the first flight of the system it was decided to make a few minor alterations, the main one being to make the veer voltage drive half of the haul voltage. This confirmed tests carried out on Cruise 66/92, which suggested that under load, the magnitude of the control voltage required to make the winch veer at a given speed was half that required to make it haul at the same speed. It was found that the minimum haul control voltage could be no lower than 0.5 volts, and the maximum was set at 0.7 volts which corresponded to approximately 12 m/min. With zero voltage applied to the control, the winch crept out at a rate of about 3-4 m/min.

After a few flights salinity bottles were analysed and an offset of +0.022 was added to the salinity equation. It was later found that the sled was still at the wrong density and this value was adjusted to +0.018 to account for the difference between the its68 and the its90 temperature scales. There were no other adjustments during the cruise, and as long as the gradients in the water were not too great, depth control was maintained in a +/-0.5 metre band around the target density.

We noted only one incident involving the winch control which might have caused problems. This was when the controlling computer was reset without the rest of the system, causing the winch to veer at maximum speed. The fault was quickly recognised and the system brought under control again.

CTD and Monitoring System

The CTD (serial no. 01-1195) used during this cruise was a MKIIB Neil Brown, which was modified to input extra analogue signals. The Rosette pylon was a standard 12 bottle 10L type manufactured by General Oceanics. The CTD deck unit was a EG&G 1401 and the rosette deck unit was a RMS MKVI. The system was monitored and logged on a Vig II personal computer fitted with a 150MB cartridge drive.

The first analogue channel in the CTD was used to detect the closing of a switch when all the top array samplers had fired. This meant that the standard RVS Breakout Box had to be modified to perform this task. The second and third channels were used to monitor the filling of samplers fitted to the sled. These channels were renamed in the EG&G software to appear as SAM1 and SAM2. During the cruise the rosette performed well, and did not fail to fire even when the confirmation pulse was not detected by the deck electronics.

Rosette

The rosette was used to fire samplers as well as 1.2L Niskin bottles and SiS digital reversing thermometers. The firing order was as follows;

Rosette position	Equipment
8	Messenger (for lower samplers)
9	Sled Samplers
10	Multichamber
11	2 reversing thermometers
12	1.2L Niskin Bottle
1	1.2L Niskin Bottle
2	1.2L Niskin Bottle
3	2 reversing thermometers
4	1.2L Niskin Bottle
5	1.2L Niskin Bottle
6	1.2L Niskin Bottle
7	2 reversing thermometers

Salinity samples were taken from every cast, initially to find the offset and consequently to check that there was no drift in the readings. For the first few casts all six of the thermometers were used. However, owing to the positioning of the thermometer frames, readings were lost due to resetting. In subsequent casts, the thermometers at position 3 were removed.

D.A.Phillips
Ocean Science Group
Research Vessel Services

Appendix VII: W.H.O.I. Float Group Summary

R.V. Oceanus & R.R.S. Charles Darwin
April 22, 1992 - June 8, 1992
by Brian J. Guest

This appendix contains
1) Shipboard Listening Station Positions (pg. xx)
2) Bobber Float Launch Information (pg. xxi)
3) Drifting SOFAR Receiver (DSR) Positions (pg. xxii)
4) RAFOS Float Launch Positions (pg. xxiii)
5) Bobber Float Ranges from the DSR and the Listening Station w/ Positions, (pages xxiv - xxx).
   a) Ranges are in miles and are not corrected for clock offsets unless noted.
   b) Positions in BOLD type are with the most confidence
   c) Dates followed by a -1 indicate a Main Pong Cycle
   d) Dates followed by a -2 indicate a Telemetry Pong
5) Bobber Pressure Telemetry Data (pg. xxxi)
6) A Summary of Bobber Float Positions with plots. (pg. xxxii-xxxv).

All of the information in this summary has been taken from the notes of Brian Guest and Jim Ledwell, and FAXs received from Jim Valdes and Chris Wooding in Woods Hole.

From the R.V. Oceanus, the Float Group, consisting of Jerry Dean, Jim Price, and Brian Guest, set out to deploy ten (10) Bobber Floats and eight (8) RAFOS Floats to be used as markers for the beginning, middle, and end of tracer injection streaks. The Bobbers are trackable by two means, a low frequency "pong" (250 hz) and by a specially fitted Benthos acoustic transponder/release (10 Khz) which also sends back pressure telemetry. The low frequency signal transmits every twelve hours at a predetermined time and is tracked via an oil filled hydrophone which is lowered to approximately 500 meters on the CTD cable. This means of tracking should give positions to within about 3 Km with one listening station moving to a different location every 12 hours. More accurate positions can be obtained if there are two or more listening stations are conducted simultaneously such as using Drifting Sofar Receivers (DSR). Where this is practical errors should be less than 1 Km.

Tracking the Bobbers by the 10 Khz pinger required us to manoeuvre the ship to an approximate position within a mile of the float and by constantly manoeuvering and plotting ranges to the Bobber we can achieve fairly accurate positions. Ranges of less than 500 meters are not unrealistic.

All ten Bobbers were deployed but due to a few problems not all were placed into the tracer immediately prior to, during, or after the injection tows. A problem with the ballasting (an incorrect density number) caused four of the Bobbers to descend too quickly causing damage to the Automatic Buoyancy Control System. This will only cause a problem to one instrument (Bobber 60) and all others should function normally. There are two other Bobbers with problems that will render them useless in tracking the tracer, Bobber 62 which has gone to 550 meters and Bobber 63 which was struck by the Oceanus and not heard again. This should still leave 7 properly operating Bobbers in the tracer. A note should be made that Bobber 61 is attached to a RiNo float and seems to be operating properly.

Along with the Bobbers, the Float Group launched eight RAFOS floats at various positions throughout the patch. All of these are assumed to be operating properly since there is no means to confirm this until they complete their mission.

Brian Guest was the only Float Group member to transfer from Oceanus to Charles Darwin. During the Darwin section of the experiment, we carried out 3 shipboard listening stations, combined the data with data from the DSR, which was received from Woods Hole and plotted the positions of the Bobbers to help plan the sampling of the patch area. The following pages contain the useful data collected during this cruise.

Ship Listening Station Positions

Station Number	Date	Position		Interval	Comments
OCEANUS:					
1	5/14/92	25 42.47N	28 17.97 W	2	5 Bobbers heard
2	5/15/92	25 35.83 N	28 30.83 W	1	
3	5/16/92	25 28.00 N	28 24.25 W	1	7 of 7 heard
4	5/16/92	25 39.77 N	28 00.65 W	2	3 of 7 heard
5	5/17/92	25 37.65 N	28 21.34 W	1	4 of 7 heard
6	5/18/92	25 42.69 N	28 19.44 W	1	
DARWIN:					
7	5/20/92	26 08.12 N	28 39.50 W	2	4 of 10 heard
8	5/23/92	25 55.56 N	28 30.68 W	1	8 of 10 heard
9	5/25/92	25 52.03 N	28 49.58 W	2	5 of 10 heard

Bobber Launch Information

Bobber	Date	Position	Time (GMT)	Clock Offset	MPT
55	5/8/92	25 38.94 N 28 11.16 W	11:37:00	1.394151 sec slow	06:50:00
56	5/10/92	25 34.09 N 28 23.30 W	15:52:00	0.014373 sec fast	07:30:00
57	5/16/92	25 39.44 N 28 12.95 W	15:06:00	0.284511 sec fast	08:50:00
58	5/9/92	25 46.20 N 28 08.30 W	16:12:00	1.298210 sec slow	07:10:00
59	5/11/92	25 42.83 N 28 20.95 W	09:00:00	4.100000 sec slow	07:50:00
60	5/18/92	25 42.82 N 28 19.41 W	05:05:00	0.000669 sec fast	06:50:00
61	5/17/92	25 44.33 N 28 14.08 W	20:17:00	0.928639 sec slow	09:10:00
62	5/17/92	25 38.24 N 28 16.98 W	10:34:00	0.593919 sec slow	08:10:00
63	5/11/92	25 34.18 N 28 15.18 W	18:11:00	0.008543 sec fast	06:30:00
64	5/12/92	25 34.27 N 28 12.08 W	19:46:00	1.077025 sec fast	08:30:00

The Bobbers are on a twelve hour "PONG" cycle, that is their main pong is the signal that is sent at the time indicated on this sheet which is followed shortly after by a telemetry pong encoded with pressure reading. Twelve hours later they send another pong which is only to aid in the tracking of the instruments position.

Drifting Sofar Receiver Positions

Date	Interval	Position	Time	Comments
5/19/92	1	26 01.92N 27 49.10W		Interval 1= 0630 Interval 2= 1830
	2	26 00.96 N 27 45.50 W		
5/20/92	1	26 01.38 N 27 46.20 W		
	2	26 00.96 N 27 45.50 W		
5/21/92	1	25 59 40 N 27 45.00 W		
	2	26 14.40 N 27 42.78 W		
5/22/92	1	25 58.98 N 27 42.84 W		
	2	25 59 10 N 27 42.48 W		
5/23/92	1	25 58.32 N 27 41.40 W		
	2	25 58.38 N 27 40.86 W		
5/24/92	1	25 58.02 N 27 40.02 W		
	2	25 59.10 N 27 39.60 W		
5/25/92	1	25 57.90 N 27 37.80 W		
	2	25 57.72 N 27 37.02 W		
5/26/92	-	25 57.90 N 27 36.00 W	09:11:00	GMT Tracking Data
	-	25 57.78 N 27 35.40 W	10:51:00	for recovery
	-	25 55.80 N 27 34.80 W	16:52:00	
	-	25 56.40 N 27 34.80 W	22:05:00	
5/27/92	-	25 57.42 N 27 34.80 W	03:41:00	No Longer hearing
	-	25 57.18 N 27 35.40 W	05:23:00	Bobbers!
	-	25 57.60 N 27 33.96 W	07:02:00	
	-	25 56.88 N 27 32.10 W	18:23:00	Last Satellite Pos.
5/28/92	-	25 56.83 N 27 30.13 W	14:00:00	Recovered DSR03

The DSR was recovered without incident but the hydrophone was missing, the cable looks to show signs of shark bite or possibly had been fouled in another ship's gear. The damaged section of cable will be brought back to Woods Hole for analysis.

RAFOS Float Launch Positions

RAFOS	DATE	POSITION		SURFACE
001	5/11/92	25 42.55 N	28 08.36 W	1/2 YEAR
002	5/06/92	25 37.70 N	28 16.13 W	1/2 YEAR
003	5/16/92	25 39.14 N	28 14.22 W	1/2 YEAR
004	5/08/92	25 45.93 N	28 09.82 W	1/2 YEAR
005	5/07/92	25 44.67 N	28 14.45 W	1 YEAR
006	5/12/92	25 42.55 N	28 08.36 W	1 YEAR
007	5/07/02	25 33.83 N	28 15.63 W	1 YEAR

RAFOS Floats are neutrally buoyant, free drifting listening stations that at the end of their mission, drop a weight and surface. They are each equipped with Toyocomm PTT transmitters and once the float has reached the surface it will begins to transmit the data it has collected during its mission. The length of the missions are coordinated with future N.A.T.R.E. cruises and should provide accurate positions of the tracer patch.

Bobber 55 Tracking

Date	DSR Range	Listening Station Range	10 Khz Position	Calculated Position
5/8/92		Launch Position = 25 38.9 N 28 11.2 W		
5/16/92-1		21.1 Miles		
5/16/92-2		32.4		
5/17/92			25 45.0 N 28 14.3 W	
5/19/92-1	37.1			
5/19/92-2	35.6			
5/20/92-1	36.0			
5/21/92-1	34.7			
5/22/92-1	34.6			
5/22/92-2	34.1			
5/23/92-1	34.0	21.8		25 41.1 N 28 12.7 W
5/23/92-2	34.0			
5/24/92-1	35.3			
5/24/92-2	34.1			
5/25/92-1	36.1	40.3		25 36.1 N 28 08.2 W

Bobber 56 Tracking

Date	DSR Range	Listening Station Range	10 Khz Position	Calculated Position
5/10/92		Launch Position = 25 34.1 N 28 23.9 W		
5/14/92-2		10.9 Miles		
5/15/92-1		5.1		
5/16/92-1		15.6		
5/16/92-2		30.8		
5/17/92-1		14.6		
5/18/92-1		16.7		
5/19/92-1	57.9			
5/20/92-1	59.4			
5/21/92-2	62.8			
5/22/92-1	64.1			
5/22/92-2	66.4			
5/23/92-1	66.7	21.4		25 54.1 N 28 55.0 W
5/23/92-2	69.7			
5/24/92-1	71.4			
5/24/92-2	74.4			
5/25/92-1	75.6			
5/25/92-2		9.6		25.49.5 N 29 00.6 W

Bobber 57 Tracking

Date	DSR Range	Listening Station Range	10 Khz Position	Calculated Position
5/14/92-2		6.7 Miles		
5/15/92-1		Instrument recovered and on deck.		
5/16/92-2		11.2	Launch Position = 25 39.4 N 28 13.0 W	
5/17/92			25 38.7 N 28 11.8 W	
5/19/92-1	38.0			
5/19/92-2	39.0			
5/20/92-1	39.5			
5/20/92-2	39.8	34.9		25 37.7 N 28 20.7 W
5/21/92-1	40.5		25 37.3 N 28 22.0 W	
5/21/92-2	40.8			
5/22/92-1	41.7			
5/22/92-2	42.5			
5/23/92-1	43.6	18.6	25 37.3 N 28 22.0 W	
5/23/92-2	44.6			
5/24/92-1	46.3			

Bobber 58 Tracking

Date	DSR Range	Listening Station Range	10 Khz Position	Calculated Position
5/09/92		Launch Position = 25 46.2 N 28 08.3 W		
5/14/92-2		15.1 Miles		
5/15/92-1		16.8		
5/16/92-1		23.7		
5/16/92-2		9.1 (?)		
5/17/92-1		15.9		
5/18/92-1		14.2		
5/19/92-1	34.5			
5/19/92-2	35.1			
5/20/92-1	36.6			
5/20/92-2	36.2	32.5		25 40.8 N 28 17.5 W
5/21/92-1	36.9		25 43.7 N 28 18.0 W	
5/21/92-2	37.5			
5/22/92-1	38.3			
5/22/92-2	39.0			
5/23/92-1	40.3	18.0	25 43.7 N 28 17.9 W	
5/23/92-2	41.1			
5/24/92-1	43.3			
5/24/92-2	42.3			
5/25/92-1	44.7			

Bobber 59 Tracking

Date	DSR Range	Listening Station Range	10 Khz Position	Calculated Position
5/11/92		Launch Position = 25 42.8 N 28 21.0 W		
5/14/92-2		1.8 Miles		
5/15/92-1		15.8		
5/16/92-1		17.7		
5/16/92-2		17.6		
5/17/92-1		9.0		
5/18/92-1		3.3		
5/19/92-1	37.0			
5/19/92-2	36.7			
5/20/92-1	38.2			
5/20/92-2	38.3			
5/21/92-1	39.7			
5/21/92-2	40.2			
5/22/92-1	41.5			
5/22/92-2	42.1			
5/23/92-1	43.1	5.8		25 49.8 N 28 28.4 W
5/23/92-2	44.3			
5/24/92-1	45.3			
5/24/92-2	47.3			
5/25/92-1	49.7			
5/25/92-2		20.4 ?		
5/29/92			25 48.5 N 28 31.0 W	

Bobber 60 Tracking

Date	DSR Range	Listening Station Range	10 Khz Position	Calculated Position

Instrument went too deep and has only been heard once!

Bobber 61(With RiNo 3) Tracking

Date	DSR Range	Listening Station Range	10 Khz Position	Calculated Position
5/17/92		Launch Position = 25 44.33 N 28 14.08 W		
5/19/92-1	36.3 Miles			
5/19/92-2	35.8			
5/20/92-1	38.0			
5/20/92-2	37.1	30.5 Miles		25 40.9 N 28 19.8 W
5/21/92-1	39.6		25 43.1 N 28 21.0 W	
5/21/92-2	39.1			
5/22/91-1	41.1			
5/22/92-2	41.7			
5/23/92-1	43.3	15.4	25 41.4 N 28 23.5 W	
5/23/92-2	45.0			
5/25/92-1	47.8			

Bobber 62 Tracking

Date	DSR Range	Listening Station Range	10 Khz Position	Calculated Position

This Bobber is too deep! (550 Meters)

Bobber 63 Tracking

Date	DSR Range	Listening Station Range	10 Khz Position	Calculated Position

Bobber 63 was hit by the R.V. Oceanus while steaming back to the launch site, it was not heard again.

Bobber 64 Tracking

Date	DSR Range	Listening Station Range	10 Khz Position	Calculated Position
5/12/92		Launch Position = 25 34.27 N 28 12.08 W		
5/13/92			25 33.9 N 28 11.7 W	
5/14/92-2		10.9 Miles		
5/15/92-1		15.6		
5/16/92-1		14.4		
5/16/92-2		14.6		
5/17/92-1		7.5	25 32.2 N 28 15.5 W	
5/19/92-1	41.4			
5/19/92-2	41.6			
5/20/92-1	42.2			
5/20/92-2	41.4			
5/21/92-1	43.1		25 35.0 N 28 21.5 W	
5/21/92-2	41.5			
5/22/92-1	43.1			
5/22/92-2	43.6			
5/23/92-1	44.5	20.5		25 34.9 N 28 23.6 W
5/23/92-2	45.5			
5/24/92-1	47.4			
5/24/92-2	47.8			
5/25/92-1	48.4			
5/25/92-2		27.3	25 35.0 N 28 24.6 W	

Bobber Pressure Telemetry

Date	Bobber 55	56	57	58	59	61	62	64
5/15/92	X	267.4	X	303.8	287.6	X	X	339.0
5/16/92	341.6	343.6	X	355.4	368.4	X	X	262.0
5/17/92	X	267.8	297.0	292.0	296.2	X	X	362.8
5/18/92	X	X	371.0	X	374.0	359.0	550.0	285.0
5/19/92	220.8	X	272.0	289.2	284.0	270.0	274.2	351.0
5/20/92	X	350.2	334.0	353.6	364.6	340.0	550.2	287.0
5/21/92	219.8	X	273.0	280.0	289.0	283.0	273.6	330.0
5/22/92	X	345.0	343.0	362.0	365.0	329.0	550.0	267.0
5/23/92	222.8	227.6	247.8	294.0	289.0	266.2	X	333.4
5/24/92	X	330.0	248.0	377.0	384.0	326.0	550.0	267.0
5/25/92	X	269.0	X	293.0	X	253.0	274.0	349.0

X= No available data.

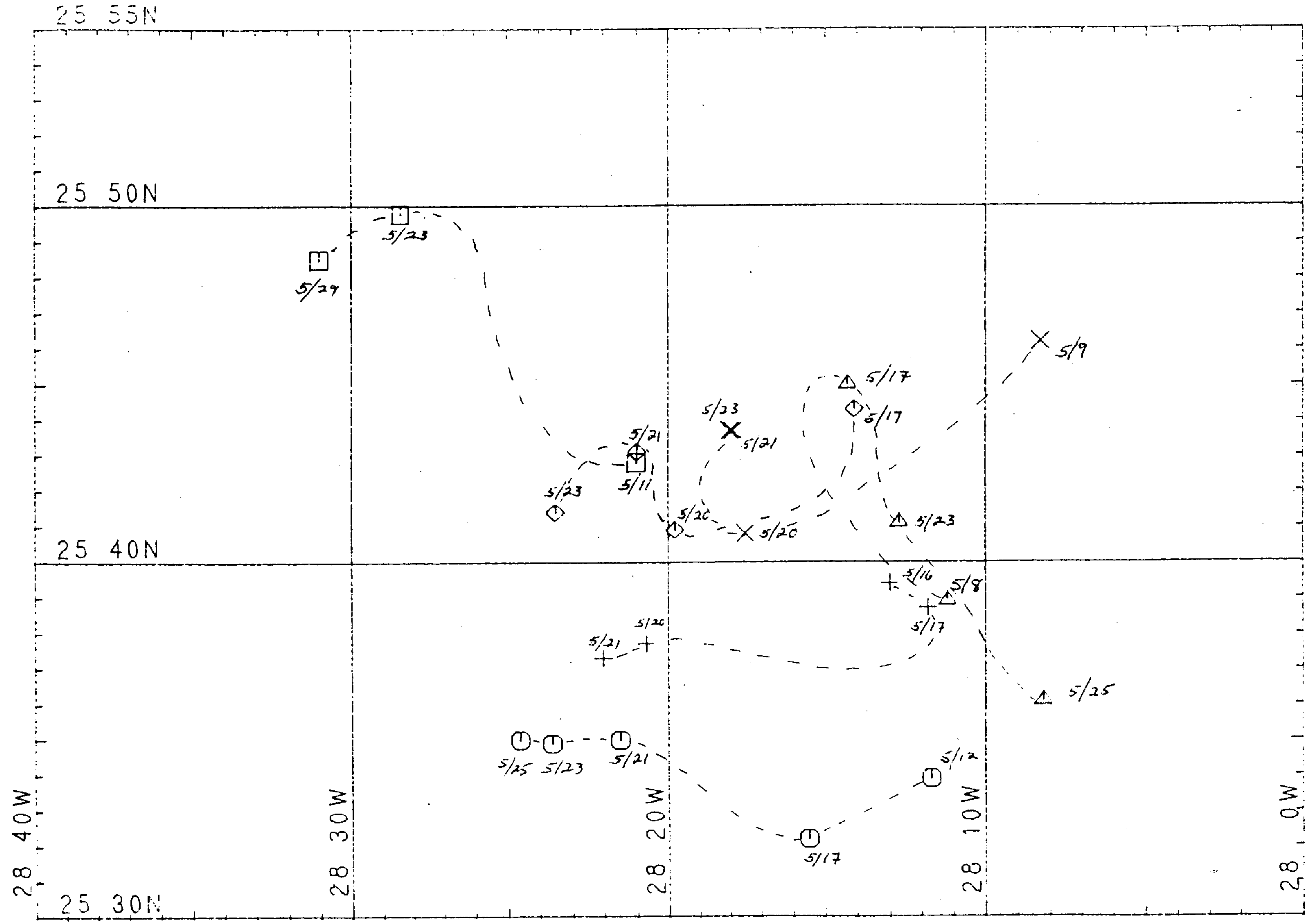
At the time of the launch, parameters are programmed into the Bobber's memory that tell it what levels it is to search out. These are denoted as Tmin, Tmax, Pmin, Pmax, and Step. Tmin represents lower temperature, Tmax is the highest value temperature, Pmin is the minimum operating pressure, and Pmax is the maximum operating pressure. Step is the amount of oil that the Bobber will pump or vent into or out of the external bladder at ten minute increments until it crosses either the Tmin or Tmax level. The numbers above represent the Pressure in Dbar that the Bobber found Tmin on one day and on the next day sends the Pressure for Tmax. All of these floats were programmed with identical values for these variables. Tmin= 15.12 C, Tmax= 16.32 C, Pmin= 120 Dbar, Tmax= 550 Dbar and the step value= 100 cc of oil.

Bobber Positions

Bobber	Date	Position
55	5/8/92	25 38.9 N 28 11.2 W
	5/17/92	25 45.0 N 28 14.3 W
	5/23/92	25 41.1 N 28 12.7 W
	5/25/92	25 36.1 N 28 08.2 W
56	5/10/92	25 34.1 N 28 23.9 W
	5/23/92	25 54.1 N 28 55.0 W
	5/25/92	25 49.5 N 29 00.6 W
57	5/16/92	25 39.4 N 28 13.0 W
	5/17/92	25 38.7 N 28 11.8 W
	5/20/92	25 37.7 N 28 20.7 W
	5/21/92	25 37.3 N 28 22.0 W
	5/23/92	25 37.3 N 28 22.0 W
58	5/09/92	25 46.2 N 28 08.3 W
	5/20/92	25 40.8 N 28 17.5 W
	5/21/92	25 43.7 N 28 18.0 W
	5/23/92	25 43.7 N 28 17.9 W
59	5/11/92	25 42.8 N 28 21.0 W
	5/23/92	25 49.8 N 28 28.4 W
	5/29/92	25 48 5 N 28 31.0 W
60	Instrument not heard, went too deep.	
61	5/17/92	25 44.3 N 28 14.1 W With RiNo 3
	5/20/92	25 40.9 N 28 19.8 W
	5/21/92	25 43.1 N 28 21.0 W
	5/23/92	25 41.4 N 28 23.5 W
62	Bobber too deep, 550 meters.	
63	Hit by ship, not heard.	
64	5/12/92	25 34.3 N 28 12.1 W
	5/13/92	25 33.9 N 28 11.7 W
	5/17/92	25 32.2 N 28 15.5 W
	5/21/92	25 35.0 N 28 21.5 W
	5/23/92	25 34.9 N 28 23.6 W
	5/25/92	25 35.0 N 28 24.6 W

N.A.T.R.E.
Key to Bobber Plots

55	△
56	▽
57	+
58	×
59	□
61	◇
64	○

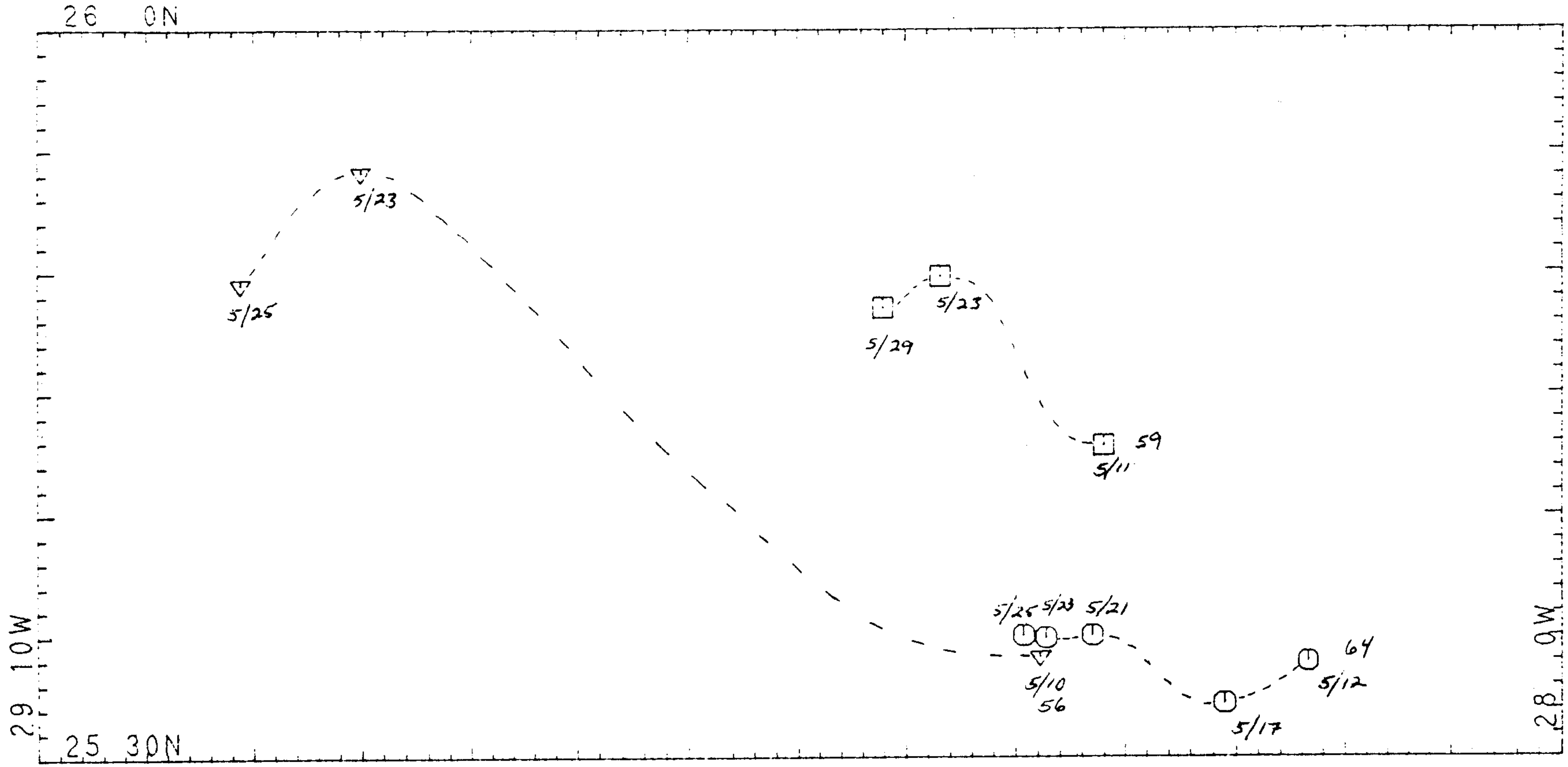


MERCATOR PROJECTION

GRID NO. 1

SCALE 1 TO 300000 (NATURAL SCALE AT LAT. 30)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 30

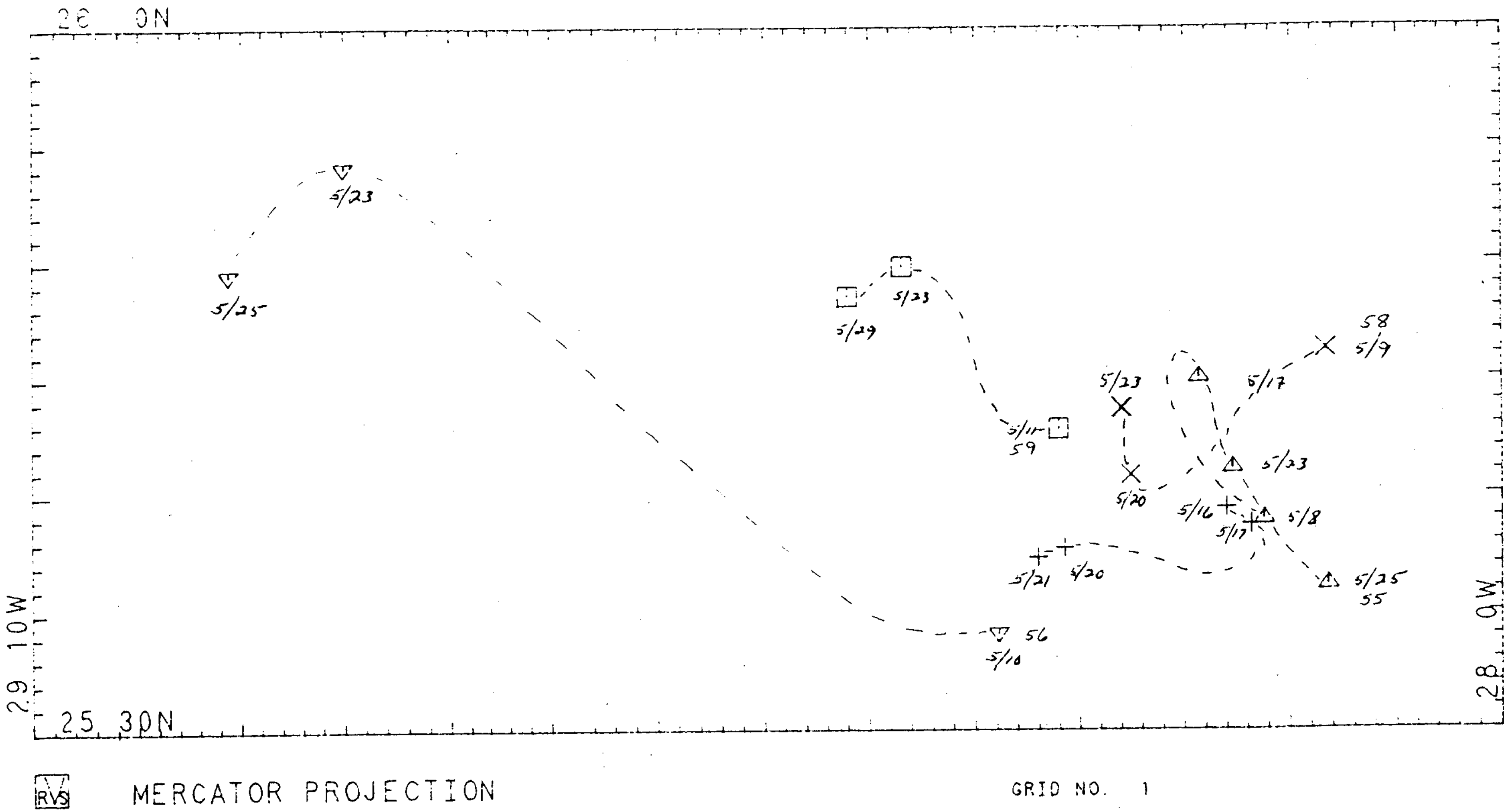


RVS MERCATOR PROJECTION

GRID NO. 1

SCALE 1 TO 500000 (NATURAL SCALE AT LAT. 30)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 30



MERCATOR PROJECTION

SCALE 1 TO 500000 (NATURAL SCALE AT LAT. 30)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 30

GRID NO. 1