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CRUISE REPORT No. 34

RRS *DISCOVERY* CRUISE 249
19 AUG - 10 SEP 2000

History of sedimentation in the Gulf of Cadiz:
investigations with the SOC giant piston corer

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2000

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ABSTRACT

This was the third cruise using the new SOC giant piston corer. The objectives were to complete the testing of the giant piston corer which was begun on cruise D219 in November/December 1995 and cruise D225 in February/March 1997, and to collect giant piston cores from the Gulf of Cadiz on sites selected from the TOBI survey carried out on cruise D244 in December 1999. As on previous cruises we had problems with both the ships equipment (outboard sheave on coring gantry), and the giant piston corer. The sheave problem necessitated 2.5 days in port plus transit time. This combined with some weather downtime severely limited the amount of work which could be carried out. Nevertheless, we resolved some coring issues, especially proving that elastic rebound of the kevlar is not a major problem. We also managed to take a consistent series of good cores with a 15 metre barrel, and although all the 27 metre barrel cores bent, the bending took place above the sediment surface leaving a good quality core below. The longest core recovered was 18.1 metres and 21 cores were obtained in all. The cruise also involved testing the scatterometer. This proved to be a failure due to multiple electronic problems and no data was recorded in any of its two deployments.

KEYWORDS

CRUISE 249 2000, *DISCOVERY*, GIANT PISTON CORING, GULF OF CADIZ, PISTON CORERS, SCATTEROMETER, SEDIMENTS

ISSUING ORGANISATION

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ITINERARY

Sailed Southampton	19th August 2000
Arrived Southampton	10th September 2000

CRUISE OBJECTIVES

To analyse the long-term history of the strength of the Mediterranean outflow by collecting a series of long piston cores in areas identified from previous geophysical surveys, in particular the TOBI survey carried out on cruise D244. To test and utilise the scatterometer to determine sediment characteristics.

NARRATIVE

Days 232 to 234 (August 19th, to 21st 2000). *Discovery* sailed on time at 1000 following the final safety briefings for new scientific members. We made good progress in good weather conditions to a point beyond the shelf edge off Brittany where the water was deep enough to pay out the aramid cable to its full length (2,600 metres). This was necessary, as this part of the cable had not been used before. Stopping at 1500/233, we spent 6 hours conditioning the cable and adjusting the scrolling device. We then headed across the Bay of Biscay reaching a waypoint off Finistere, Spain at 2000 on August 21st.

Day 235 (August 22nd, 2000) Progressed along the Portuguese coast in moderate to heavy weather. Stopped to pay out cable to continue its conditioning from 0730 to 0930 and from 1305 to 1810.

Day 236 (August 23rd, 2000). Started PES and 3.5 watches at 0500 on approach to Lisbon. Selected coring target on basis of 3.5 records in area south of Cascais in water depth of approx. 85 metres, using this as a shakedown station. Deployed corer with 15.5 metre barrel at 0640 and recovered a 13.6 metre long core of fine mud (D13882). The coring operation went smoothly and efficiently. We then progressed to Cap St Vincent and on to the work area in the Gulf of Cadiz.

Day 237 (August 24th, 2000). Arrived at start of short survey line across broad canyon at 0145. Coring position (D13883) chosen in the centre of the canyon and corer with 15 metre barrel deployed. A failure in the trigger arm release prevented triggering and the corer was brought back empty (but not bent). The problem was related to the toothed safety device to which some adjustment was made. However, this problem, which has occurred on previous cruises, could be due to pretriggering whilst the hydrostatic release is still in place. This could cause the safety tooth to jam. We decided to lower future corers to 50 metres to retract hydro release and then bring corer back to surface to ensure pretriggering had not occurred. Corer then to be lowered at max 30 m/min to prevent trigger corer kiting.

Carried out survey to east across splay sand deposit and chose core site in sand (D13884, 15 metre barrel). During survey we encountered a long line and could not find its end. We brought in the PES and 3.5 fish and crossed the line before resuming the survey. Core D13884 was bent although it contained 8.5 m of sand which was recovered. We then returned to the site of core D13883 to retry a 15 metre core (D13885). This core was also bent possible due to very hard sediment which was present in the core cutter, but 3.9 metres was recovered.

Day 238 (August 25th, 2000). Proceeded to start of survey line across small channel deviating to pass around the end of a long line on the way. Carried out survey line but sediment appeared to be sandy throughout. Decided it was better to establish that the corer would work in muddy sediment before tackling more sand, so we proceeded east to an area of mud waves. Chose suitable site and began coring at 0840 (D13886). The core was again bent, even though it only contained mud (2.6 metres). Examination of the tensiometer records suggests elastic rebound of the aramid may be the problem, preventing the corer penetrating properly. We will increase the rebound allowance and fit a pinger for later cores.

Some damage to the aramid sheath was caused by slippage on the cable haulers during deployment, but the aramid itself was not affected. During the haul-in the large nut on the new outboard large davit block came loose, and this was found to be related to a seizure of the block. The block was removed and, although new, its bearings had failed. This terminated giant piston coring operations. The engineers stripped the block and determined the part number which was ordered from an agent in Cadiz. We switched operations to

deeptow work and launched the scatterometer at 1430. Our intention was to head for Cadiz to repair the sheave at an appropriate time once the parts had arrived.

Day 239 (August 26th, 2000) The scatterometer was lowered to 200 metres and tested thoroughly. It appeared to be functional although at this depth no return signal from the seabed could be seen. Eventually it was lowered to its operational depth (c 400 metres above the seabed) but again no seabed return could be seen. After several hours testing we finally decided to give up operations with this vehicle and switch to the mini profiler (MPV), taking a series of cores whilst the MPV was prepared.

Day 240 (August 27th, 2000) The scatterometer was secured on deck at 0100 and the cable was changed to the coring warp ready for kasten coring. We ran a 3.5 kHz survey across the small channel and chose kasten core sites on each levee (D13887 and D13888) and in the channel axis (D13889). Each of these was successful. We then progressed down channel to the sand splay and tried to core this at the location where the giant piston corer had recovered a core of disturbed sand but also bent. No core was recovered (D13890#1) though there were traces of mud on the side of the corer head. This suggested the possibility of a mud drape over the sand and so we tried to take a box core (D13890#2). This also failed. We then moved some 3 miles west further down the channel to core the muddy broad canyon floor using the 4 metre barrel kasten corer (D13891). We recovered 1.2 metres of mud with sand layers but the core barrel was bent.

The MPV was tested on deck and found to be fully operational. Following a cable change it was launched at 2217. This vehicle also failed to work and was brought back on deck at 0315/241.

Day 241 (August 28th, 2000) We concluded operations in the small channel and moved east to TOBI area 1 where we planned to investigate the large channel which carries an offshoot of the Mediterranean undercurrent water towards the south. During the transit the cables were changed again to the coring warp. The first 2 metre kasten core was deployed at 0630 GMT in an area west and downslope of the sand splay (D13892). This worked well and a second kasten core was taken to the south in a similar environment (D13893). The transect

between core sites D13892 and D13893 revealed a small channel which we cored next (D13894) at 1120. We then decided to try the MPV again as repairs had been carried out and it appeared to be working on deck. It was deployed at 1945 following a cable change and a 3.5 kHz survey across the channel. The MPV again failed - at first due to a problem with the conducting cable, but when this was fixed a problem with the umbilical cable became apparent. MPV operations were terminated and we decided to head to Cadiz as soon as possible to effect a repair of the coring sheave.

Day 242 (August 29th, 2000) Transit to Cadiz and arrival at 0800. The agent arranged the sheave to be picked up and taken to the dockyard for repair. It was expected back at c1600 and although it did return around that time, no testing had been carried out. We were assured this would happen the following morning.

Day 243 (August 30th, 2000) The promised load test could not be carried out in any local shipyard due to lack of testing equipment. The agents suggested it should be transported to Bilbao, but we tried a number of other options before we accepted their suggestion. The sheave was sent with an estimated return the following day at c2100.

Day 244 (August 31st, 2000) Spent day waiting for sheave to return from testing in Bilbao. It finally arrived at 2230 and was fitted back on the gantry. We finally left Cadiz at 2330 and headed back to the TOBI box I area.

Day 245 (September 1st, 2000) Arrived at start of short survey line running south across small splay sand into what should have been a basin beyond the sand. However, the 3.5 kHz record showed sand throughout with higher ground to the south. We therefore chose a site in the muddy area south of the splay sand and deployed the giant piston corer with a 15 metre barrel at 0900 (D13895). On this occasion, we tested using a longer pennant of 45 metres. This appeared to overcome the core bending problem as a good straight core was obtained. The corer head had penetrated the sediment by about half a metre, but on recovery less than 2 metres of sediment was present in the barrel. This could be due to one of two reasons a) the piston had moved up the barrel during deployment; b) the piston had been carried down into

the sediment because the pennant was too long! This latter seemed to be the case as the split core revealed only flow in. A mistake was found in the original pennant length - it was 50 metres long instead of 45. For the next core the pennant length was reduced to 40 metres (including 19 metres allowed for rebound).

We decided to core a transect of cores in the mudwave field from the shallowest mudwaves to the deepest (approx. 820 to 1400 metres water depth). This would allow the variable of sandy sediment to be eliminated, leaving "easily coreable mud". The first core (D13896) was deployed at 1430. It penetrated right up to the core head but only recovered 4.2 metres of mud with sand layers. We moved to the second mudwave position (D13897#1) to avoid the sandy layers and reduced the pennant length to 30 m (including 10 metres allowed for rebound). The core again penetrated to the core head and this time recovered 6 metres, although the core top appeared to be missing, suggesting the pennant was still too long.

Day 246 (September 2nd, 2000) We stayed on the same station to take a second core (D13897#2) with the pennant reduced to 25 metres (5 metres rebound). This time we recovered 10.8 metres of sediment and the core head again reached the seabed. It therefore seemed that rebound was not a significant factor and that previous bent barrels were more likely due to stiff or sandy sediment preventing corer penetration. Having determined this we moved to the next mudwave site and tried the same configuration (D13898#1). This time we recovered 10.6 metres of sediment but without a good core top. During the deployment some uneven running of the repaired sheave was seen and tests were carried out, but no recurring problem was found. We tried the same site again with the pennant now reduced to 21 metres (1 metre rebound) and this time recovered 12.5 metres of sediment with a better coretop (D13988#2). We now felt confident to attempt a 2 barrel core with a total barrel length of 27 metres. However, we added an extra ton of lead to the core head to aid penetration.

Day 247 (September 3rd, 2000) During deployment the cable haulers gave problems again, burning the outer cable sheath. It was decided to divert the cable away from this device and to use the old cable hauler system with very reduced pressure. A two barrel core was deployed (D13988#3). This returned bent but with a 16.5 metre long core. This core appeared to be of good quality with no flow-in and oxidised sediment at the core top. The

pilot corer was lost during the coring operation - perhaps due to the need to switch from chain to wire to save weight on the trigger arm for such a long core. From the dynamometer record it seemed that we had reduced the rebound cable length too far, so that the corer could not penetrate the last 6-7 metres and it thus fell over. We moved to another mudwave site for the next core (D13989) and added an additional 5 metres of pennant length. This core was also bent at the same position as the previous one, but again contained a good quality core of 14.7 metres length. It seems that the corer penetrates about 20 metres into the seabed but the remaining 7 metres cannot hold the core head and so the head falls over.

Day 248 (September 4th, 2000) We moved to another mudwave site (D13990) and tried another 2 barrel core, this time adding another ton of weight to the core head and keeping the pennant the same length as in the previous core. This core also bent at the same distance from the core head, and contained 18.1 metres of apparently undisturbed core, although there was a large amount of sand in the core. As we were trying to test the corer in muds before attempting sand we made our way back to a previous site (D13897) to take another 2 barrel core (D13901).

Day 249 (September 5th, 2000) Core D13901 again bent at the same position as previous cores and unfortunately the lower barrels were lost during the core cutting on retrieval. The weather worsened during recovery of this core and was not good enough to carry out any further coring during day 249. Work was still progressing on the scatterometer and so we spent much of the day carrying out a 3.5 kHz survey around the main undercurrent channel. By 2000 the scatterometer was ready for launch. After much testing, no signal could be found and so we brought the vehicle back onboard.

Day 250 (September 6th, 2000) The scatterometer was secured on deck at 0130 and a 3.5 kHz survey set in progress as the weather was too poor to core. By morning, the swell had increased and winds were force 7 to 8. More repairs were carried out on the scatterometer, but by 1100 there was no indication that it would be operational in time to carry out a survey during the day. We therefore decided to leave the work area and head for Lisbon to take a final core off the mouth of the Tagus.

Day 251 (September 7th, 2000) Arrived at start of short survey line at 0630 and began coring at 0800 using a 15 metre barrel (Core D13902). The head weight was reduced by 1 ton. The corer was bent but a core was recovered.

GIANT PISTON CORING

We began the cruise with an instrument which had not been fully tested. Unfortunately, the first sites cored (D13882 to D13886) were in relatively sandy locations where it was impossible to determine whether bent barrels were due to the core configuration or a hard seabed. Following our visit to Cadiz we resolved to concentrate on muddy sites where we could test rebound cable lengths. We did this first with a 15 metre core barrel at sites D13895 to D13898#2. In these sites we progressively reduced the rebound length from 30 metres to 1 metre and recovered longer and longer cores without any bent barrels. The last of these cores (D13898#2) had virtually no rebound allowance, but mud still came to the top of the outside of the barrel, suggesting proper penetration. The core length was 12.5 metres in a 15 metre barrel, and this may be the maximum we can expect.

Our attempts at coring with a 27 metre barrel were partially successful. All corers were bent at approximately 7 metres below the core head. However, they all contained good quality cores varying between 12.5 and 18.1 metres long. We added 1 ton extra weight and then 2 tons extra for core D13900 and this extra weight may have made an improvement to core length. The problem of preventing core bending remains. An accelerometer connected to the cable on core D13901 showed very interesting results. The core penetrates the seabed in less than 2 seconds following its release. The column of water above the piston would need to be evacuated in this interval. For shorter cores, this may not be a problem but it may provide an obstacle to proper piston movement in longer cores. The critical factor is the diameter of the vent through the core head which should be as close to the diameter of the piston as possible. However, the piston has to be caught below the core head by the piston stop which is of narrower diameter. One amendment for future coring attempts is to cut slits in the neck adapter which will allow a greater volume of water escape.

Other amendments, which may help, are a re-engineered trigger assembly with a longer arm and a capability to release under greater load. This would enable us to use chain to connect to the pilot corer.

PRINCIPAL RESULTS AND CONCLUSIONS

We have made progress with the giant piston corer. We collected a consistent set of cores in muddy sediments using one barrel and a very short pennant. We did not have time to try to core sandy sediments with the short pennant, but cores collected with a long pennant bent. We have had partial success in collecting long cores (27 metres). Although each corer was bent the recovered core was of good quality and up to 18 metres in length. An additional vent for water escape near the top of the barrel may improve the situation bur we did not have time to carry out this experiment. It is unfortunate that equipment failure and finally poor weather prevented the completion of these trials.

The scatterometer was not a success and needs more lab testing plus seatrials in shallow water before it is taken to sea again. This is unfortunate, as the data would have been of great value.

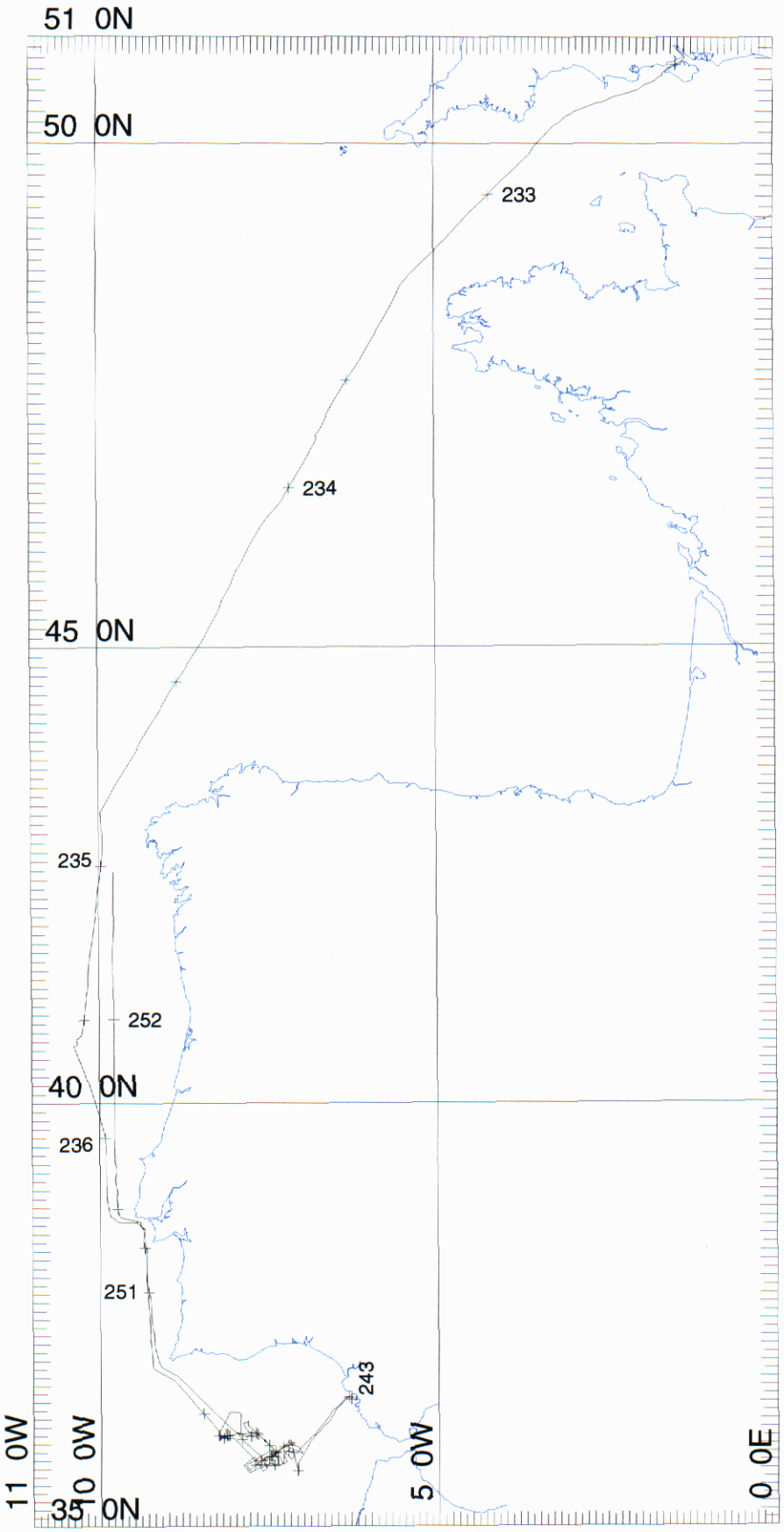
From a scientific point of view we collected some cores in and near one of the sandy channels, identified on the TOBI sidescan, which should help us to determine its history. We also collected a number of cores from the large mudwave field west of the large channel which should provide a lot of information on the history of the Mediterranean outflow. One of these cores shows very well developed contourite deposits which may indicate a significant shift in the position of the current with time.

Table 1 Discovery 249 Giant Piston Core Locations

Core No	Lat N	Long W	Water Depth uncorr m	Recovered Core
D13882	38°38.07'	9°27.25'	87	13.625
D13883	36°05.25'	8°14.06'	1978	0
D13884	36°05.46'	8°08.12'	1949	8.49
D13885	36°05.25'	8°13.57'	1979	3.92
D13386	36°05.03'	7°46.47'	1019	2.60
D13887	36°07.54'	7°58.31'	1543	2.11
D13888	36°07.12'	7°57.30'	1568	2.01
D13889	36°07.29'	7°58.00'	1580	1.18
D13890#1	36°05.29'	8°08.02'	1945	NA
D13890#2	36°05.31'	8°07.55'	2304	NA
D13891	36°04.58'	8°11.58'	1971	1.16
D13892	35°47.01'	7°43.02'	1497	1.86
D13893	35°42.59'	7°43.00'	1442	2.02
D13894	35°44.08'	7°43.00'	1538	1.945
D13895	35°39.54'	7°04.59'	1185	1.91
D13896	36°02.60'	7°11.60'	817	4.15
D13897#1	35°58.00'	7°18.00'	957	6.0
D13897#2	35°58.04'	7°18.05'	969	10.81
D13898#1	35°53.59'	7°25.00'	1098	10.60
D13898#2	35°53.53'	7°25.04'	1114	12.5
D13898#3	35°54.00'	7°24.58'	1111	~16.5
D13899	35°50.57'	7°29.00'	1179	14.735
D13900	35°48.57'	7°31.01'	1297	18.11
D13901	35°58.01'	7°18.02'	964	0
D13902	38°33.24'	9°20.13'	93	6.00

Table 2 Discovery 249 Giant Piston Core Locations

Core Number	TYPE	Lat	Long	Time	Day	W. Depth (m)	Barrel (m)	Free Fall	Rebound	Pullout (tonne)	Length (m)	No. of Sections	Comments
D13882	GPC*	38°38.07'	9°27.25'	0900	236	87	18	1.5	5	10	13.625	10	Perfect core recovered no disturbance
D13883	GPC	36°05.25'	8°14.06'	0510	237	1978	18	1.5	5		0	0	Did not trigger
D13884	GPC	36°05.46'	8°08.12'	1256	237	1949	18	1.5	5	9.5	8.49	6	Bent Barrel very sandy
D13885	GPC	36°05.25'	8°13.57'	2037	237	1979	18	1.5	5	9.3	3.92	3	Bent Barrel
D13386	GPC	36°05.03'	7°46.47'		238	1019	18	1.5	11	7.5	2.60	2	Bent Barrel
D13887	Kasten	36°07.54'	7°58.31'	0430	240	1543	2	NA	NA	3.5	2.11	2 sections and one bucket	Bucket samples for Geotechnical experiments (Angus Best)
D13888	Kasten	36°07.12'	7°57.30'	0845	240	1568	2	NA	NA	3.6	2.01	2 sections 2 buckets	
D13889	Kasten	36°07.29'	7°58.00'	1110	240	1580	2	NA	NA	3.4	1.18	2 sections 2 buckets	
D13890 #1	Kasten	36°05.29'	8°08.02'	1324	240	1945	2	NA	NA	2.8	NA	NA	EMPTY
D13890 #2	BOX	36°05.31'	8°07.55'	1626	240	2304	NA	NA	NA	NA	NA	NA	EMPTY
D13891	Kasten	36°04.58'	8°11.58'	1924	240	1971	4	NA	NA	2.9	1.16	1	BENT
D13892	Kasten	35°47.01'	7°43.02'	0737	241	1497	2	NA	NA	3.5	1.86	2 section 3 buckets	
D13893	Kasten	35°42.59'	7°43.00'	0940	241	1442	2	NA	NA	3.7	2.02	3 buckets	
D13894	Kasten	35°44.08'	7°43.00'	1123	241	1538	2	NA	NA	3.0	1.945	2 sections 6 buckets	



GRID NO. 1

Figure 1. Discovery 249 Cruise Track

Core Number	TYPE	Lat	Long	Time	Day	W. Depth (m)	Barrel (m)	Free Fall	Rebound	Pullout (tonne)	Length (m)	No. of Sections	Comments
D13895	**GPC**	**35°39.54'**	**7°04.59'**	**1000**	**245**	**1185**	**18**	**1.5**	**30**	**10.1**	**1.91**	**2**	***Pennant too long.* Sediment disturbed and evidence of flowing within liner.**
D13896	**GPC**	**36°02.60'**	**7°11.60'**	**2118**	**245**	**817**	**18**	**1.5**	**19**	**7.9**	**4.15**		**Mudwave location one, significant disturbance and flow with in core, some sand recovered-move to next mudwave site.**
D13897 #1	**GPC**	**35°58.00'**	**7°18.00'**	**2300**	**245**	**957**	**18**	**1.5**	**10**	**8.8**	**6.0**		**Full penetration with little sediment in barrel**
D13897 #2	**GPC**	**35°58.04'**	**7°18.05'**	**0655**	**246**	**969**	**18**	**1.5**	**5**	**8.3**	**10.81**		**Triggered at 961m full penetration, more sediment recovered**
D13898 #1	**GPC**	**35°53.59'**	**7°25.00'**	**1314**	**246**	**1098**	**18**	**1.5**	**6.5**	**8.5**	**10.60**		
D13898 #2	**GPC**	**35°53.53'**	**7°25.04'**	**1826**	**246**	**1114**	**18**	**1.5**	**1**	**8**	**12.5**		
D13898 #3	**GPC**	**35°54.00'**	**7°24.58'**	**0829**	**247**	**1111**	**30**	**1.5**	**0.5**	**11.1**	**~16.5**		**Barrel bent however maximum sediment depth recovered undisturbed**
D13899	**GPC**	**35°50.57'**	**7°29.00'**	**1849**	**247**	**1179**	**30**	**1.5**	**5.5**	**10.51**	**14.735**	**11**	**Barrel bent –undisturbed sediment recovered Mud wave**
D13900	**GPC**	**35°48.57'**	**7°31.01'**	**0609**	**248**	**1297**	**30**	**1.5**	**5.5**	**12.4**	**18.11**	**14**	**Bent Barrel record length of undisturbed core recovered**
D13901	**GPC**	**35°58.01'**	**7°18.02'**	**0312**	**249**	**964**	**30**	**1.5**	**5.5**		**0**	**0**	**Barrel bent – bent section lost during recovery**
D13902	**GPC**	**38°33.24'**	**9°20.13'**	**0748**	**251**	**93**	**18**	**1.5**		**10**	**6.00**		**Barrel bent –undisturbed sediment recovered**

* = Giant Piston Corer

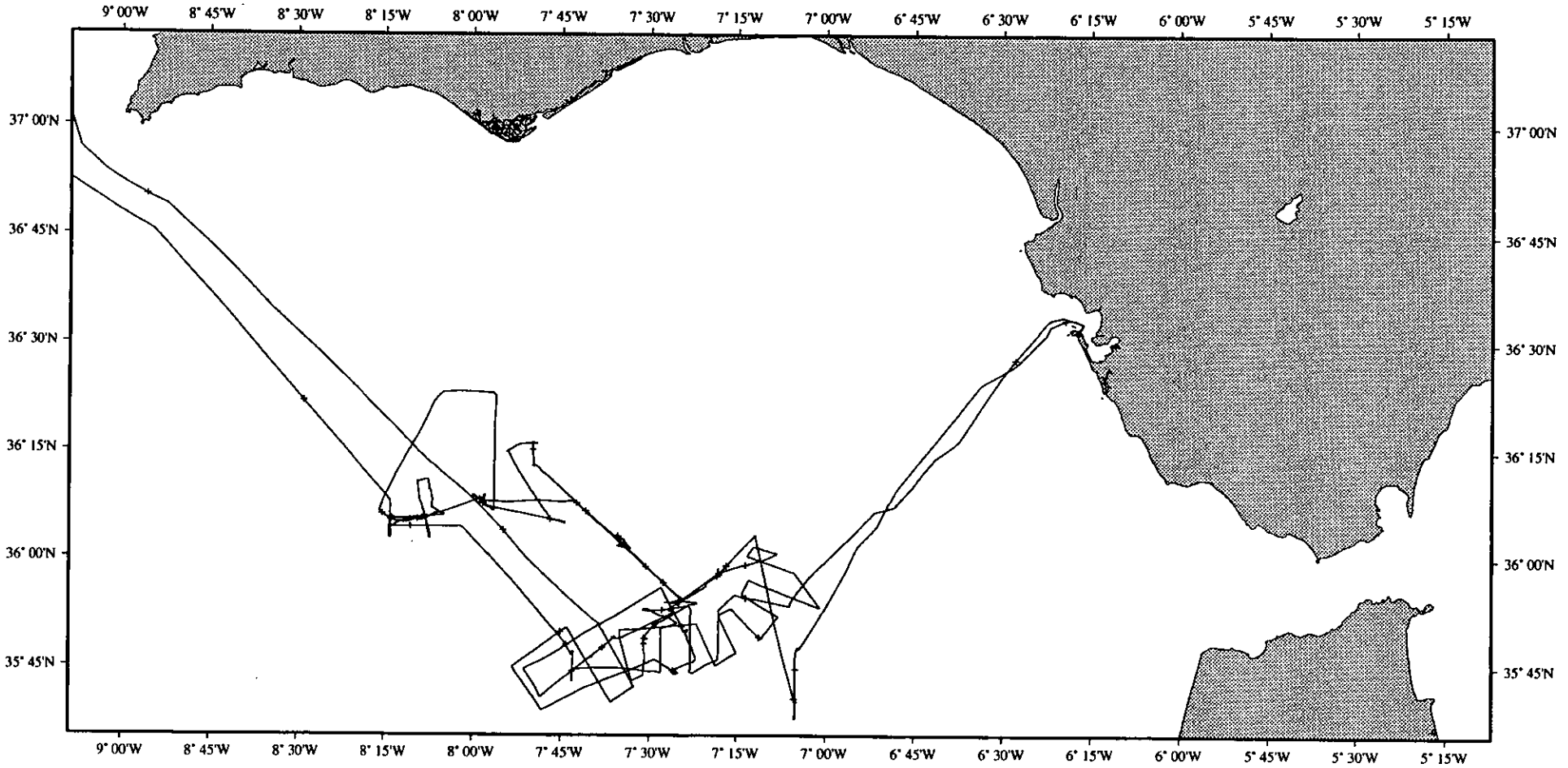


Figure 2 Track chart in work area. For details of times and dates see Fig. 3

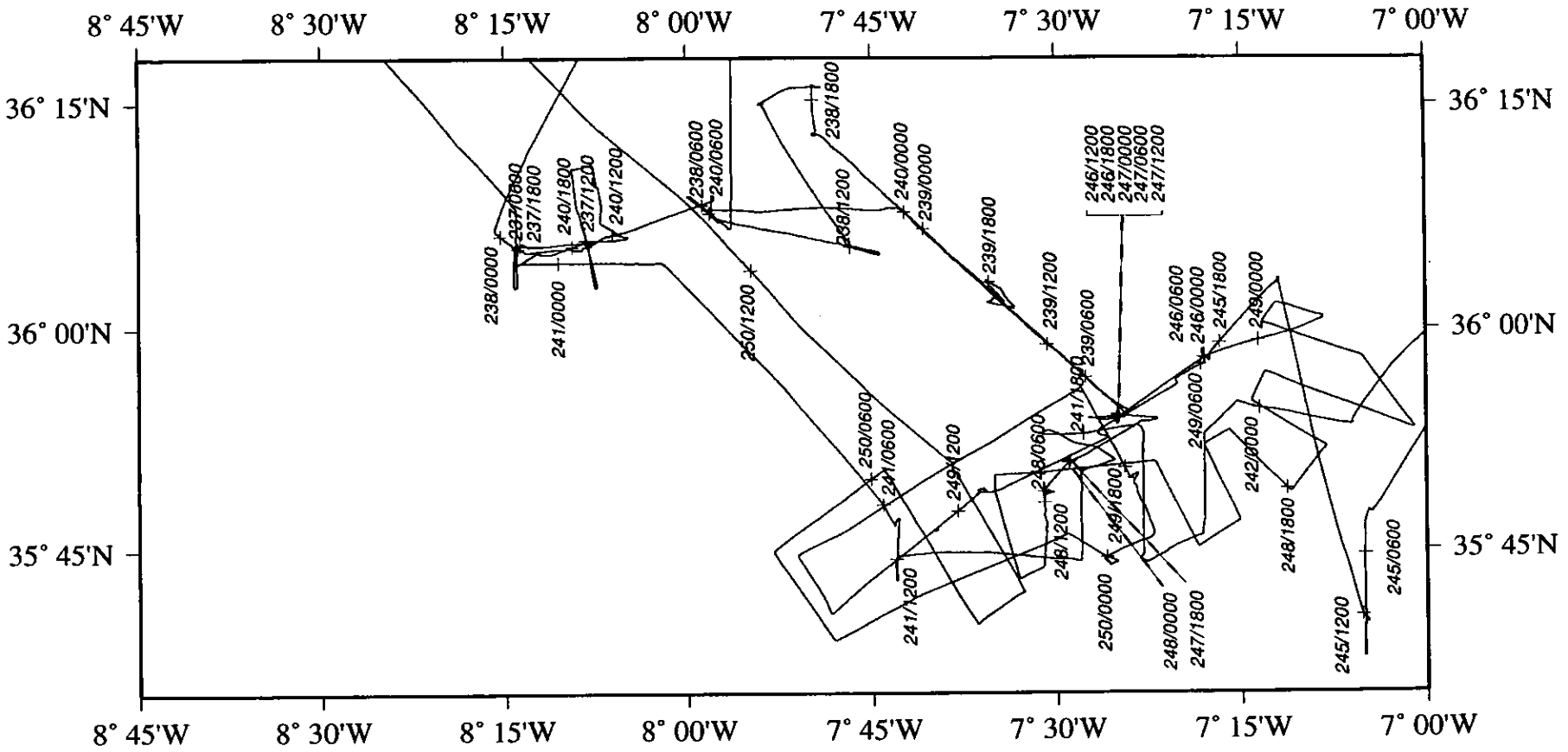
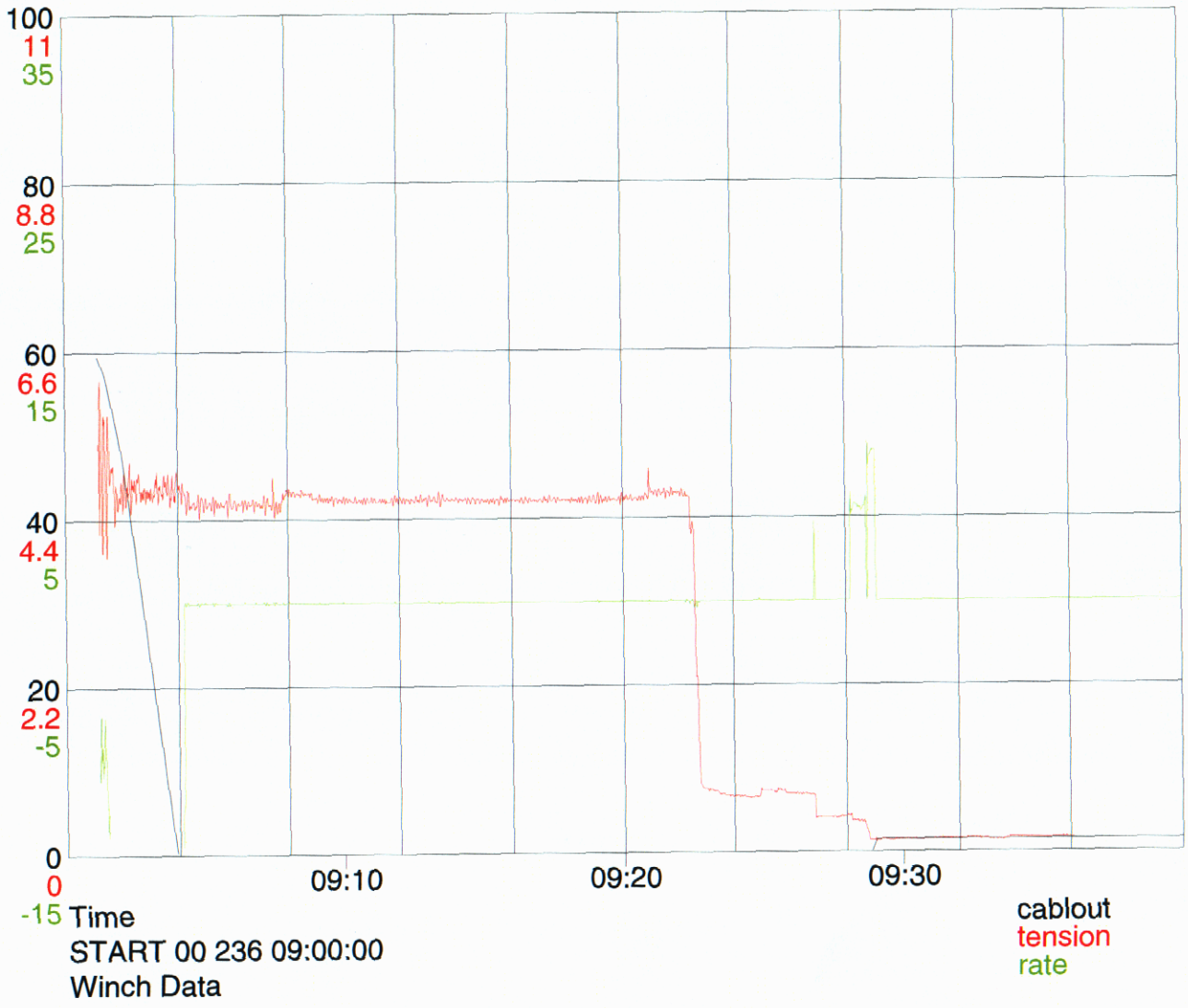
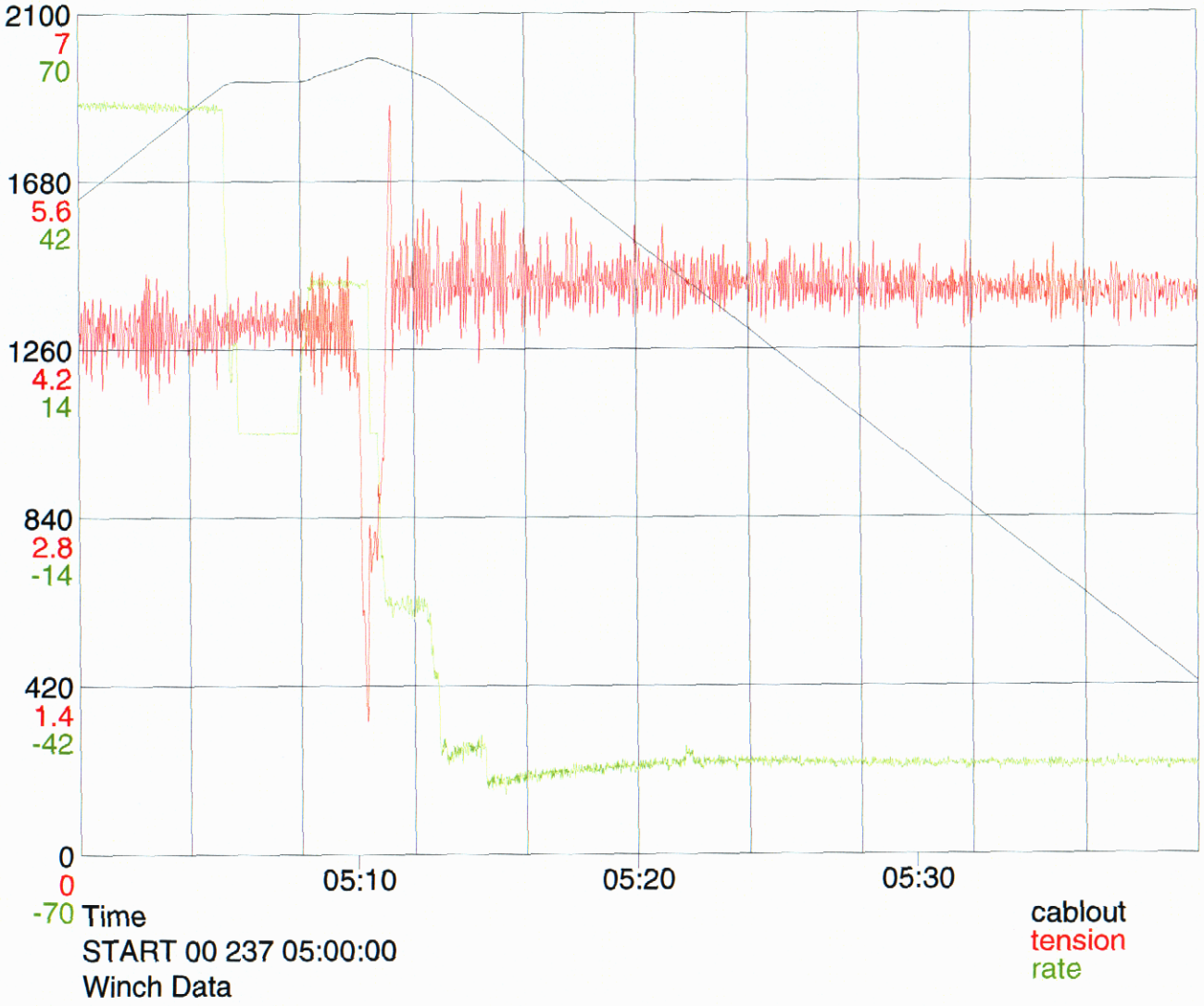


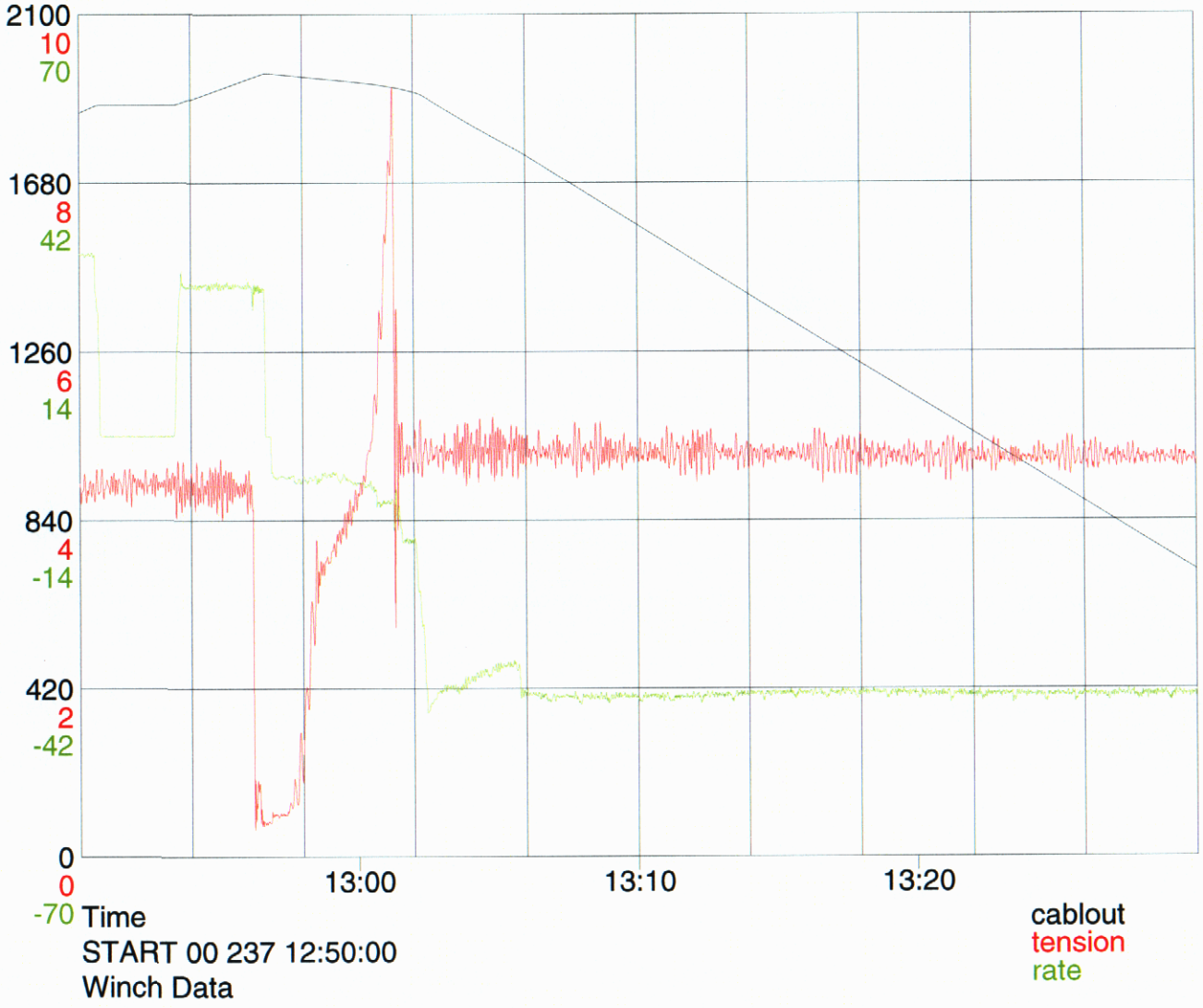
Figure 3. Detailed track chart with day numbers and times.



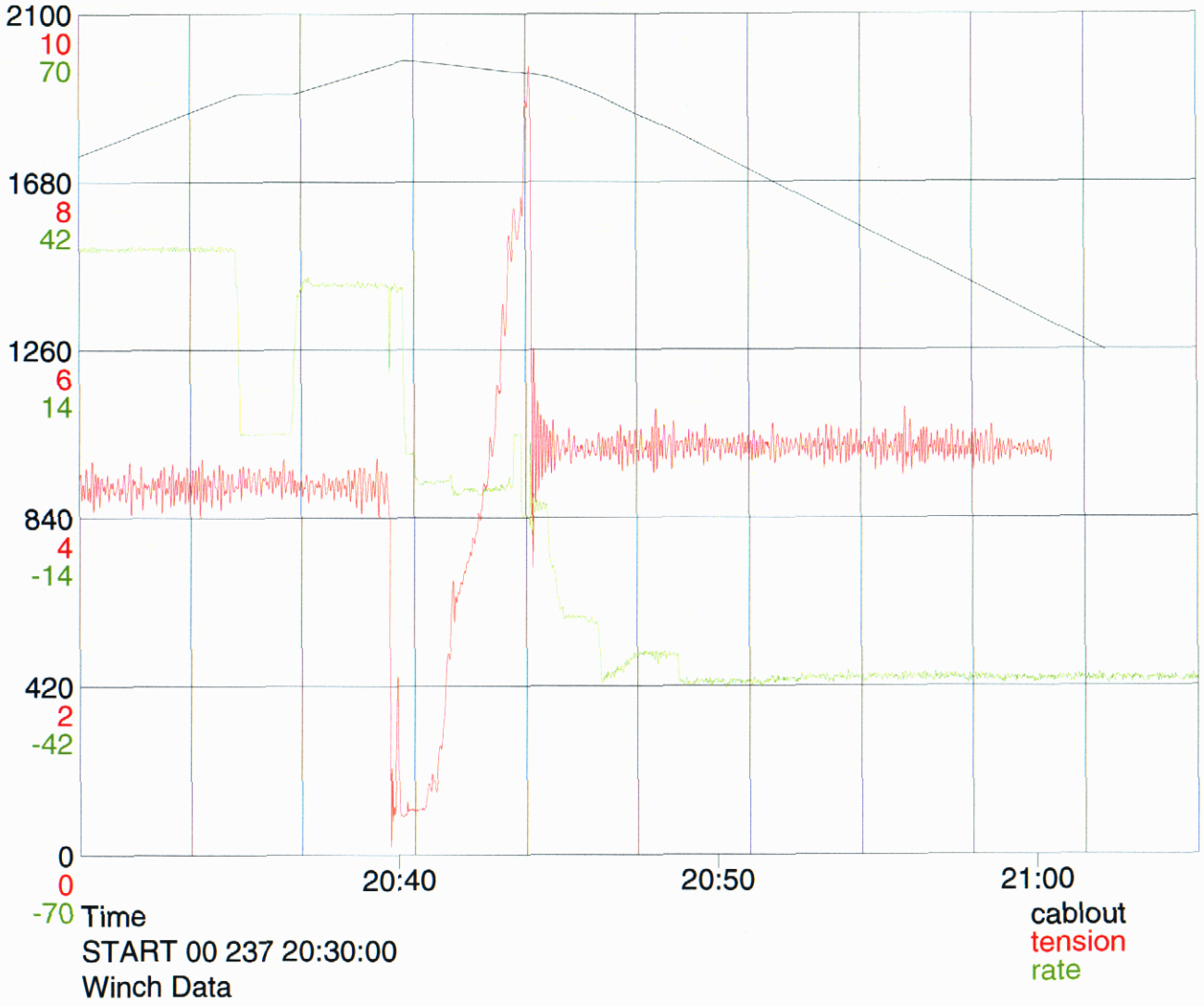
Core Station 13882



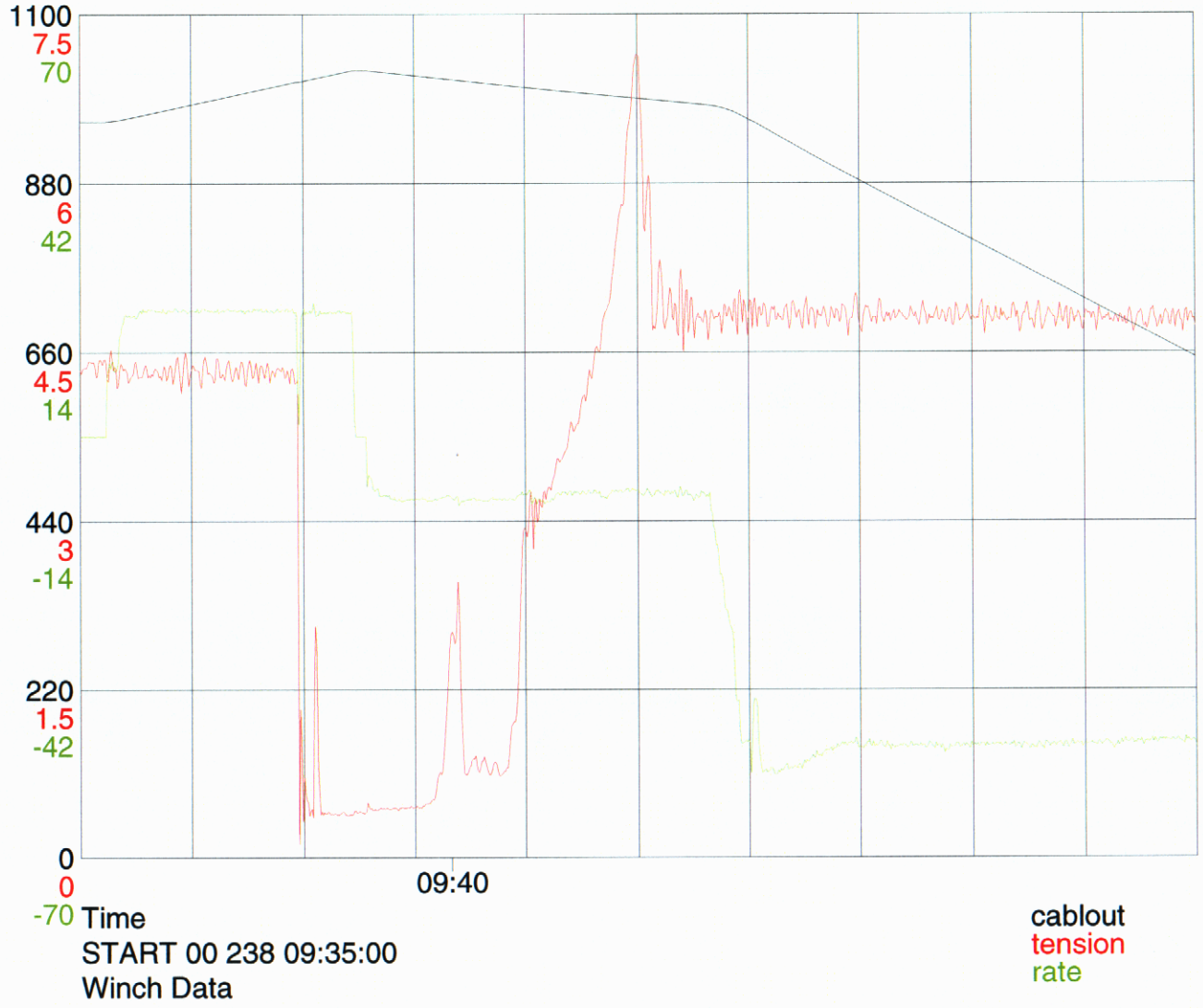
Core Station 13883



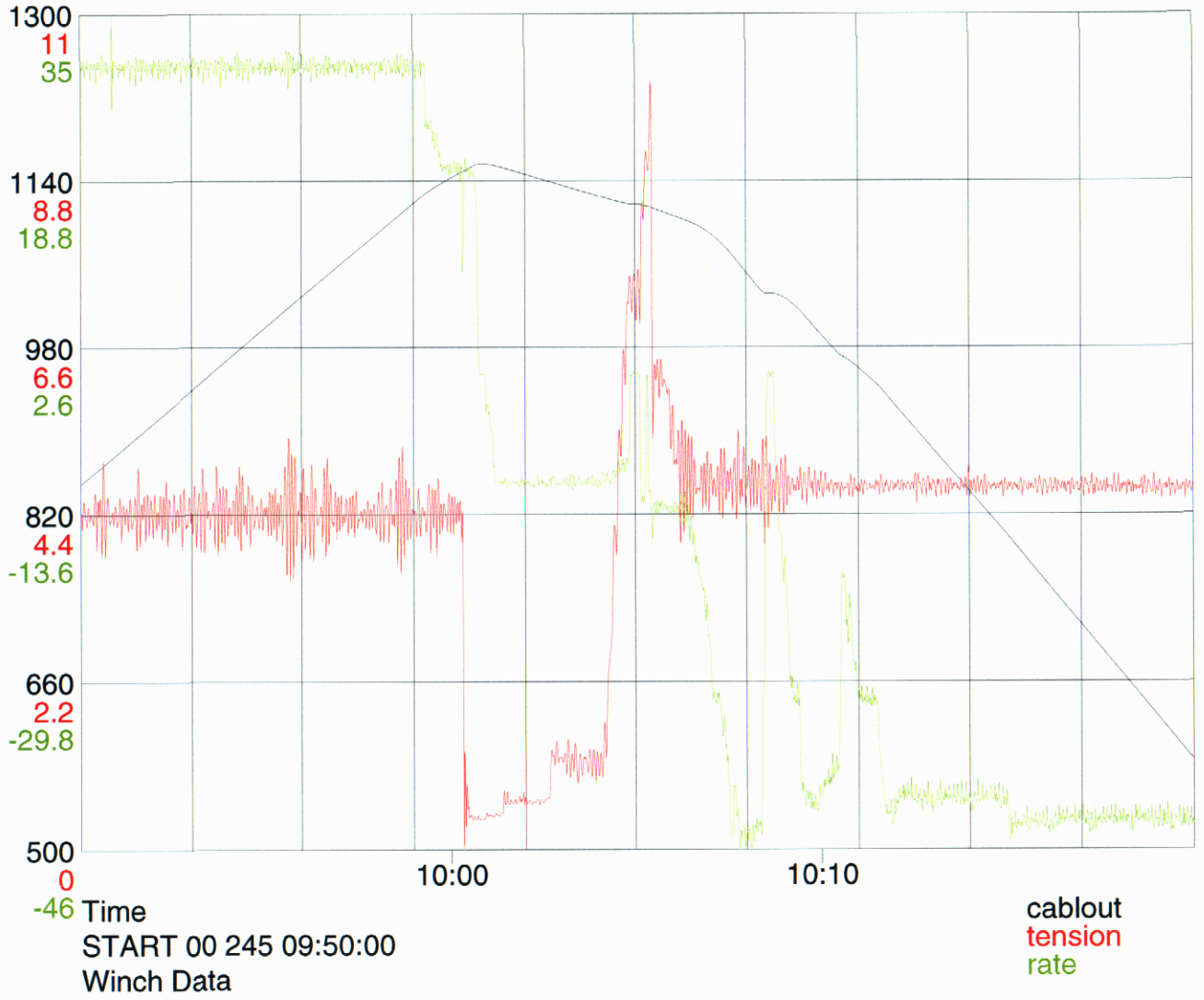
Core Station 13884



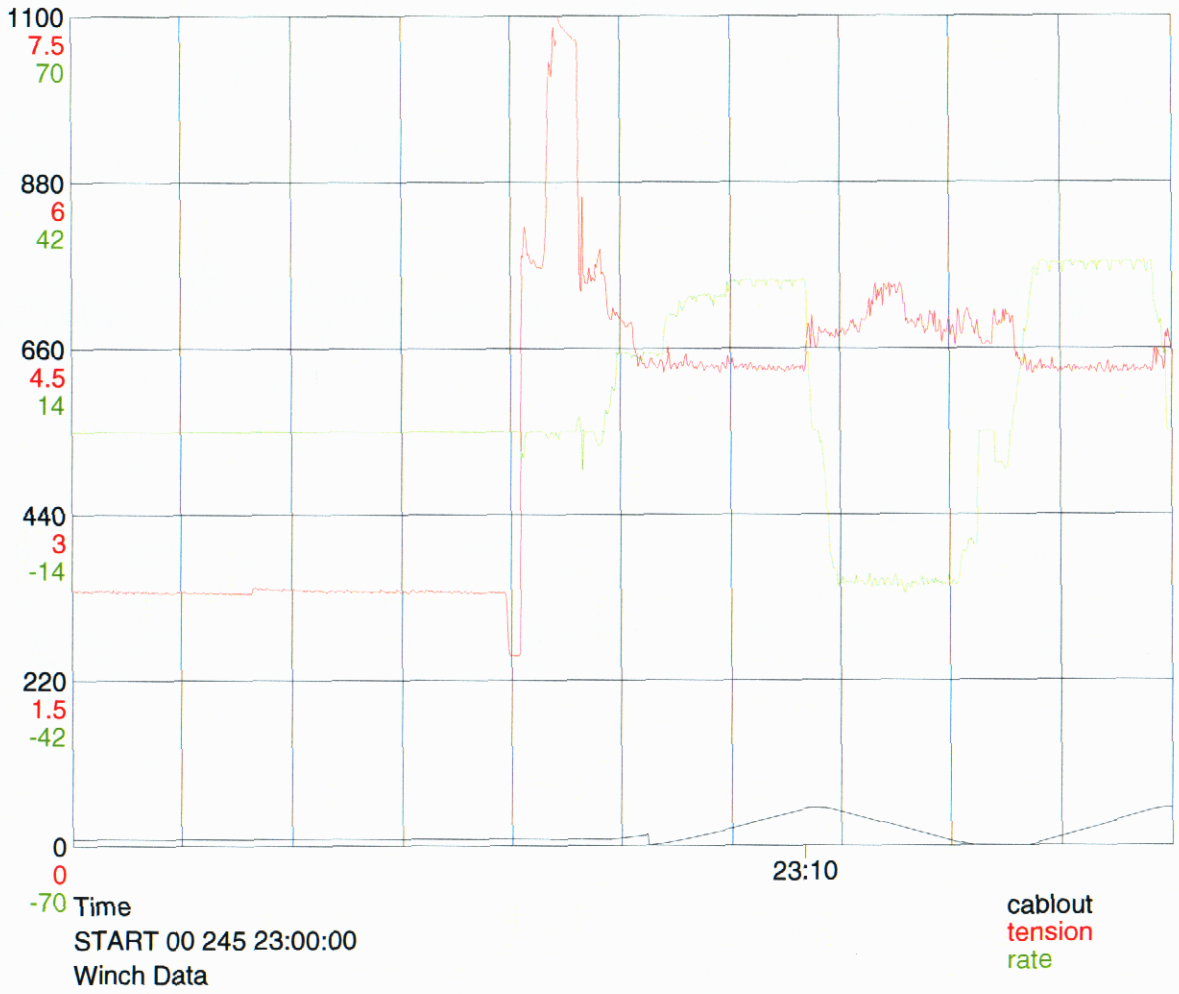
Core Station 13885



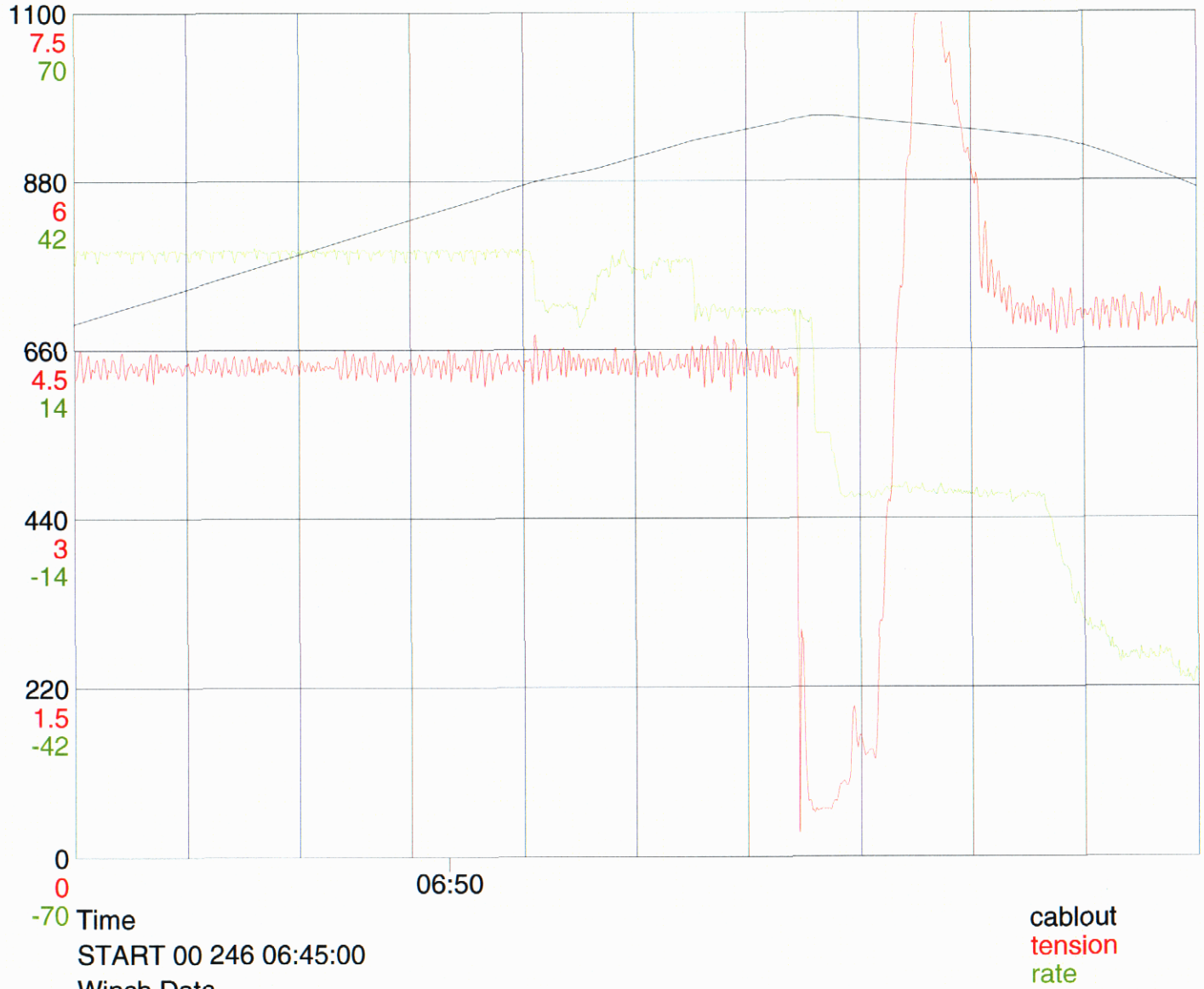
Core Station 13886



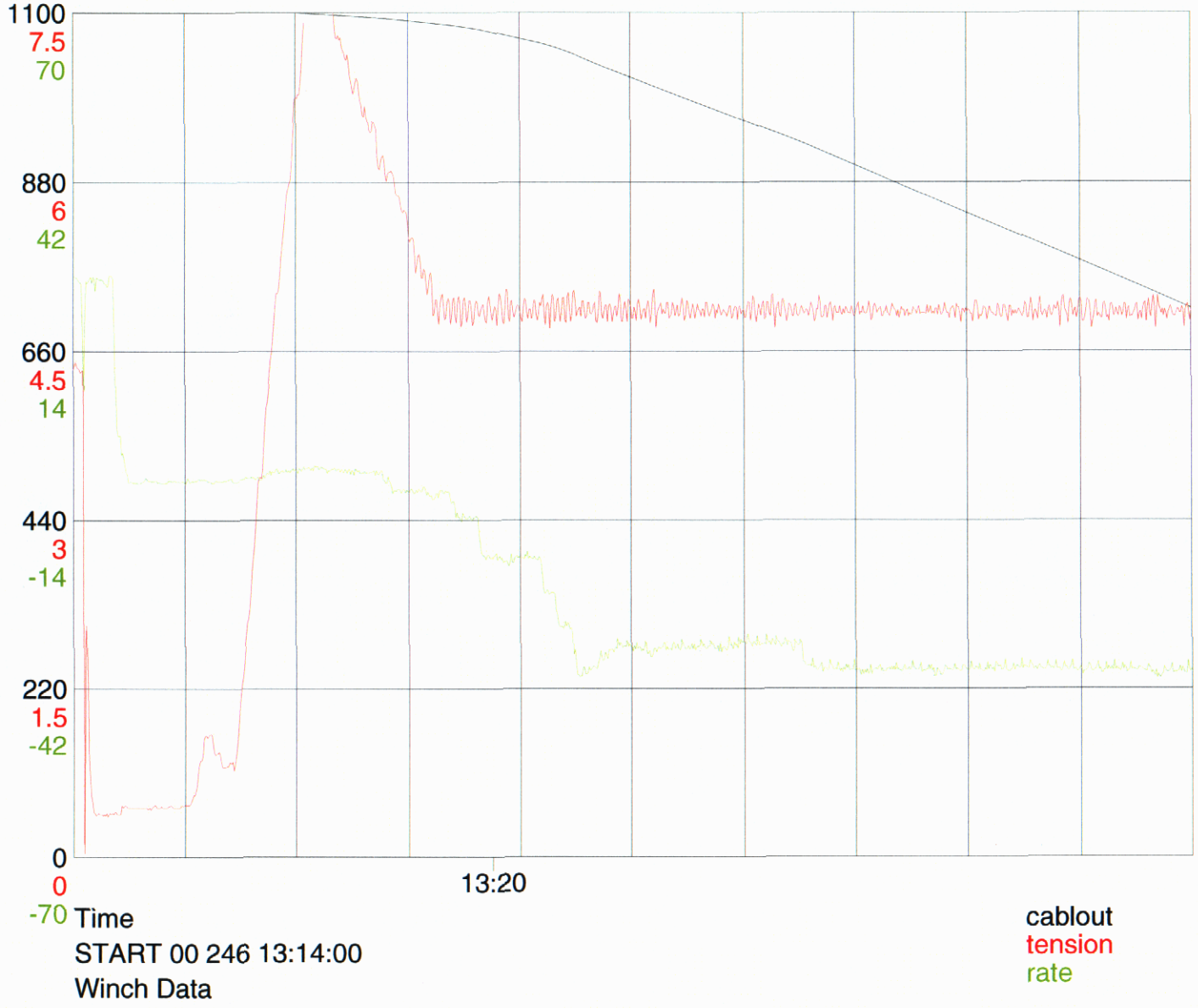
Core station D13895



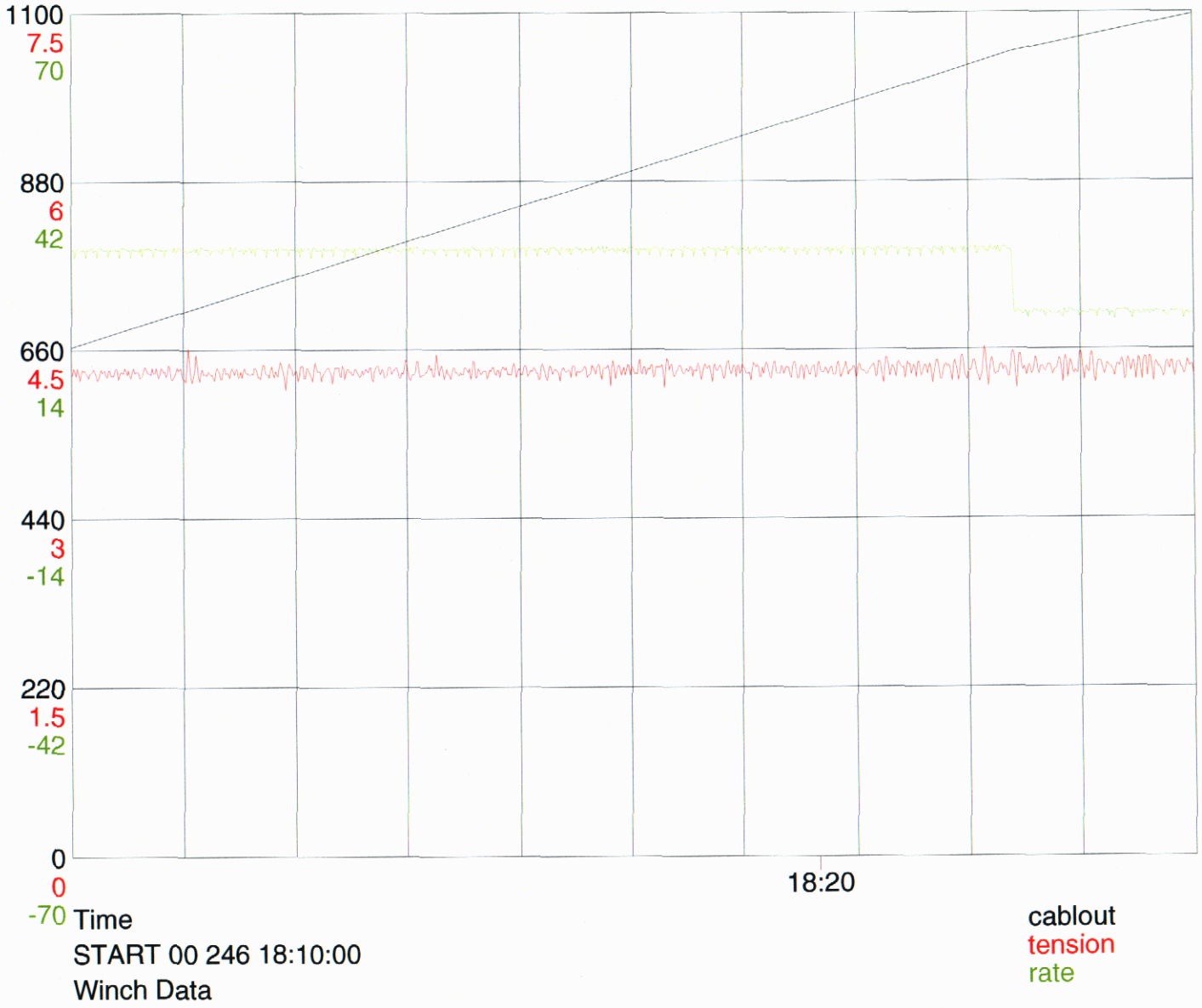
Giant Piston Core Station D13897#1



Giant Piston Core Station 13897 #2



Giant Piston Core Station 13898 #1



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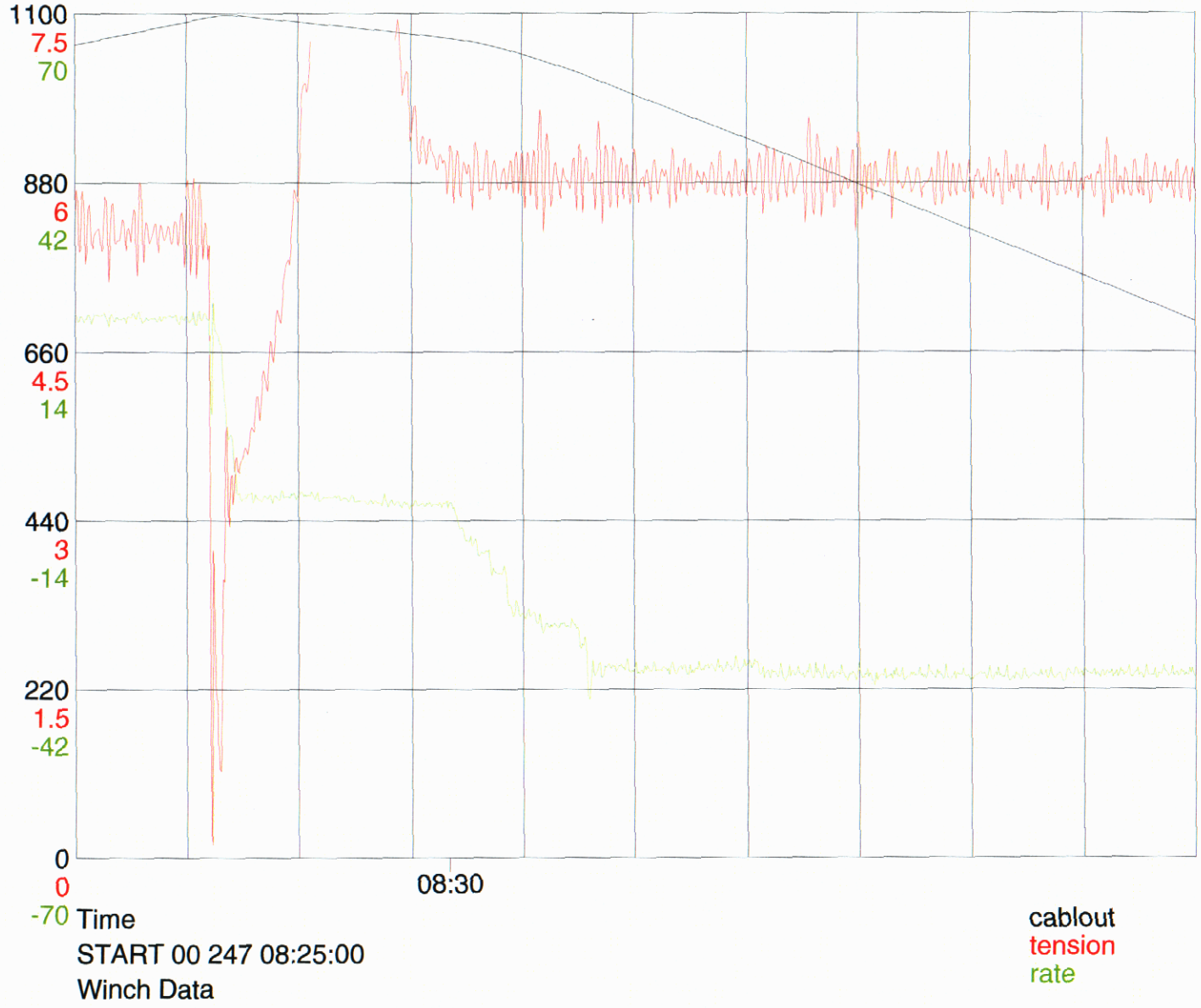
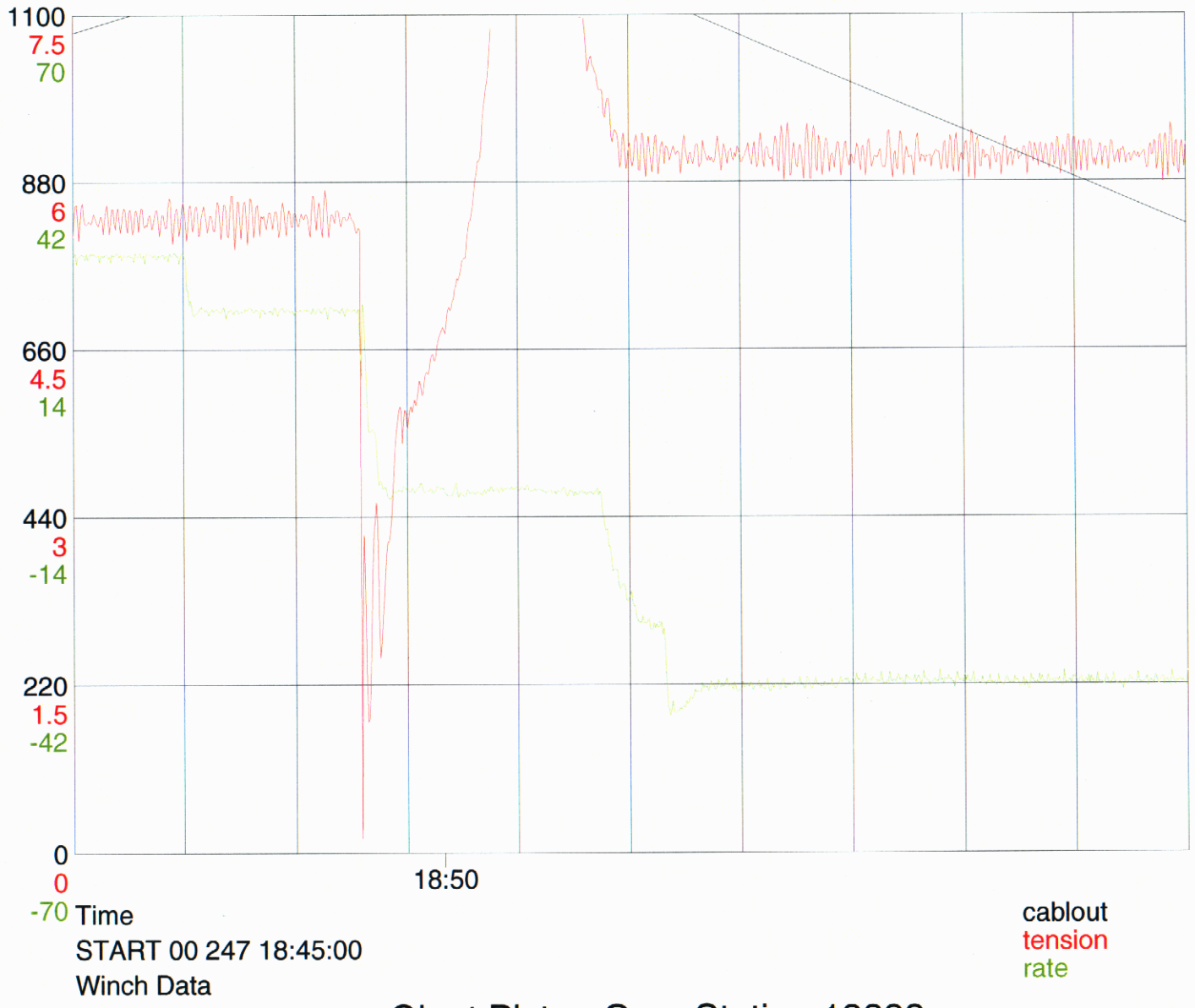
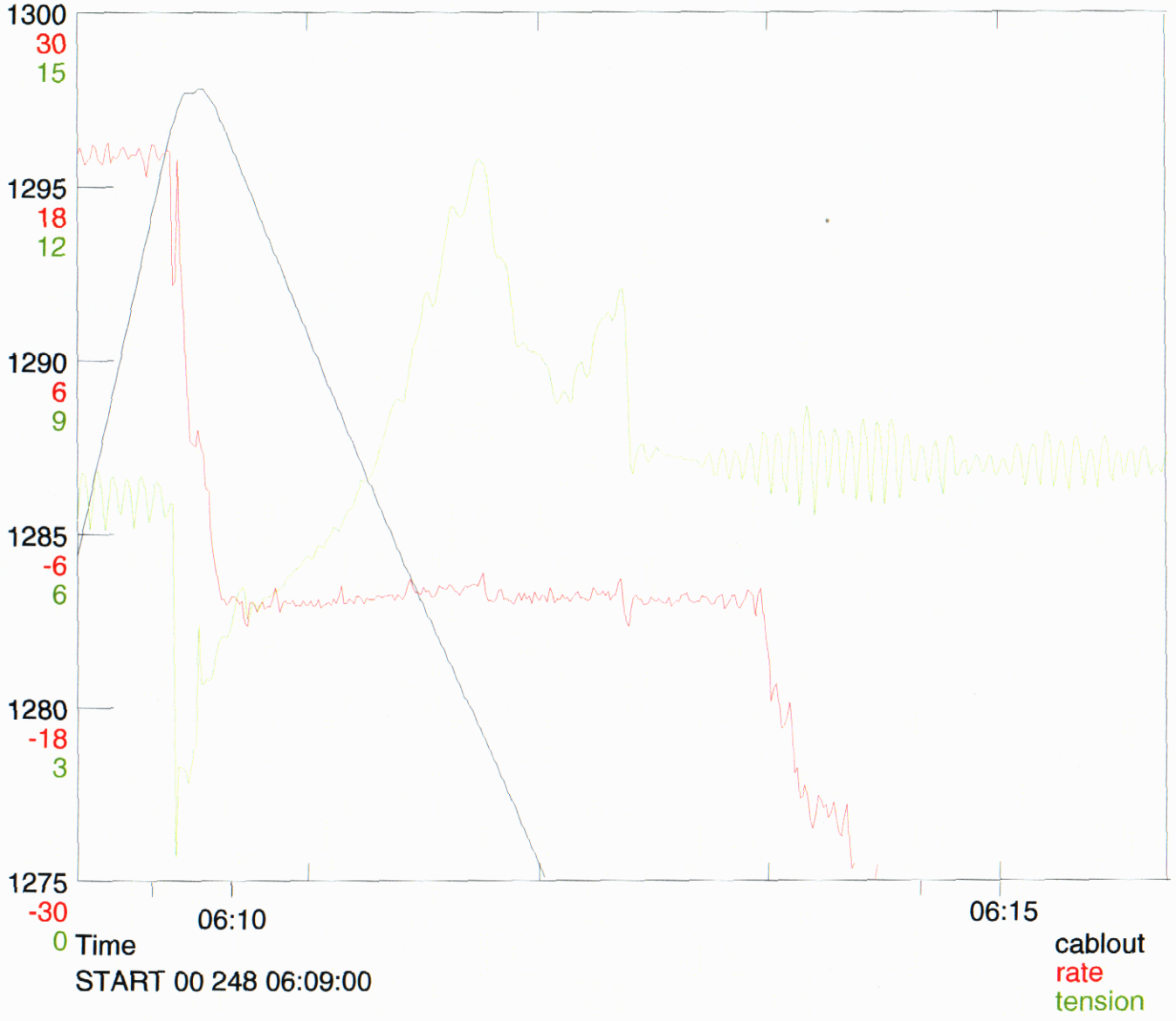


Giant Piston Core Station 13898 #3



Giant Piston Core Station 13899



Giant Piston Core D13900