SOUTHAMPTON OCEANOGRAPHY CENTRE

CRUISE REPORT NO. 3

RRS *DISCOVERY* CRUISE 219
28 NOV-11 DEC 1995

Mass wasting off Portugal and the Canary Islands - investigation by giant piston coring

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ABSTRACT

Cruise D219 was beset with problems - bad weather, the need to transfer seamen to port on two separate occasions for compassionate reasons, combined with the need for further trials of the coring system limited our coring attempts to 6 deployments of which only one produced a core. After only 12 days at sea considerable wear was detected on the ship's coring gantry making it unsafe for further work. The cruise was therefore terminated one week early. Nevertheless, we believe that the corer will work and produce good quality cores when the problems with the ship have been rectified.

KEYWORDS

CRUISE 219 1995
DISCOVERY/RRS
GIANT PISTON CORING

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DUNCAN	AS	STWD
BRIDGE	AM	PO Motorman

ITINERARY

Sailed Lisbon	28th November, 1995
Arrived Madeira	11th December, 1995

CRUISE OBJECTIVES

The primary objective was to collect giant piston cores of up to 30 metres length from the Portuguese margin, Agadir Canyon levees and flanks of Tenerife and the western Canary Islands. A secondary objective was to collect PUPPI data on in situ pore pressures from area showing potential sediment instability.

NARRATIVE

Cruise D219 was a pioneering cruise, attempting to giant piston core for the first time from a British ship. The corer, a new design based on the French system, uses drill pipe, and is capable of taking cores up to 30 metres in length. Cruise D219 was preceded by a trials cruise in which some tests were made of the new kevlar cable, trigger arm and BAS core handling system. During these tests deflections of the deck were noticed under the diverter sheaves under loads of about 8 tons. Since greater forces of up to 15 tons were expected during coring operations it was necessary to strengthen the decks beneath the sheaves. This was done during the port call between cruises D218 and D219.

Day 332 (28th November 1995). Left Lisbon at 0800 for Alfeite to test the new strengthening structures under the deck. Tests were completed by 1330 and the ship sailed at 14.21. We progressed to outside the Tagus River and stopped while there was still daylight to remove weights from the core head. The 3.5kHz fish was deployed and we were underway by 2000. A westerly course was set for a core and PUPPI site on the distal end of the southern levee of the Lisbon Canyon. We arrived at 2345 and began a 5 hour 3.5 kHz survey.

Day 333 (November 29th). The survey revealed a potential coring site approx 370 metres above the canyon axis at the top of the levee. The ship returned to this position and a wire test of 2 PUPPI releases was carried out, starting at 0548. One release was not functional but the other was suitable for deployment. PUPPI deployment was deferred so as to maximise the daylight for coring operations. A core station (D219/1) was begun at this site at 1130 with a launch at 1400. Deployment of the 20 metre corer was succesful but the tensiometer showed a gradual decrease of load when the corer hit the seabed. This suggested that the corer had not triggered and so it was brought back to the ship where our suspicions were proved correct and a problem in the trigger mechanism was identified. The corer had penetrated by about 10 metres and taken about 1.3 m of core, but both barrels were slightly bent and so the system had to be rebuilt. A PUPPI was launched at 1949 (site D219/2) and the ship made way to a potential coring site on the upper continental slope NW of Lisbon.

Day 334 (November 30th). We arrived at the site at 0100 but found little suitable sediment cover. A 3.5kHz survey was begun down the continental slope to the west whilst the corer was rebuilt and problems with the trigger mechanism sorted out. The shape of the teeth in the safety locking mechanism appeared to have prevented its release. This work was completed by 1330 and a coring site was chosen at the bottom

of the continental slope on a probable southerly extension of the Iberia Abyssal Plain. The corer (20 metre) was deployed at 1600 and showed a succesful trigger at 1807 (core D219/3). A significant rebound on the dynamometer was noticed immediately after triggering which may have been due to elastic rebound of the cable. On recovery problems were experienced with the block leading to the auxillary winch which was too small. The core length was 16.4 metres but this included some possible flow in - perhaps caused by the rebound of the cable. To remedy this more rebound cable will be added to later cores. The trigger corer was lost during recovery. The ship steamed back towards the PUPPI site (D219/2).

Day 335 (December 1st). A short 3.5 kHz survey was run over the mouth of the Lisbon and Setubal Canyons until first light and then the next core station (D219/4) 1/3 mile west of the PUPPI site was occupied. A third barrel was added to the corer and 6 metres of rebound cable was provided. The block for the auxillary winch was also changed. The corer was deployed at 1730 and triggered at 1930. A pull-out of 11.5 tons was recorded but the barrels were severely bent and had to be cut whilst outboard. This was done whilst the core head was in its handling cradle. The operation was completed at 2330.

Day 336 (December 2nd). The PUPPI at station D219/2PUP was recovered at 0152 but the data showed anomalous results indicating that the PUPPI had not penetrated the sediment. This may have been due to the new thin probe which was tested on this deployment. We then moved to attempt a core (D219/5) on a shallow water mudwave field west of southern Portugal. We reverted to 2 barrels and the same configuration as core D219/3. The record of triggering and penetration at 1517 looked good with all weight coming off the cable whilst the core was on the seabed. The core barrels returned straight but it was not possible to remove the liner from the lower barrel, probably due to a liner collapse. The mud at the bottom of the corer was very stiff and we presumed that the rebound cable was too long: when the cable was hauled in, the piston rose through the barrel but could not suck in the stiff mud thus creating a potential vacuum and leading to the liner collapse. The trigger corer was lost during its recovery. Rather than try to re-core such stiff mud we moved to another mudwave field south of Faro where several previous cores had been successful.

Day 337 (December 3rd). Core D219/6 was deployed with 2 barrels (20 metres) at 1145. Instead of triggering normally the weight came slowly off the cable suggesting a failure of the release. The winch was therefore stopped immediately and the cable hauled in. When at the surface it was clear that the release had worked and the corer was in a condition ready to fire. We therefore redeployed the system and this time the same slow decline of weight began, but was followed immediately by a normal triggering. On recovery the pennant cable supporting the trigger corer was wrapped several turns around the core barrel and the upper core barrel was bent. There was no core in the barrel. This problem of the trigger corer wrapping around the main corer may have occured on previous coring attempts, especially those where the trigger corer was lost. We had been using kevlar ropes for attaching the trigger corer but decided to modify the trigger arm to take the weight of chain for future deployments. Following completion of this station at 1700 we made way towards the Seine Abyssal Plain where we knew the sediments were soft.

Day 338 (December 4th). Made way on SW course, but news of bereavement of close relative of one of the scientists caused us to head towards Funchal to drop scientist. We also took the opportunity to pick up chain for trigger corer deployment. Stopped along way at 1918 to test PUPPI acoustics. 3.5 kHz fish brought inboard to enable greater speed. The engineers spent the day disassembling the corer, especially the

upper barrel which had overtightened onto the core head. Eventually it had to be cut through and a wedge driven in to loosen its grip on the threads.

Day 339 (December 5th). Steaming for Funchal all day. Corer prepared for next station. Arrived in Funchal at 1800. Unfortunately no chain was available in Funchal and so we had to rely on two lengths which were on the ship. Left for core-site on flat area of continental rise south of Madeira.

Day 340 (December 6th). We arrived at station D219/7 at around 7am and began to prepare the trigger assembly. The trigger arm was tested to see if it would operate with the weight of chain instead of rope but the chain proved too heavy to allow a proper release. Plastic coated wire rope was used for the upper 14 metres and 6mm chain for the lower 10 metres. The corer was deployed over the side at 1130 and lowered to 1000 metres before being brought back to the ship's side to see if the new chain/wire arrangement was lapping around the barrel or not. The new arrangement seemed to be working but the weather was turning against us with force 6 winds. It was decided that coring was unsafe in such weather and the corer was brought inboard at 1300. We waited until 1500 for an improvement in the weather, but when it did not arrive we decided to steam south to a series of PUPPI and core sites off the Canary Island of La Palma. We headed for a waypoint *en route* which would have provided a core site if the weather had improved, but unfortunately a steady force 5/6 was blowing from the N.E. (i.e. typical trade winds).

Day 341 (December 7th). The first PUPPI was deployed at 0441 (station D219/8PUP) at the position of kastenlot core CD56-26 taken on a previous cruise. This core was located about 35 km north of the debris flow on the lower flank of the island of La Palma, and showed inclined beds which may be indicative of sediment creep. The weather was too windy to core at this site and so we moved west to the second PUPPI site (D219/9PUP), located 5km NE of the Canary Debris Flow. A previous kastenlot core here (CD56-25) showed a pelagic record. Puppi was deployed at 0852 (station D219/9PUP), but suffered a premature release in the water column and had to be recovered. Unfortunately one of the officers received news of the death of a close family member this morning and we had to make plans to drop him in Santa Cruz de La Palma. We were able to attempt a second deployment of PUPPI (station D219/9PUP) at this site before moving off. This PUPPI was successfully launched at 1429. At 1510 we were underway at full speed to Santa Cruz, and arrived at 2200 to transfer the officer to the pilot boat. Following this we returned to the PUPPI sites to deploy a further PUPPI or core depending on the weather.

Day 342 (December 8th). PUPPI station D219/8 was crossed at 0400 but the weather was too poor to stop for a core site. We therefore continued to a core and PUPPI site located on the debris flow west of station D219/9PUP. This site was located in the lee of an abyssal hill which protrudes through the debris flow, and showed at least 10m of debris flow on the 3.5 kHz records. On arrival at the site at 1112 the weather had improved sufficiently for a coring attempt. The corer was deployed at 1310 and triggered at 1519 (station D219/10) . The dynamometer record showed no pull-out force and so we suspected another failure. The corer was brought inboard at 1730, and although the barrels were straight the core cutter had been ripped from the end barrel shearing the attachment pins and dragging one through the steel barrel. The liner was shattered and there was no core. We surmised that the corer had hit and slightly penetrated a large block of basalt. As the corer fell over the cutter was ripped off. The lower 2 m of barrel was covered in sediment and above this only part of the barrel was covered, suggesting the corer was suspended with the core head not touching the seabed. Traces of basalt were found near the end of the barrel. We

decided not to deploy a PUPPI at this site because of the hard seabed and so we moved to a site just off the debris flow where the sediments should be softer.

Day 343 (December 9th). The PUPPI was deployed at 0409 (station D219/11PUP) and we made way towards station D219/8PUP to attempt a core. At 0900 the RVS engineers inspected the mounting of the outboard block on the main davit and found it to be suffering considerable wear. It was regarded as unsafe to continue coring operations and there was no possibility of repairing the block mounting at sea. We therefore decided to teminate the cruise and began to collect the three PUPPI's which were on the seabed. These were recovered at 1410, 1745 and 2210. We then proceded towards Madeira to disembark the scientific party.

Day 344 (December 10th). Proceded towards Madeira against a headwind and swell. 3.5 kHz survey continued until 2000.

Day 345 (December 11th). Arrived at Funchal at 0600. Scientific part disembarked at 1000.

GIANT CORER OPERATIONS

At the beginning of this cruise there was much to learn about the new corer and how to handle it, especially on the new Aramid cable. The trials cruise which preceded D219 had not completed the corer trials because of structural weaknesses in the ship's deck which necessitated the abandonment of all winch work. The first few coring attempts were therefore seen as a continuation of the trials and we did not expect these to be a complete success. We had barely passed this trials part of the cruise when the problem with the outboard block on the starboard gantry became apparent, causing the termination of all winch work and thus the premature end of the cruise.

BAS corer handling equipment

The British Antarctic Survey supplied the tilt transfer unit and two handling davits for the core barrel. The davits worked well in principle, moving the core barrels from an inboard to outboard position and then rotating them vertically. The electrical control boxes, however, were not very robust and two electrical wires were found to be broken within the armoured sheath just before they entered the box. This necessitated a complete rewiring of this box. The hydraulic system for moving the davit in and out worked only in an on/off mode with no speed control. Such a control would have made operations smoother and the corer more manageable.

The tilt transfer unit worked well in stabilising the corer and changing it from vertical-outboard to horizontal-inboard positions. However, we recommend the following modifications:

1. As with the davits the hydraulics should be given a speed control and the delay in starting movement following operation of the joystick should be eliminated.

2. A removable pin should be fitted to prevent the system rotating the barrels beyond a horizontal position. This is particularly important when there are no barrels attached to the core head as the pivot point would then allow the handling gear to tip the core head upside down.

3. The hydraulic jaws worked on unbent cores, but bent cores do not necessarily hang vertically thus giving problems in guiding the corer into the jaws. Also the system was not easy to operate in anything but calm weather due to the narrow jaw opening. The possibility of fitting longer guides to funnel the corer into the jaws should be investigated.

4. The trigger corer has to be connected to the main corer by means of shackles when it is in a vertical position. This necessitates two men climbing onto the handling device outboard of the ship's rail. Although the men use safety harnesses, more safety could be provided with a platform and safety rail. This may need to be on a hinged system so that it can be removed during deployment and recovery.

Dealing with bent Corers

The BAS handling system works well with unbent corers, though the changes noted above will improve handling and safety. For bent corers we found the following procedure to be the most satisfactory. Bring core head into jaws of handling gear; take weight of corer on main cable and rotate corer so that bent pipe points towards the bow of the ship; Lower corer back onto handling gear and bring horizontal (the bent barrels will now point downwards) then rotate inboard (in this position the bent barrel will point outboard). One problem with this is that in the final step the weight of the barrel acts to tighten the threads on the barrels near the core head. Such overtightening can be very difficult to undo as we found to our cost!

ANALYSIS OF CORING ATTEMPTS

This section is included so as to aid future coring efforts. The digital printout of cable tension, cableout and rate of veer/haul is particularly useful in interpreting the corer's action on the seabed.

Core D219/1

The tensiometer showed a gradual decrease of load as the corer hit the seabed. This indicated that the corer did not trigger, but it must have penetrated the seabed as a pullout force of 8.3 tons was recorded. On recovery a failure of the trigger was noted and a 1.3 m core was taken which was compatible with incorrect movement of the piston. The shape of the teeth in the safety locking mechanism of the trigger appear to have prevented its release. The teeth were reshaped to match a gear mechanism and polished and greased for optimum operation.

D219/3

The triggering of this core was instantaneous, although a major load of 5.5 tons reappeared momentarily after the triggering. A force of 3 tons remained on the cable whilst the corer was in the seabed, suggesting not all the weight had come off the cable. Following this a pullout of 8.75 tons was recorded. The core was 16.4 m long but showed signs of sediment disturbance throughout with curved lithological boundaries and possible flow-in at the base. This suggets that the rebound cable was too short, and may explain the 3 ton force when the corer was in the seabed.

D219/4

Following the success of the previous core a three barrel core was attempted (30 m). A good trigger was observed, but again a weight of over 3 tons returned shortly afterwards. The pull-out force was 11.5 tons. This core was severely bent and had to be cut whilst outboard. No record of the core length (if any) was obtained.

D219/5

We used 2 barrels for this core (c20m). The trigger was sharp but there was a rebound immediately after this. When the corer was in the seabed the load on the cable was less than 1 ton. There was a good pull-out of 11.25 tons. Unfortunately, the liner imploded on this deployment and prevented us from removing the core. The mud at the bottom of the corer was very stiff and we presumed that the rebound cable was too long: when the cable was hauled in, the piston rose through the barrel but could not suck in the stiff mud thus creating a potential vacuum and leading to liner collapse. The trigger corer was lost during its recovery.

D219/6

In the first deployment at this station the trigger did not work properly as the weight could be seen coming gradually off on the tensiometer record. The deployment was therefore terminated and the corer brought back to the ship. No problems were seen when the corer was at the sea surface and so it was redeployed. This time the weight began to reduce slowly and then the corer triggered. Following triggering more weight came back on the cable before it declined to about 1 ton. There was a good pull-out of about 11 tons. The corer returned bent and with the trigger corer wrapped around the barrel of the main corer. There was no core in the barrel. This problem of the trigger corer wrapping around the main corer may have occured on previous coring attempts, especially those where the trigger corer was lost. We had been using kevlar ropes for attaching the trigger corer but decided to modify the trigger arm to take the weight of chain for future deployments.

D219/7

The trigger arm rope was replaced with plastic coated wire rope for the upper 14 metres and 6mm chain for the lower 10 metres. Following deployment the corer was lowered to 1000 metres before being brought back to the ship's side to see if the new chain/wire arrangement was lapping around the barrel or not. The new arrangement seemed to be working but the station was abandoned due to poor weather.

D219/10

A two-barrel core was used and a good triggering recorded. 3.5 tons of weight came back onto the dynamometer after triggering suggesting a coring problem. There was no pull-out force and when the corer was recovered the barrels were straight but the core cutter had been ripped from the end barrel shearing the attachment pins and dragging one through the steel barrel wall. The liner was shattered and there was no core. We surmised that the corer had hit and slightly penetrated a large block of basalt. Traces of basalt were found near the end of the barrel. As the corer fell over the cutter

was ripped off. The lower 2 m of barrel was covered in sediment and above this only part of the barrel was covered, suggesting the corer was suspended with the core head not touching the seabed.

PPEW

3.5 kHz PROFILING

3.5 kHz profiles were collected at every coring and PUPPI station and along most of the passage tracks between stations. The seabed character as determined from the 3.5 kHz records was the principal parameter in choosing the suitability of coring sites. No serious failures of the system were experienced. A minor but irritating problem was experienced in displaying the bottom trace on the Raytheon recorder using the offset dispaly mode. This was found (post cruise) to be due to an incompatibility between the newer digital Raytheon recorders and the 3.5 kHz acquisition system.

DGM

PUPPI OPERATIONS

Three PUPPI units and 10 sets of disposable equipment were made available for the cruise in order to make pore pressure measurements in and around submarine slides. The intended purpose of these measurements was to investigate the pore pressure records in order to determine whether the current physical state of the sediments could indicate the state of stability.

The short time period and the competing cruise logistics were always going to make a large number of deployments difficult as each deployment should ideally remain on the sea floor for at least 3 or 4 days. As it transpired this indeed was the case and this was then further aggravated by the early termination of the cruise programme.

The first PUPPI deployment (Station 219/PUP2) was made in an area on the distal end of the southern levee of the Lisbon Canyon. Logistics allowed only a short deployment of 2 days. However, the data indicated that the instrument had not penetrated the sea floor although the reason for this is not known.

The original plan was to make PUPPI deployments both in the centre and around the flanks of the Canary debris flow. However, after the unsuccessful attempt to core in the centre of the debris flow (it seems that the corer hit basalts!), it was considered prudent not to drop the PUPPI in the debris flow itself. Consequently we decided to locate further deployments just off the flow to the NE (as defined by an interpretation of the 3.5kHz record). Three subsequent deployments were made (Stations 219/PUP 8, PUP10 & PUP12) in this area, all of which were prematurely recovered on day 343 after the decision to terminate the cruise was made. The last deployment PUP12 was only a few hours long and hence cannot be used to interpret equilibrium pore pressure.

Unfortunately no penetration event is seen on the data set from either PUP8 or PUP10. At first sight this again looked like a penetration problem but on further analysis it has been concluded that the pre-release pipe cutter had prematurely failed in both cases during the descent. Although the technical difficulty with the instruments could have been rectified and 5 further sets of disposable equipment were prepared, the early termination of the cruise prevented us from obtaining any usable data.

Date Day	PUPPI Operation
Nov 27 331	Sailed from Lisbon
Nov 28 332	Ready for wire test and 1st deployment. Ship delays (crane-time prevented tests and deployment).
Nov 29 333	Wire Tested Acoustics 380 & 535. 380 has problem (stuck in release channel) 535 functioned well Deployed PUPPI unit No. 2 (Station 219/PUP2).
Nov 30 334 Dec 1 335	Ready for 2nd wire test. Logistics prevented. Recovered PUPPI unit No. 2 (Station 219/PUP2). Delays with piston corer resulted in cut off barrel falling whilst PUPPI on way up after release on back up clock at 334/2355. PUPPI on board at 335/0145.
Dec 2/3 336/337	Out of range of PUPPI sites: Coring operations take priority.
Dec 4 338	Wire Tested Acoustics 380 & 400. Acoustics 400 functioned well but 380 still has a small problem. It is thought to be a function of acoustic masking during the test and hence should function well on a normal deployment.
Dec 5 339	Dropped Eric Darlington in Madeira
Dec 7 341	Deployed PUPPI unit No. 1 (Station 219/PUP8). Deployed PUPPI unit No. 3 (Station 219/PUP9). Instrument pre-released in water column and was recovered. Deployed PUPPI unit No. 3 (Station 219/PUP10).
Dec 8 342	Delayed deploying next PUPPI in debris flow because core hit very hard material (basalt?). Moved to new site.
Dec 9 343	Deployed PUPPI unit No. 2 (Station 219/PUP12). Cruise aborted due to unsafe wear on main sheave block. Decision made to prematurely recover up all 3 PUPPIs. Recovered PUPPI unit No. 2 (Station 219/PUP12). Recovered PUPPI unit No. 1 (Station 219/PUP8). Recovered PUPPI unit No. 3 (Station 219/PUP10).
Dec 11 343	Arrived Funchal

PJS

PRINCIPAL RESULTS AND CONCLUSIONS

This cruise was the first one on which giant piston coring was attempted on the RRS Discovery. A large number of problems were encountered in the configuration of the equipment and the shipboard handling gear. Many of these problems were overcome onboard, but in the end the ship's gantry was damaged by the loads imposed and the cruise had to be abandoned.

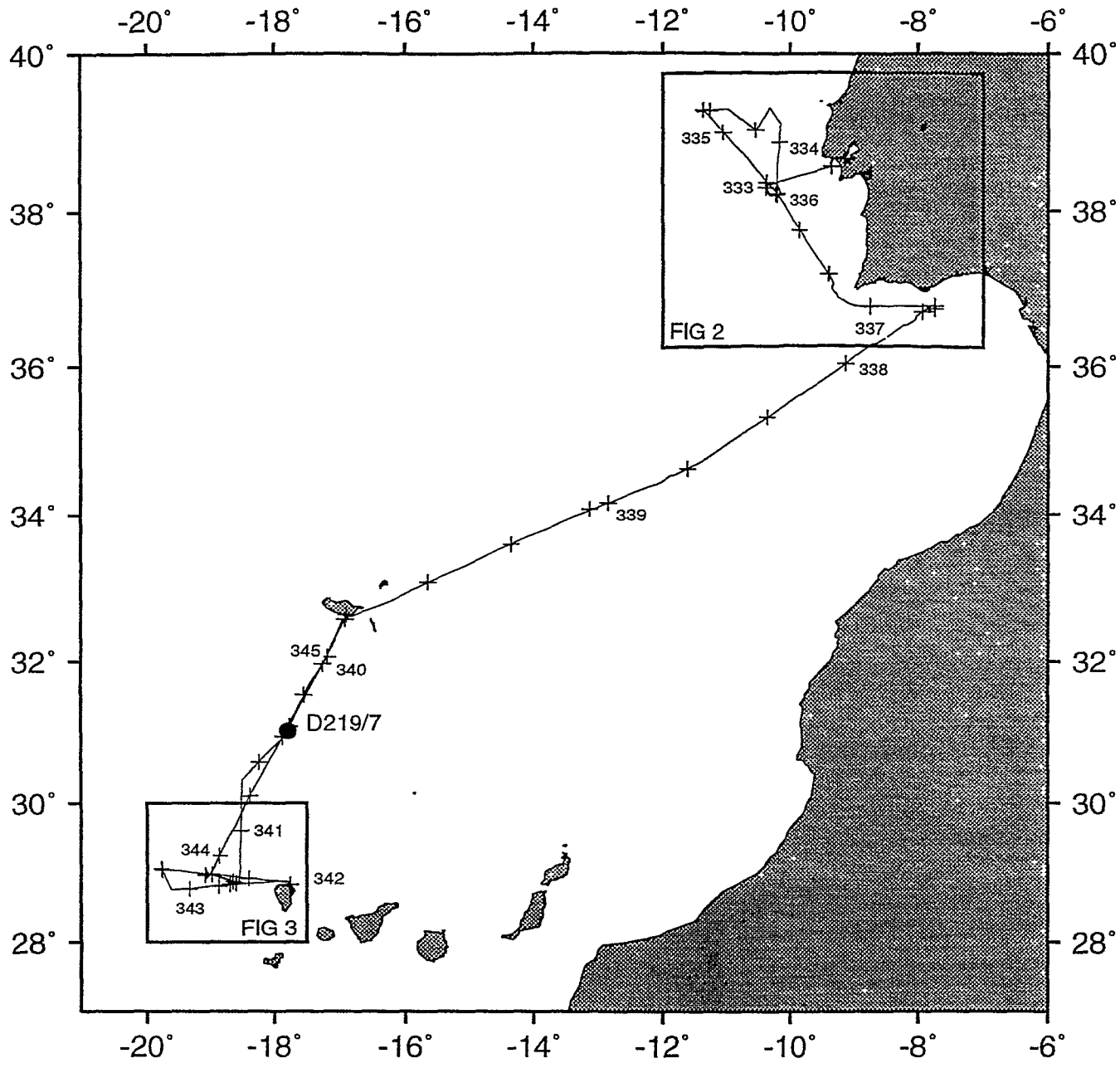

FIGURE 1. Track chart for RRS Discovery Cruise 219 showing position every 6 hours.

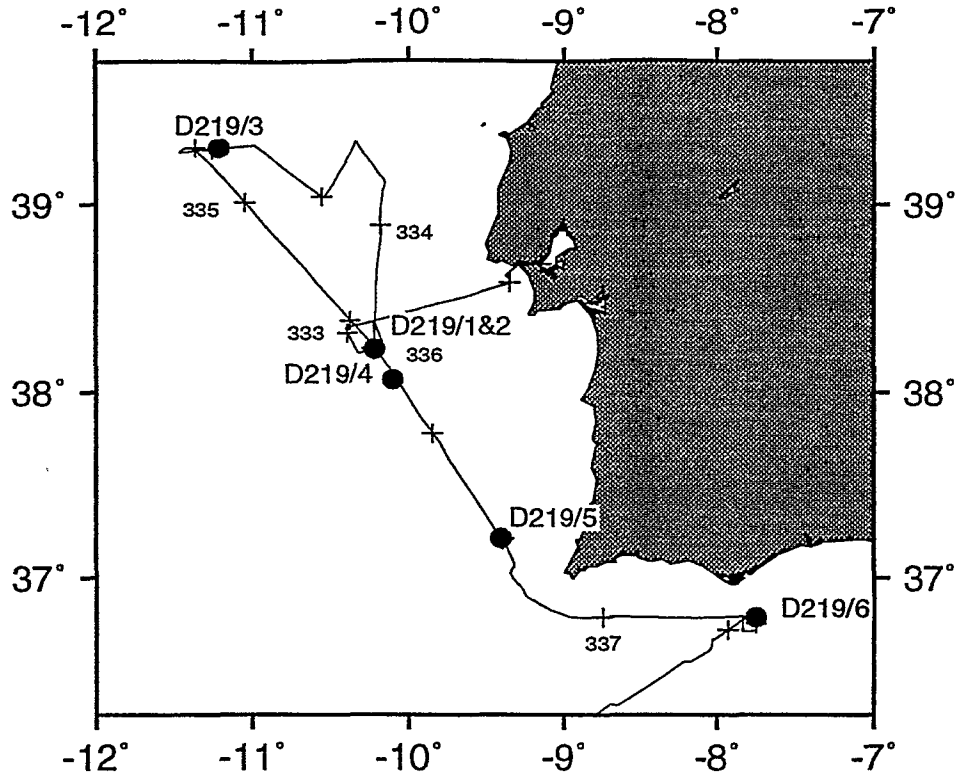

FIGURE 2. Detailed track chart for area west off Portugal.

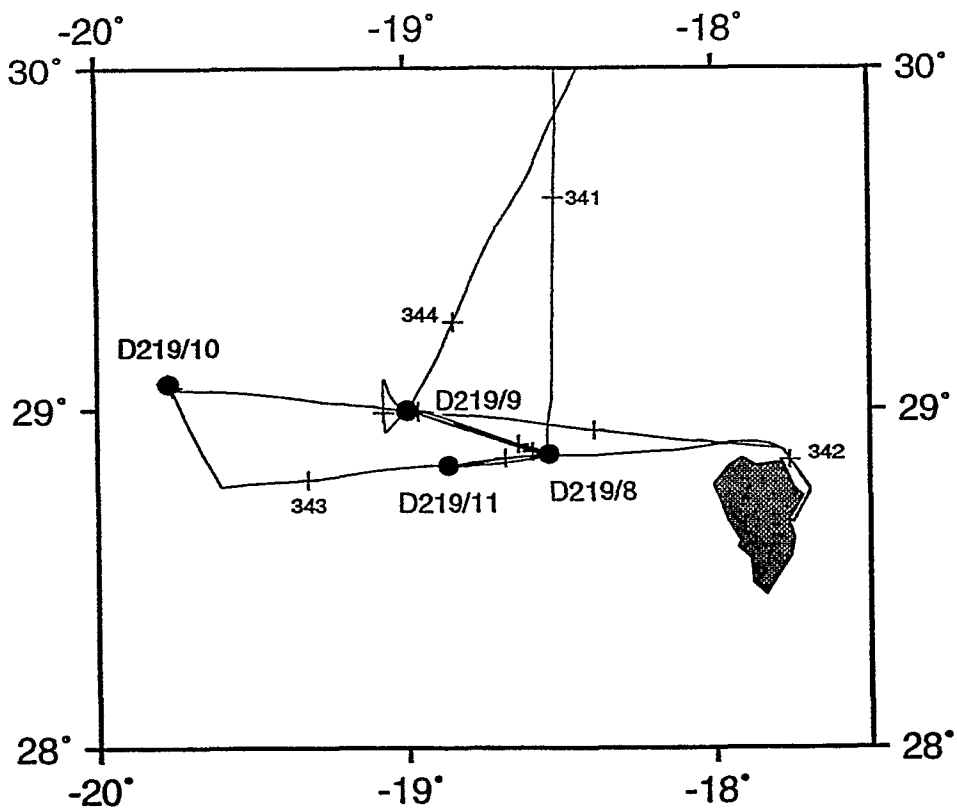

FIGURE 3. Detailed track chart for area west of La Palma.

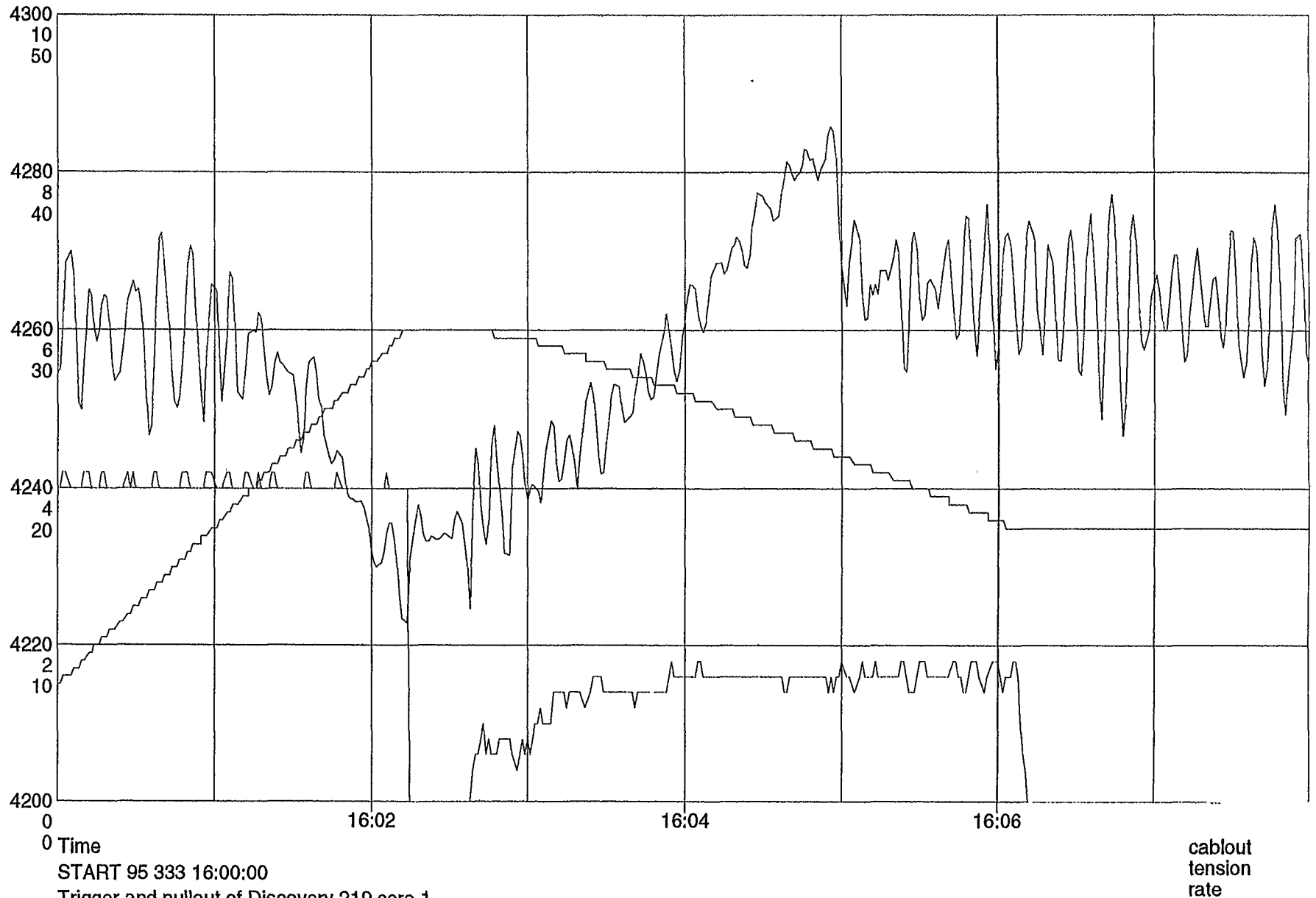

FIGURE 4. Coring record for station D219/1.

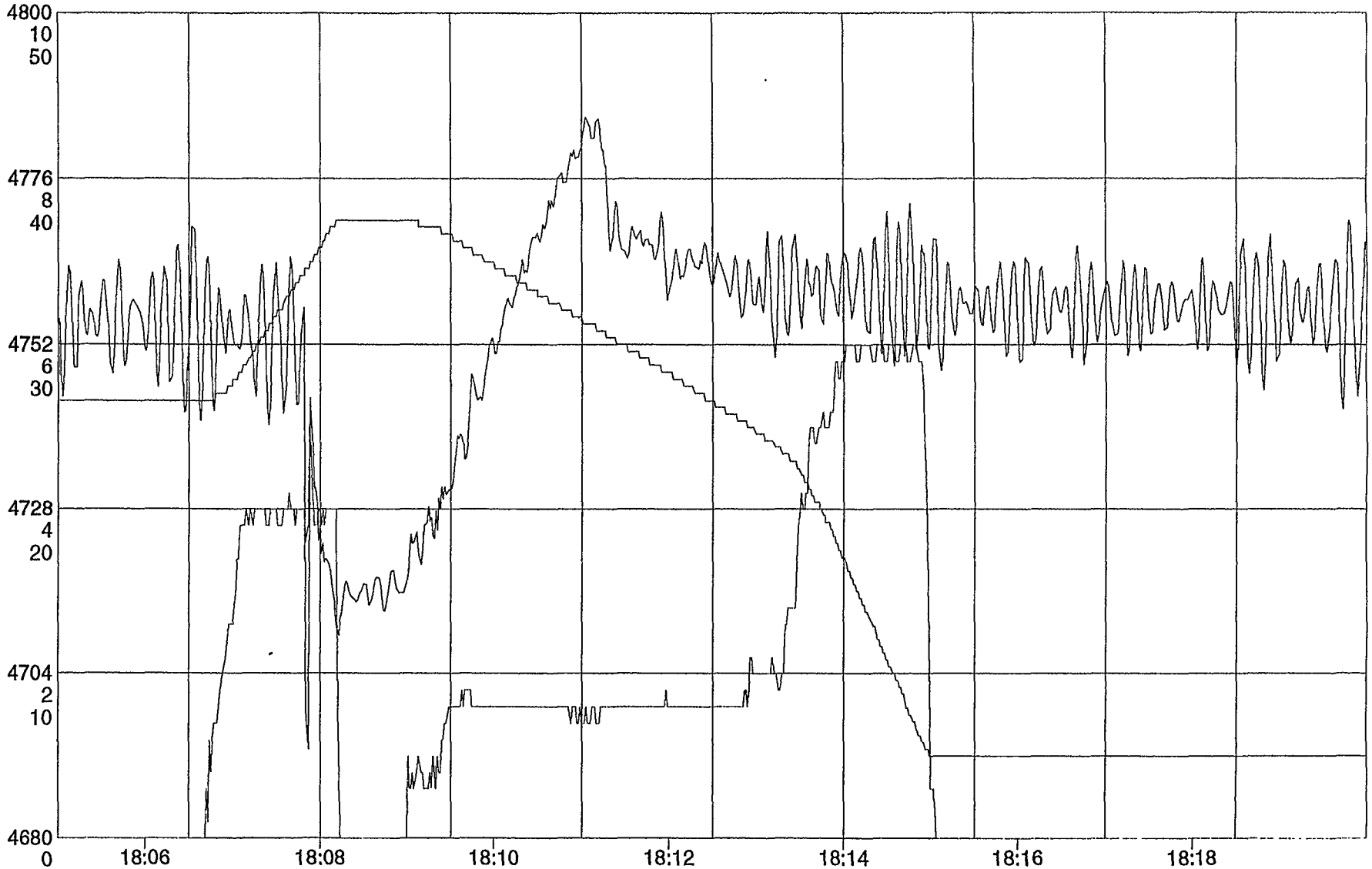

FIGURE 5. Coring record for station D219/3.

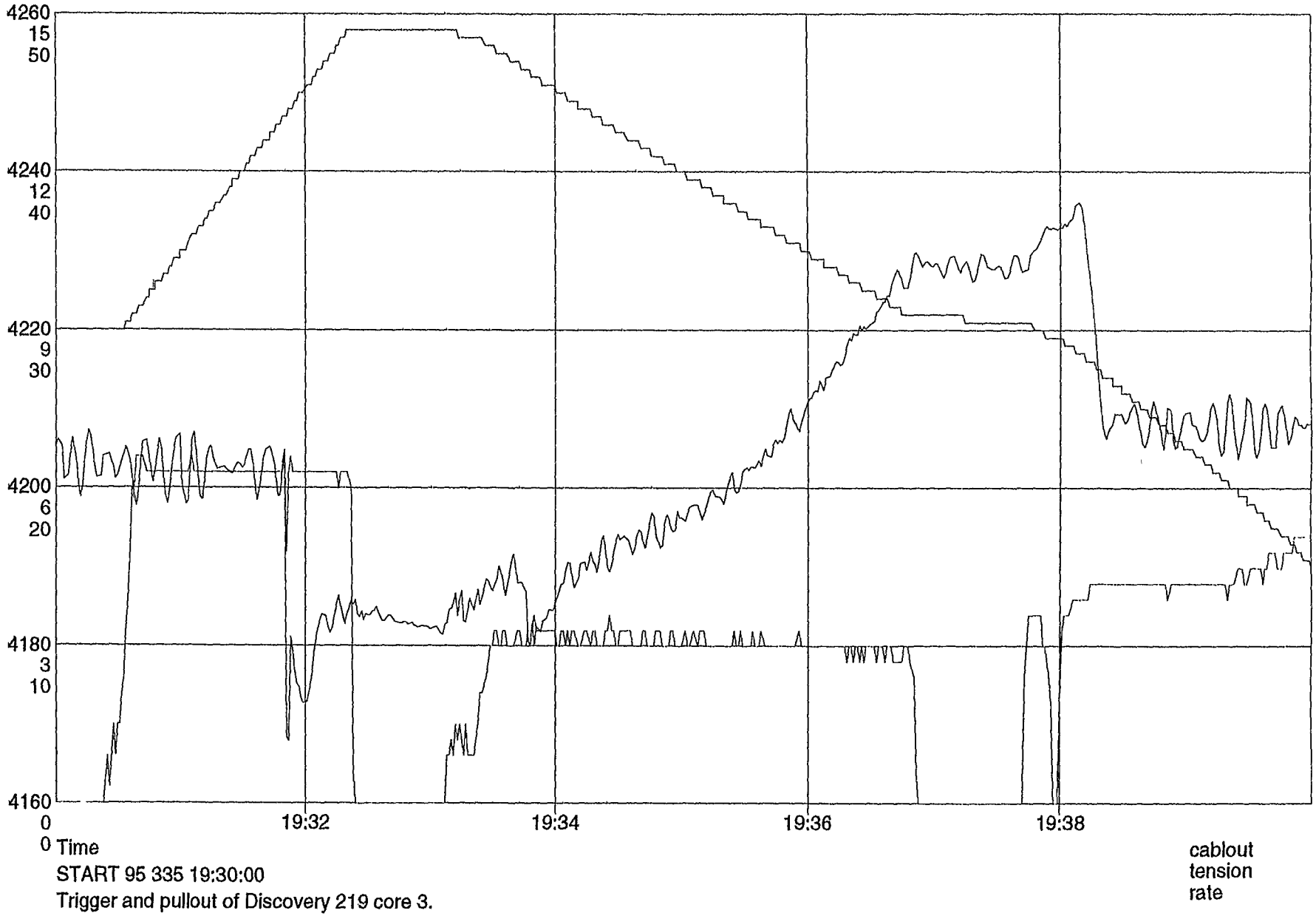

FIGURE 6. Coring record for station D219/4.

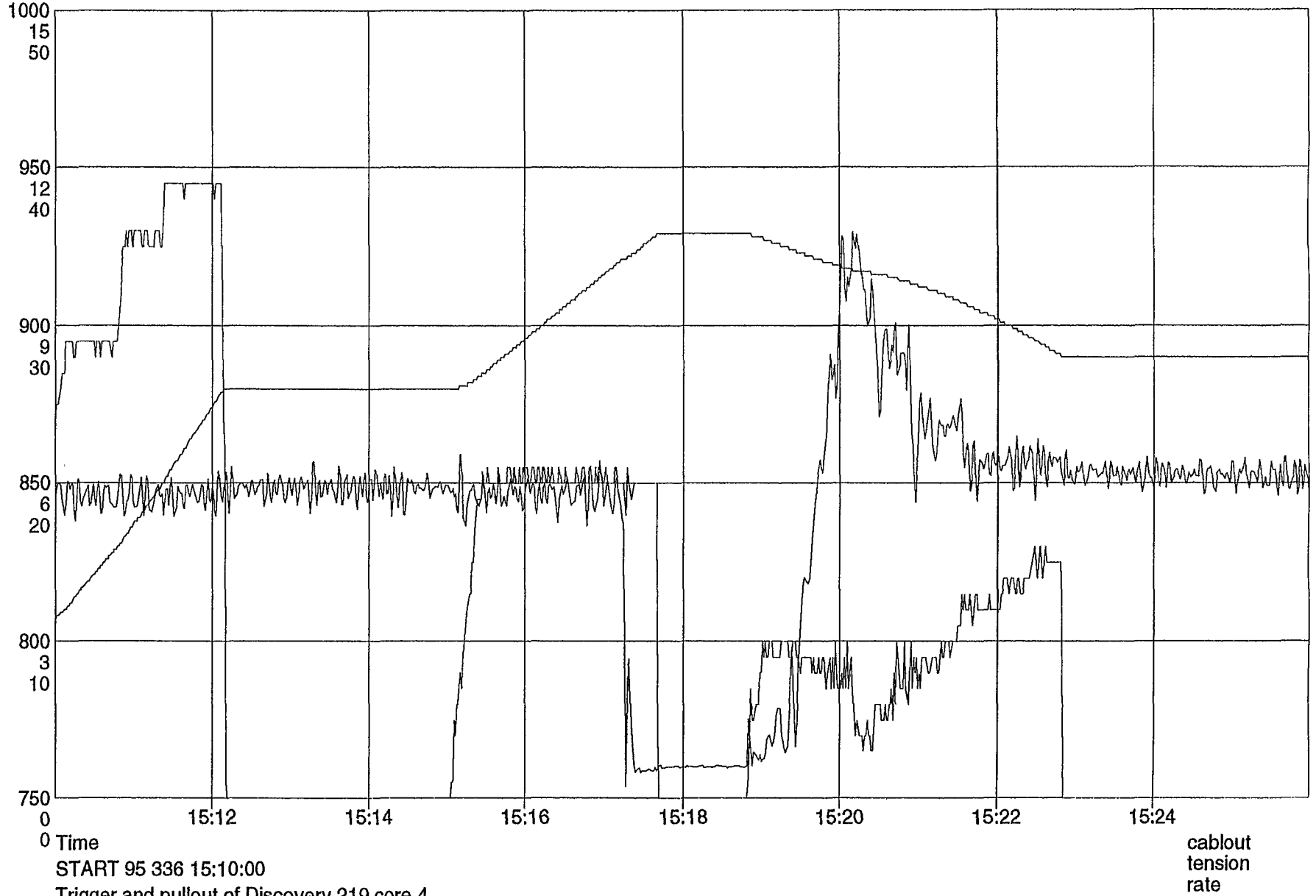

FIGURE 7. Coring record for station D219/5.

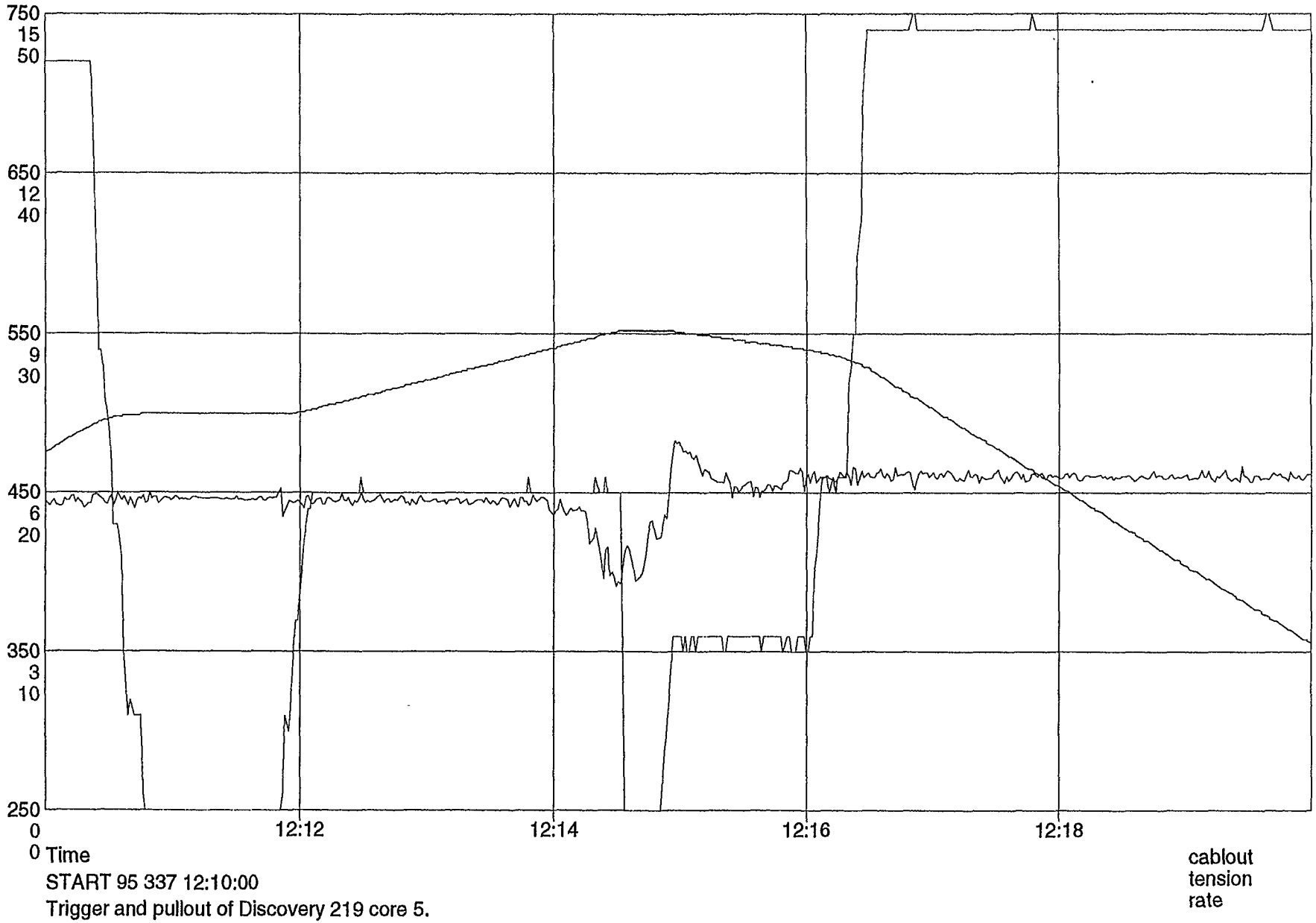

FIGURE 8. Coring record for station D219/6 (first attempt).

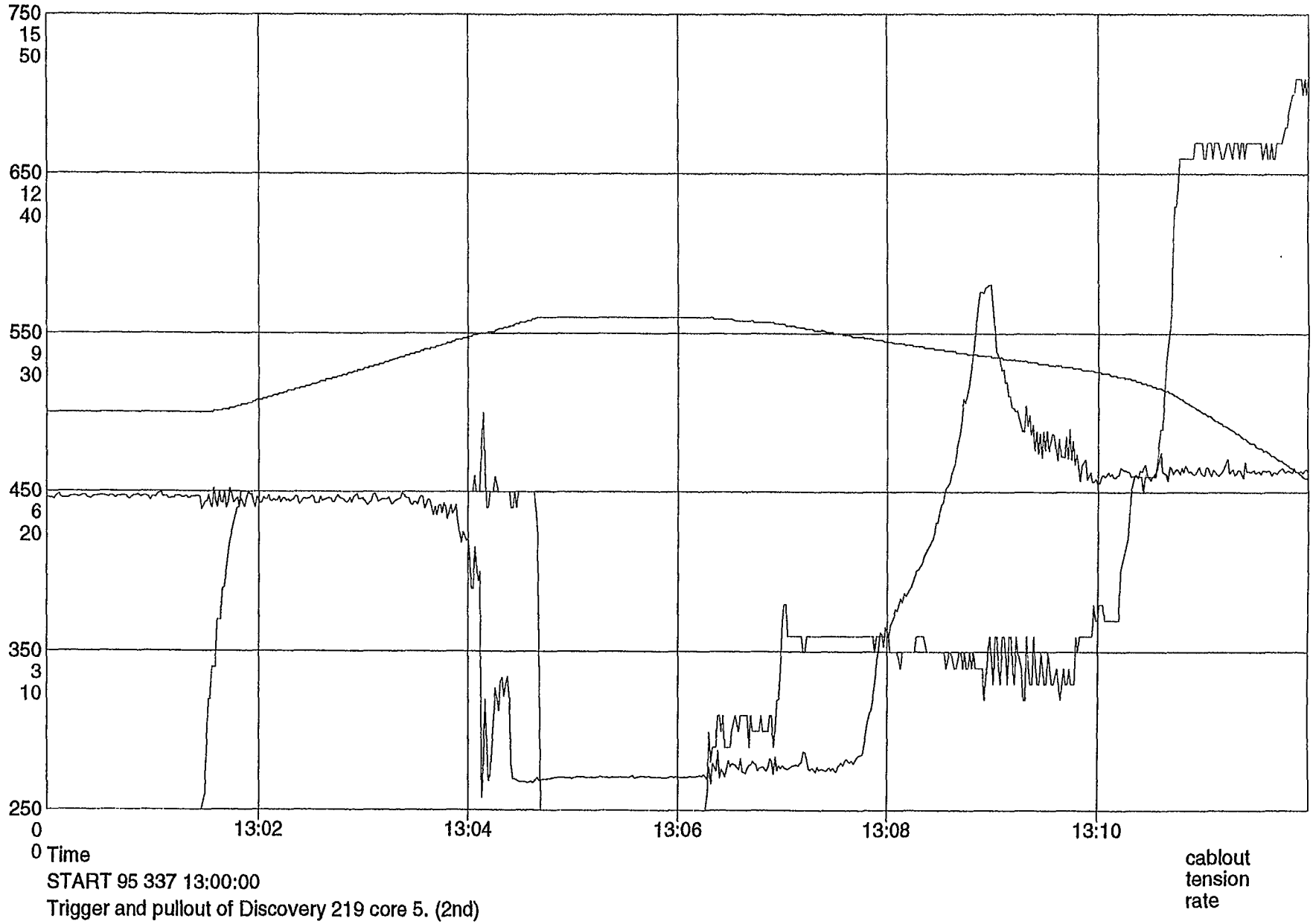

FIGURE 9. Coring record for station D219/6 (second attempt).

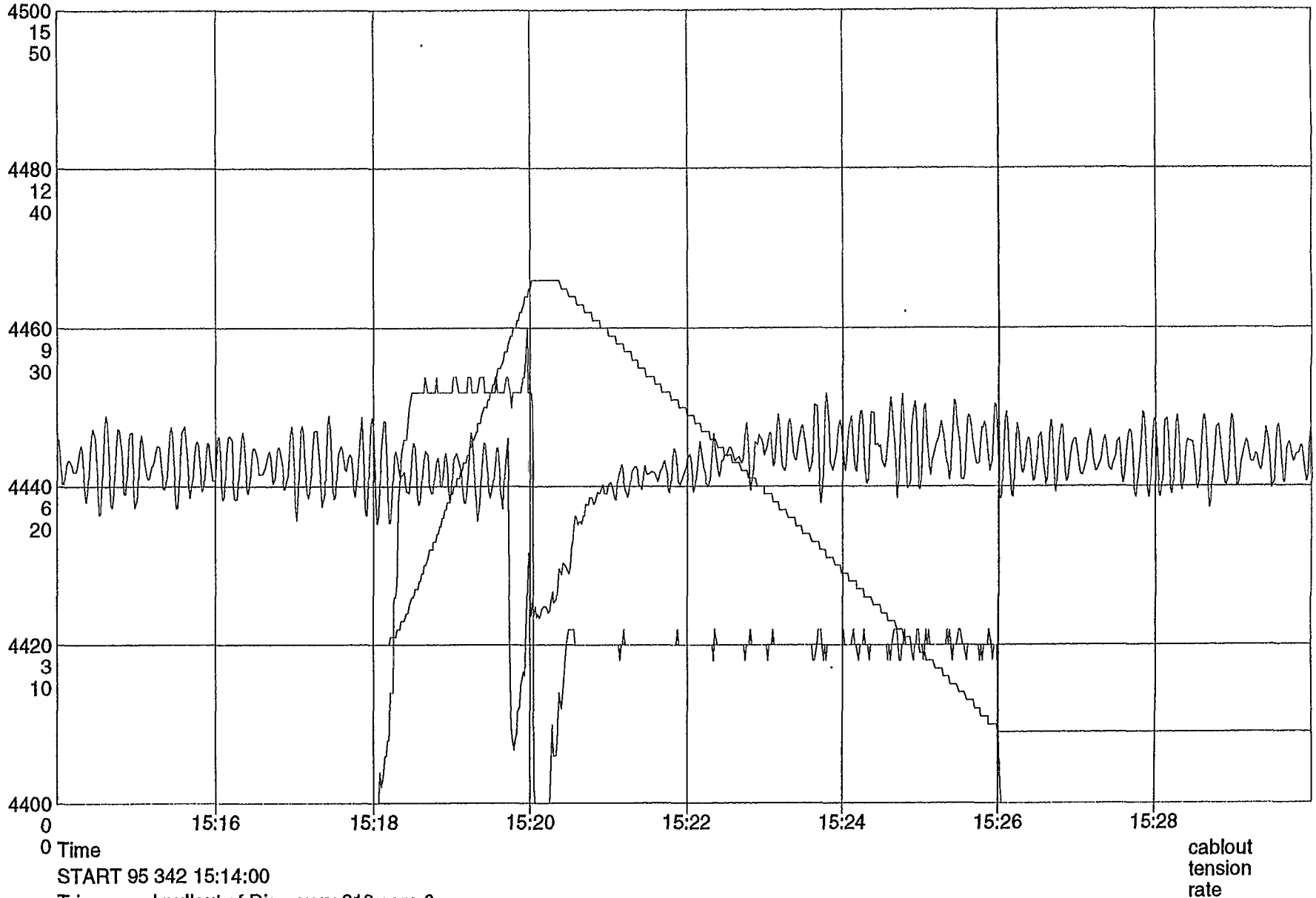

FIGURE 10. Coring record for station D219/10.