INSTITUTE OF OCEANOGRAPHIC SCIENCES

(b) R. V. SARSIA
Cruise 4/76

5-15 April, 1976

Turbulence measurements in Start Bay

CRUISE REPORT NO. 44

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Institute of Oceanographic Sciences
Crossway
Taunton
Somerset

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SCIENTIFIC STAFF

R L Soulsby (Principal Scientist)	5 - 15 April
Dr A P Salkield	5 - 10 April
Dr A G Davies	5 - 9 April
M R Lees	5 - 15 April
M A S Moore	5 - 10 April
Dr K R Dyer	10 - 14 April
G P LeGood	10 - 15 April
E J Moore	9 April
C N Puckett	9 April

SHIP'S OFFICERS

Captain E Dowell (Master)
C George (1st Mate)
I Jude (Fishing Mate)
R Young (Chief Engineer)
G Parker (2nd Engineer)
J Taylor (3rd Engineer)

OBJECTIVES

The aim of this cruise was to continue and extend the measurements being made of sediment transport by turbulent tidal streams. A rig was deployed on the seabed, carrying instruments to measure the currents and monitor the sediment movement. Three experiments were planned, two to investigate the turbulent structure of the boundary layer and the third to investigate the suspended sediment concentrations.

Five sites were chosen within Start Bay to give a range of conditions for the experiments. The first two experiments needed to be performed in areas of no sediment movement, whereas the third experiment required as much movement as possible. All the work needed strong tidal currents, shelter from wind, waves and swell, and a flat bed. Depths, holding and currents must be compatible with good anchoring. It was not possible to meet all these conditions simultaneously, but the sites chosen gave a good compromise.

MEASUREMENTS

The three experiments performed were:

(1) Measurement of the vertical and horizontal structure of the intermittent bursts of turbulent momentum flux observed on previous cruises. This entailed using two E/M flowmeters, one held at a reference height of 35cm, while the other was placed successively at 15, 35 and 175 cm. For horizontal work the flowmeters were placed 50cm apart in the cross-stream direction, at a height of 35cm. This work was planned to give information about the size, 'shape' and strength of the burst-like events.

(2) Simultaneous measurement of U, V and W (downstream, cross-stream and vertical components of current). Normally only U and W are measured, and it is essential to find out what is entailed in ignoring the V-component. The two flowmeters were mounted with their stems at right angles to each other, and the heads close together, at 45° and -45° to the vertical respectively. Thus the upper flowmeter measured U and $\frac{1}{\sqrt{2}}(W + V)$, and the lower measured U and $\frac{1}{\sqrt{2}}(W - V)$.

(3) Pumped sampling to give a time series of suspended sediment concentration, while simultaneously making current measurements. This will give a quantitative measure of the sediment transport to be correlated with the measurements of bed shear stress and Reynolds Stress. The underwater TV monitored the performance

of the sampling system, as well as giving an independent indication of sediment movement. Time series were made at different heights, while occasional vertical profiles gave total suspended sediment transport rates.

Background information was obtained throughout the experiments:
(i) Tidal velocities and directions were measured at half-hourly intervals with a direct-reading Braystoke directional current meter at 5m depth.
(ii) A T-S bridge was used to take temperature and salinity profiles to ensure there was no density stratification.
(iii) Water depth was read periodically on the ship's echo sounder.
(iv) The attitude of the rig on the sea bed was monitored by an inclinometer indicating pitch and roll. A pivoted flag mounted about 20cm above the bed was visible on the TV, and indicated the flow direction at that point to assist with aligning the rig with the flow. A compass was also visible, showing the azimuth of the rig's axis.
(v) An EG & G sidescan sonar was used at sites 2 and 5. The sonar was towed from the ship's boat and viewed the position of the rig relative to the surrounding topography.
(vi) Echo-sounder arrays were made at each site, consisting of three runs parallel to the tide direction, spaced 2.8 cables apart, and each of length 5.6 cables.
(vii) Grab samples at each site will be taken on a later cruise in mid-May.

INSTRUMENTATION

A new underwater rig was used on this cruise. This was designed in conjunction with the Inshore Sedimentation Team for pumped sampling, and/or turbulence measurements. Most of the instruments were carried on an angle iron vertical post near the front of the rig. A high-aspect ratio fin aligned the rig with the flow, being mounted well behind the suspension point to give a large turning moment. The lifting and electric cables were attached to a swinging bridle, which was upright when the rig was lifted, but fell to the horizontal when the rig was on the bed so as to carry the cables away from the rig and minimise overturning moments.

Two types of current meter were used simultaneously: Braystoke rotor current meters were mounted in a vertical array at four heights from 12cm to 177cm from the bed, giving velocity profiles from which bed shear stresses could be calculated; and electromagnetic flowmeters mounted at two heights giving a faster response (4 Hz), two-component measure of the currents for calculation

of Reynolds stresses. Sediment motion was observed with an underwater TV system. In addition a pumped sampling system was used, allowing sediment-laden water drawn from one of six nozzles at different heights on the rig to be pumped and filtered on deck to give suspended sediment concentration. A cable connected the rig to the ship, where all the information was monitored.

NARRATIVE

The movements of the ship, the experiments being performed, and the individual run numbers are shown on a day-by-day basis in Figure 1.

It was necessary to re-anchor the ship at Position 5 on 7 April so as to face into the (stronger) ebb tide.

9 April was given over to D N Langhorne for lifting of three current meter rigs on the Skerries Bank. Operations were directed by J Moore and C N Puckett.

On 10 April, the crew rest-day, Mr A E Soleman of the Academy of Scientific Research and Technology, Cairo, was given a demonstration of the equipment.

On 12 April, the stern anchor cable fouled the rig as the ship swung, necessitating re-anchoring.

The three sites occupied were surveyed by echo-sounder on 14 April, before sailing for Plymouth.

INSTRUMENT PERFORMANCE

It was unfortunate that this cruise immediately followed three others using the same instruments and instrumentation personnel, putting a heavy strain on both. This resulted in the TV and Braystoke systems being out of action at the start of the cruise, and the EM flowmeters not having a (successful) prior calibration.

However, through the efforts of the instrumentation team all the instruments were back in working order by the second half of the cruise, and the EM flowmeters were brought back to Taunton intact, allowing a post-cruise calibration to be made.

Underwater Rig

This performed satisfactorily. The fin aligned the rig positively with the flow, and it showed no tendency to 'fall off' the current direction on touchdown. At one stage in the first week the TV camera and a light were faced backwards to observe the bridle, lifting cable and electric cables. This

showed that the bridle was effective in lifting when the cable became tight, and that a surprising amount of slack had to be paid out to prevent the bridle lifting at all. The 200 kg of ballast seemed quite adequate to keep the rig stable under most conditions. The rig was pulled over forwards on one occasion, its most vulnerable position for the instruments, but, apart from the loss of the compass and flag, the only damage was two bent Braystoke spindles. The protection for the instruments seemed adequate in general, though when the EM flowmeters are mounted at their highest position they are in some danger of striking the ship's side on deployment and recovery. A box section might be more rigid than the angle iron for the instrument mounting post.

Electromagnetic flowmeters

These behaved very much more reliably than in the past.

The 5cm heads used previously had been replaced by 10cm ones (Heads A and D) as it was thought these might be more reliable. In fact this was the first cruise of the series in which it was not necessary to change the heads at all. In addition the underwater electronics did not need attention. All the problems which occurred could be attributed to earthing, but an infallible noise-free earthing system has still not been discovered. Tension in the cable and misalignment of the rig also upsets the flowmeters, but this can usually be cured by re-positioning the rig.

Braystoke flowmeters

The PDP-8 and Braystoke interface were both out of action at the start of the cruise. After replacing the PDP-8L by the PDP-8F and repairing the interface they gave no trouble. The rotor spindles were frequently bent due to a number of causes, but easily straightened or replaced. As always there was some fouling of rotors by seaweed and grit.

TV system

At the start of the cruise the camera would not focus. This was corrected on 7 April and gave no further trouble.

Pumped sampling system

This was only the second time this system had been used, and none of the scientists on this cruise had experience of it. There was some difficulty priming the pump, probably mainly due to a leak in the manifold on the rig.

However, in use there were few problems. Filter changing could be accomplished in 1 min, and this could be reduced in future by using a change-over tap in place of the pairs of tubing clips.

Inclinometer, Compass and Flag

The inclinometer gave no trouble after being repaired on 7 April. The compass and flag behaved well until they were lost on 13 April.

Braystoke Direct Reading Current Meter and T-S Bridge

These both performed well.

EG & G Side-scan Sonar

This performed well, but at times could not be used due to weather conditions.

SHIP PERFORMANCE

Again the three-point anchoring capability of Sarsia proved invaluable. On one occasion only was there any problem, when the ship swung the wrong way at the turn of the tide, causing the stern anchor to foul the port bow anchor, and also the rig. This was quickly sorted out with minimal damage.

The new platform on the fore-deck for the rig to sit on was a big improvement on the previous arrangement, when the rig had to balance on the taut stern anchor cables.

A new scientific supply generator had been installed and this proved much less troublesome than the old shared power supply.

RESULTS

Overall, the cruise was very successful, especially the second week. All three experiments were satisfactorily completed.

An hour-by-hour record of the data collected and an estimate of its quality is shown in Figs 2 - 5.

Vertical and Horizontal Structure Experiment

Although there were instrument problems during this work, they did not seriously affect the quality of the results, as only the EM flowmeters were essential, and these were working. Data was obtained at all four head heights in the vertical structure work, hopefully in usable quantities. The horizontal

structure work was reduced to three hours, and during this time the X2 channel was giving trouble, so this may be less successful.

The choice of site was not ideal, due to the presence of sandwaves.

UVW experiment

The heads were first placed at a mean height of 65cm and measurements taken over 15 hours. The quality of the data was generally good. However, when the heads were moved to a mean height of 145cm, eight hours of work was marred by a bad tape on the 7-track tape recorder.

Pumped Sampling Experiment

Three ebb tides were worked, taking sediment concentration time series at heights of 12, 7, 52 and 17 cm. The quality of the data was generally good.

STATIONS OCCUPIED

Start Bay Position	Latitude	Longitude	Decca Red	Decca Purple	Bottom	Depth (m)	Max Currents at 5m
1	50°14.27'N	3°37.88'W	B04.25	A75.33	Medium sand Highly mobile	13	82cm/sec
2	50°15.58'N	3°34.12'W	B11.13	B56.05	Very coarse sand & shell Not mobile	42	130cm/sec
5	50°17.45'N	3°32.25'W	B13.30	B65.27	Medium sand Not mobile	34	79cm/sec

ACKNOWLEDGMENTS

We are grateful to Dr E Denton, Director of the Marine Biological Association, Plymouth, for making RV Sarsia available to us. Captain E Dowell and the Officers and crew of Sarsia gave us every assistance with the work, and helped make the cruise an enjoyable and successful one. Captain M Perry assisted throughout with the organisation of the cruise.

PREVIOUS CRUISE REPORTS

RV Edward Forbes Cruise 20/74. 9 - 25 October 1974. Solent. IOS Cruise Report Report No 15, 1974.

RV Sarsia Cruise 5/75, 25 May - 6 June 1975. Turbulence measurements on the seabed carried out in Start Bay, SW England. IOS Cruise Report No 30, 1975.

RV Sarsia Cruise 10/75. 26 August - 11 September 1975. Turbulence measurements on the seabed off Southern England. IOS Cruise Report No 38, 1975.

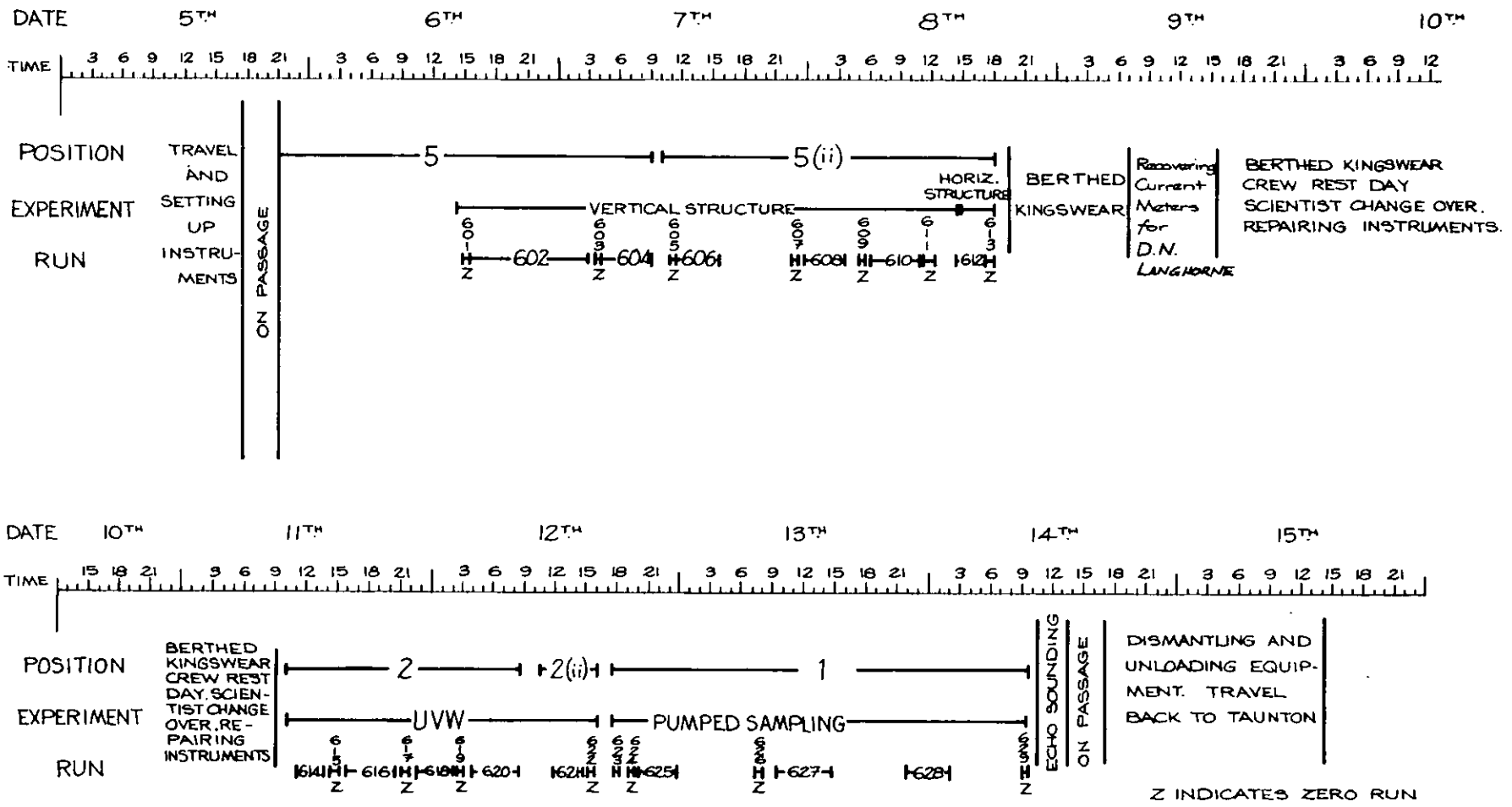

Figure 1: Day-by-day summary of experiments and events

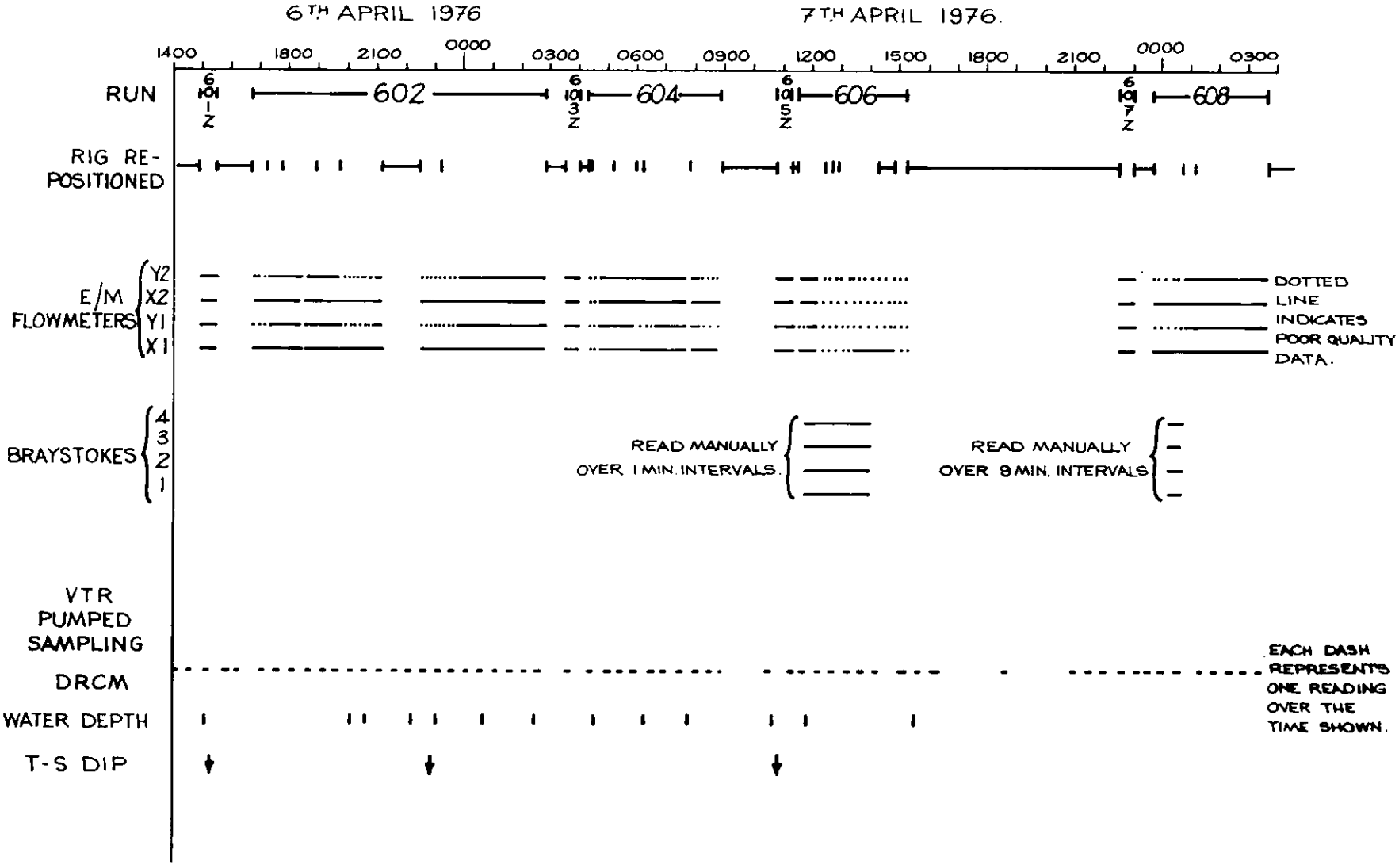

Figure 2: Summary of measurements taken 6 - 7 April

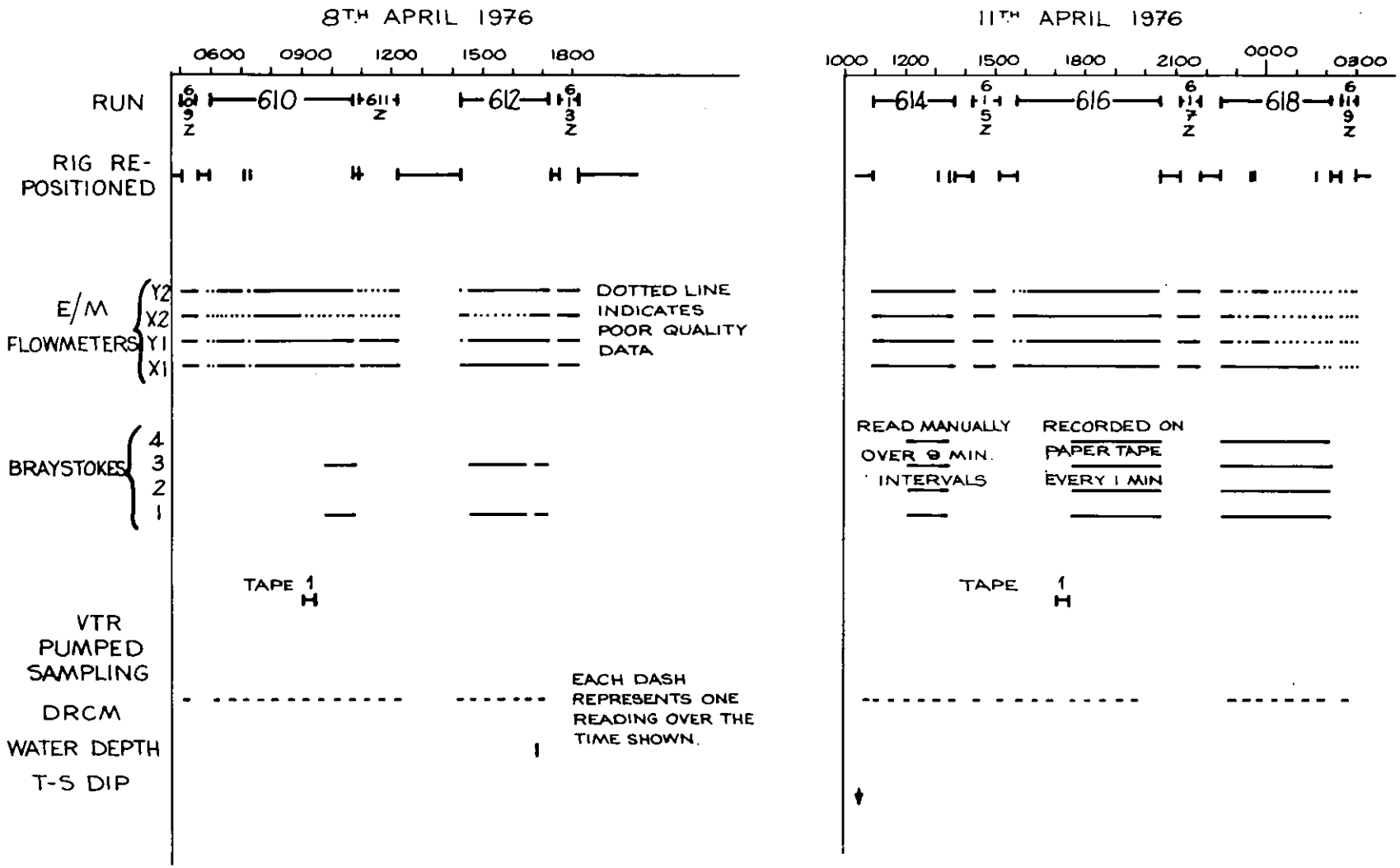

Figure 3: Summary of measurements taken 8 and 11 April.

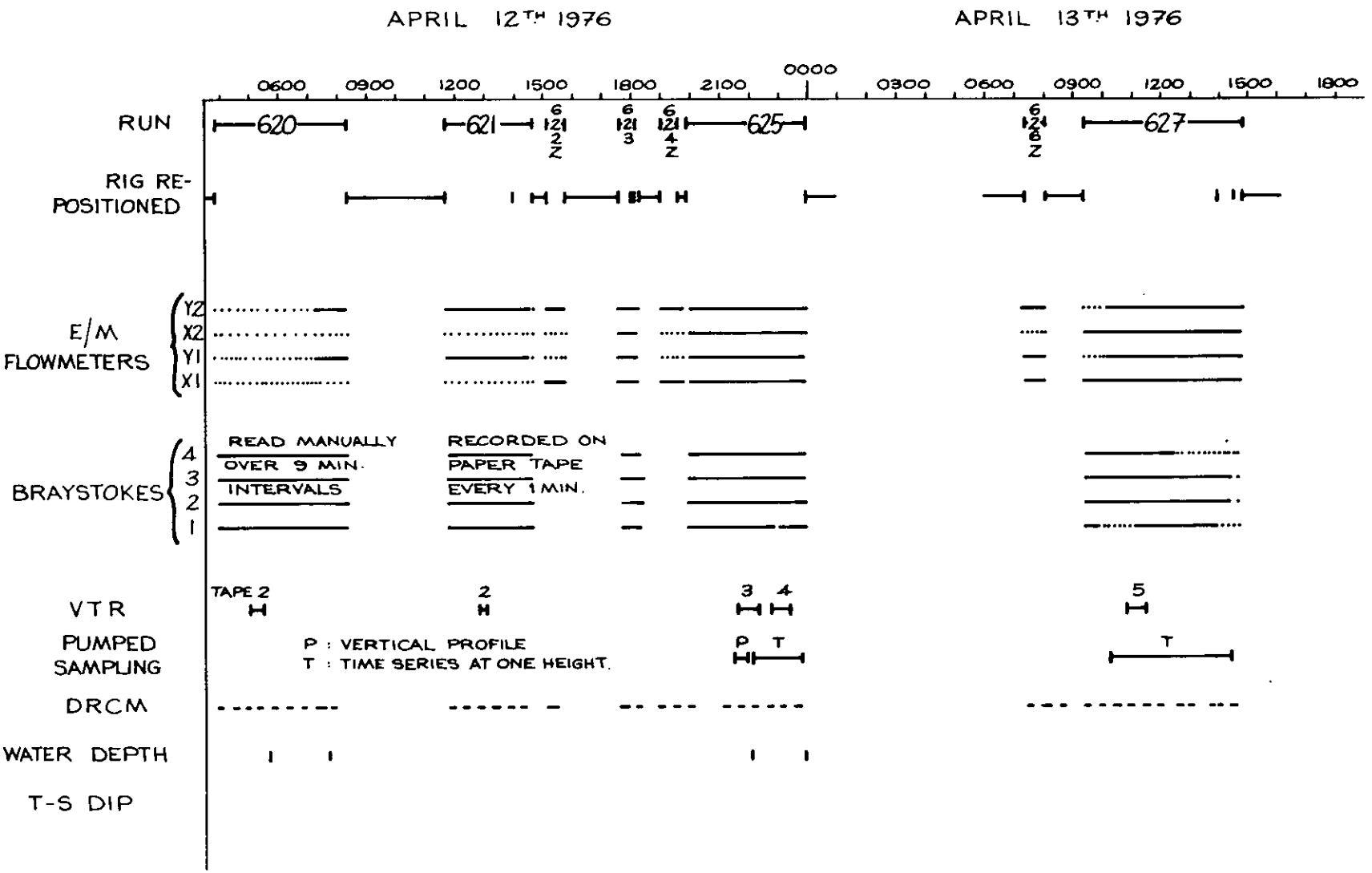

Figure 4: Summary of measurements taken 12 and 13 April.

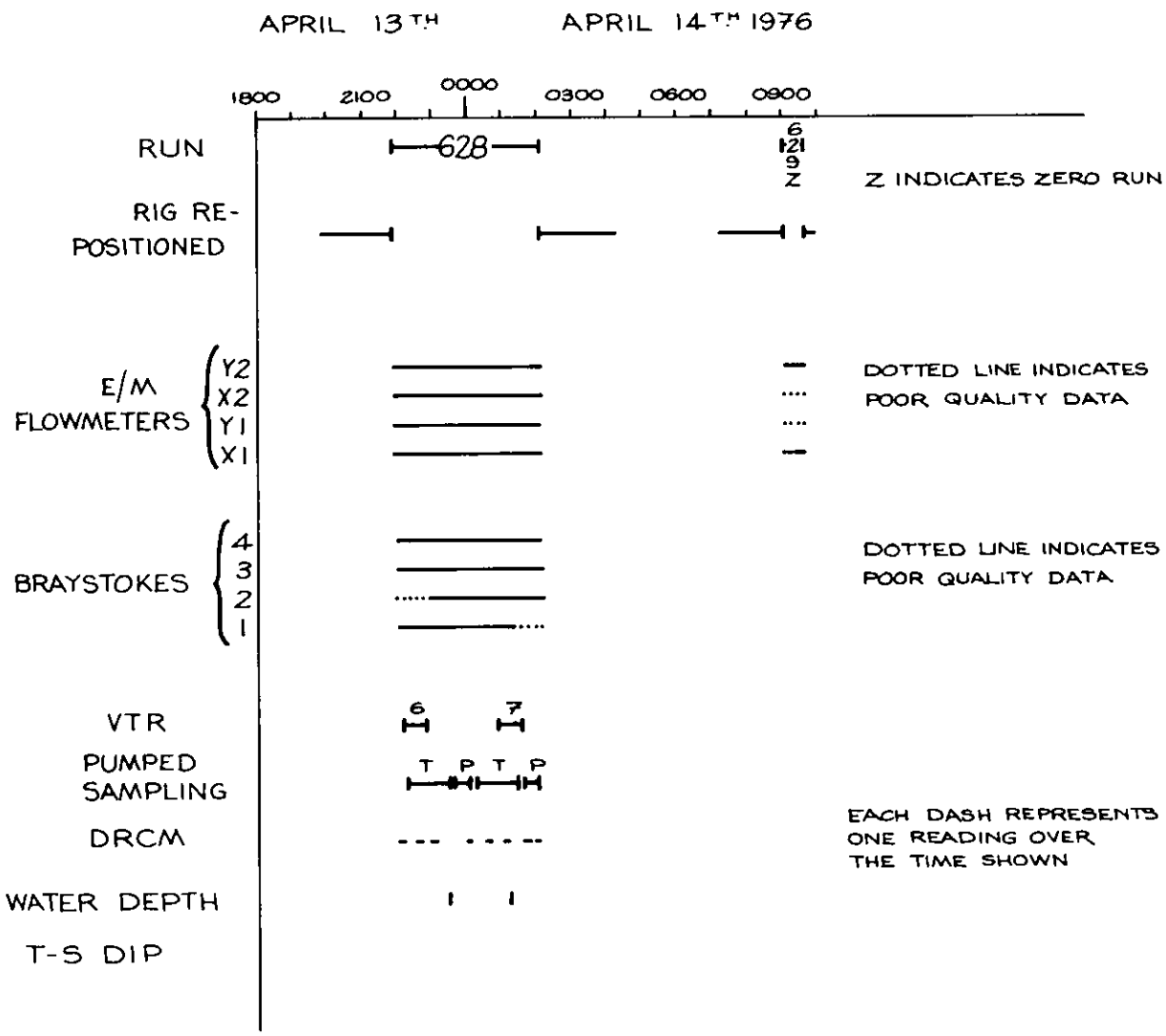

Figure 5: Summary of measurements taken 13 and 14 April.