INTERNAL DOCUMENT 223

I.O.S.

Analysis of piston cores from Great Meteor East : report to Rijks Geologische Dienst, Haarlem, Netherlands

by P.P.E. Weaver

1983

NATURAL ENVIRONMENT RESEARCH COUNCIL
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Analysis of Piston Cores from Great Meteor East

General Considerations

The cores consist of alternating ooze, marl and pelagic clay units, as well as the thick turbidites. In this area, which today lies in the lysocline but above the CCD, the amount of calcium carbonate in the pelagic (non-turbidite) sediment is controlled by the height of the CCD. Gardner (1975) has shown that during glacial intervals more corrosive bottom waters raised the height of the CCD, thus affecting larger areas of sea-floor and causing increased corrosion in those areas previously in the lysocline. Thus, the alternations of sediments with more and less calcium carbonate reflect interglacial and glacial stages respectively. Although the pelagic clay units contain no coccoliths they can be assigned to glacial stages between the adjacent datable more calcareous units.

The stratigraphy is based on counts of six coccolith species, namely *Emiliania huxleyi*, *Gephyrocapsa muellerae*, *G. aperta*, *G. caribbeanica*, *Pseudoemiliania lacunosa* and *Cyclococcolithina macintyrei*. These have proved to be the most useful species, and whilst other species have been noted, only the above six have been counted. The nannofossil zones are those described by Martini (1971) and the subdivisions are based on the work of Gartner (1977), Thierstein *et al*. (1977), Pujos Lamy (1977) and Weaver (in press).

Core 82PCS17 (Figure 1)

This core contains almost exclusively pelagic deposits, the only turbidite occurring from 71-81 cms. The sediments above the turbidite show a complete record of oxygen isotope stages 1-5, *E. huxleyi* being present throughout and being dominant over *Gephyrocapsa* species in post stage 5 samples. The next easily identifiable horizon is stage 13 which occurs from 204-254 cms, and contains P. lacunosa. The sediment between 81-204 cms must therefore contain stages 6-12 but there are only two warm intervals (marls) and three cold intervals (pelagic clays) in this interval. By analogy to IOS core D10320 stage 7 should be a marl with a coccolith flora dominated by G. aperta. No such G. aperta dominance is found during this interval in core 82PCS17, and it is therefore concluded that stage 7 is missing in this case. The thick pelagic clay layer beneath the turbidite may therefore represent a combination of stages 6 and 8. The coccoliths in the marl beneath contain a flora typical of NN20 zone being dominated by G. caribbeanica. This marl is therefore regarded as being stage 9. Stages 10 and 11 then follow in sequence with stage 11 again containing a zone NN20 flora. Stage 12 appears to stretch from 161-204 cm which is remarkably thick for a pelagic clay interval of 27,000 years duration (dates taken from Pisias & Moore, 1981). I would therefore suspect either coring disturbance or local redeposition for this stage.

The next easily definable point in the core is the extinction point of C. macintyrei at around 697 cms. This extinction occurred at 1.46 Ma (Jan Backman, pers. comm.) and up to this time Gardner (1982) has recognised 39 oxygen isotope stages based on oxygen isotope and carbonate analyses. A continuation of the lithological subdivision of the core gives stage 39 at 658-685 cms which indicates no erosion during the interval 450,000-1,460,000 years. Below this there is 45 cms of sediment older than 1.46 Ma but younger than 1.8 Ma - the extinction point of Discoasters. The interval from 450,000-1,460,000 years is represented by about 480 cms of sediment giving an average sedimentation rate of 0.47 cm/1000 years. Extrapolating this rate to the base of the core at 830 cms gives an estimated age for the base of the core of 1,767,000 years. Thus the core almost extends to the Plio/Pleistocene boundary at 1.8 Ma.

Turbidite cores 82PCS13, 20 and 34

These three cores contain thick and thin turbidite units with thin layers of pelagic sediment between. In the first analysis the turbidites were ignored, thus figure 2 shows plots of the reassembled pelagic units. This facilitates much easier comparison to core 82PCS17 and should enable any erosion caused by the turbidity flows to be more easily identifiable. In the first instance, all units which could have been either turbidite or pelagic in origin, on the basis of the visual description, were included in this plot. Those of turbidite origin were identified on the basis of their coccolith floras and eliminated.

Oxygen isotope stage 1 is present in all three cores whilst stage 2 occurs as a thin pelagic clay unit in cores 82PCS13 and 20. Stages 3 and 4 are present as marl and pelagic clay intervals repsectively and stage 5 is also represented by a marl. In core D10320 stage 5 contains declining numbers downcore of E. huxleyi, high numbers of G. muellerae and downcore increases in G. aperta. The samples from the turbidite cores all show high numbers of these three species, although the proportions vary from core to core. In core 82PCS20 stages 6 and 7 are present with stage 7 being the lowest pelagic interval. In core 82PCS13 the lowest unit is a pelagic clay interval below stage 5 which in the absence of any other evidence is regarded as belonging to stage 6.

In core 82PCS34 stages 6 and 7 appear to be in sequence but the expected pelagic clay of stage 8 is not present. There is no turbidite between stages 7 and 9 but in the visual description stage 7 (1146-1162 cms) showed some signs of being turbiditc. It is therefore possible that there is a stratigraphic gap between stages 6-9. Further analyses may resolve this problem. Stages 9 and 10 appear to be present but stage 11 is considerably reduced in comparison to core 82PCS17, and stage 12 appears to be absent. Stage 13 then follows as two white ooze units separated by a thick turbidite (1294-1548 cms). The upper of these two oozes contains very few P. lacunosa specimens and such small numbers could represent reworked specimens. This would mean that the upper ooze belonged to stage 11 and stage 12 could then have been removed by the turbidite (1294-1548 cms). This problem can only be resolved by comparison to cores with complete coccolith records such as D10320 which unfortunately is not long enough to solve this particular problem. The lowest pelagic intervals in 82PCS34 do not compare exactly in lithology to those in 82PCS17 although the coccolith floras do show similarities. The reasons for this are unclear and again more cores penetrating these intervals are needed.

When the turbidite units are put back into the correlated core logs (Figure 3) we can see which turbidites correlate between the cores. The coccolith floras contained in the turbidites can be used as a second check on all the correlations. For east of explanation the turbidites are designated by letters. A turbidite which is present in all three cores is given a letter and these run alphabetically from the top of the core. Turbidites which are only present in one or two cores are given the letter of the next lettered turbidite above, with a numbered suffix. The major turbidites can in every case be correlated between the cores and more surprisingly the 6-21 cm thick turbidite c can also be correlated. Turbidite e2 in 82PCS13 correlates with e2 in 82PCS34 but is not found in 82PCS20. The other small turbidites cannot be correlated with confidence, their origin may be due to local redeposition or to flows which did not spread throughout the area. Although each turbidite has been characterised by only one or two samples the general coccolith make-up of individual turbidites is similar in each core. Thus turbidite b contains 10-20% E. huxleyi with G. aperta and G. caribbeanica being the most common species, turbidite e is dominated by G. aperta and turbidite f is dominated by G. caribbeanica. The turbidites can therefore be correlated by their own coccolith floras as well as by the pelagic intervals between them. Each method reinforces the other.

When the reassembled pelagic intervals from the turbidite cores are compared to the pelagic core 82PCS17 (Figure 2), not only are most of the oxygen isotope stages seen to be present in the turbidite cores, but their thicknesses are also comparable to the pelagic core. This suggests that there is a minimal amount of erosion associated with the deposition of each turbidite. Figure 4 shows that at the top and bottom of each major turbidite (b, d, e, f and g) there are different pelagic lithologies. Thus the major turbidites lie between adjacent oxygen isotope stages. The thickest turbidites b and f are found at the end of glacial stages whilst slightly thinner turbidites e and g are found at the end of interglacials. Turbidites e1 and e2 in core 82PCS13 both occur within stage 5 but they are both very thin. Turbidite d occurred at the end of stage 4 and is presumably thin because stage 4 was a very short cold interval at the beginning of the last glacial.

Conclusions

1) Core 82PCS17 contains a record back to about 1,760,000 years, nearly to the beginning of the Pleistocene. Oxygen isotope stage 7 is missing in this core and the pelagic clay of stage 12 appears to be anomalously thick.

2) The turbidites can be correlated both by the coccolith floras within them and by the floras in the pelagic intervals between them.

3) The turbidites do not cause any significant erosion.

4) The major turbidites are emplaced at the transitions from glacial to interglacial or interglacial to glacial conditions. The former transition is associated with slightly thicker turbidites.

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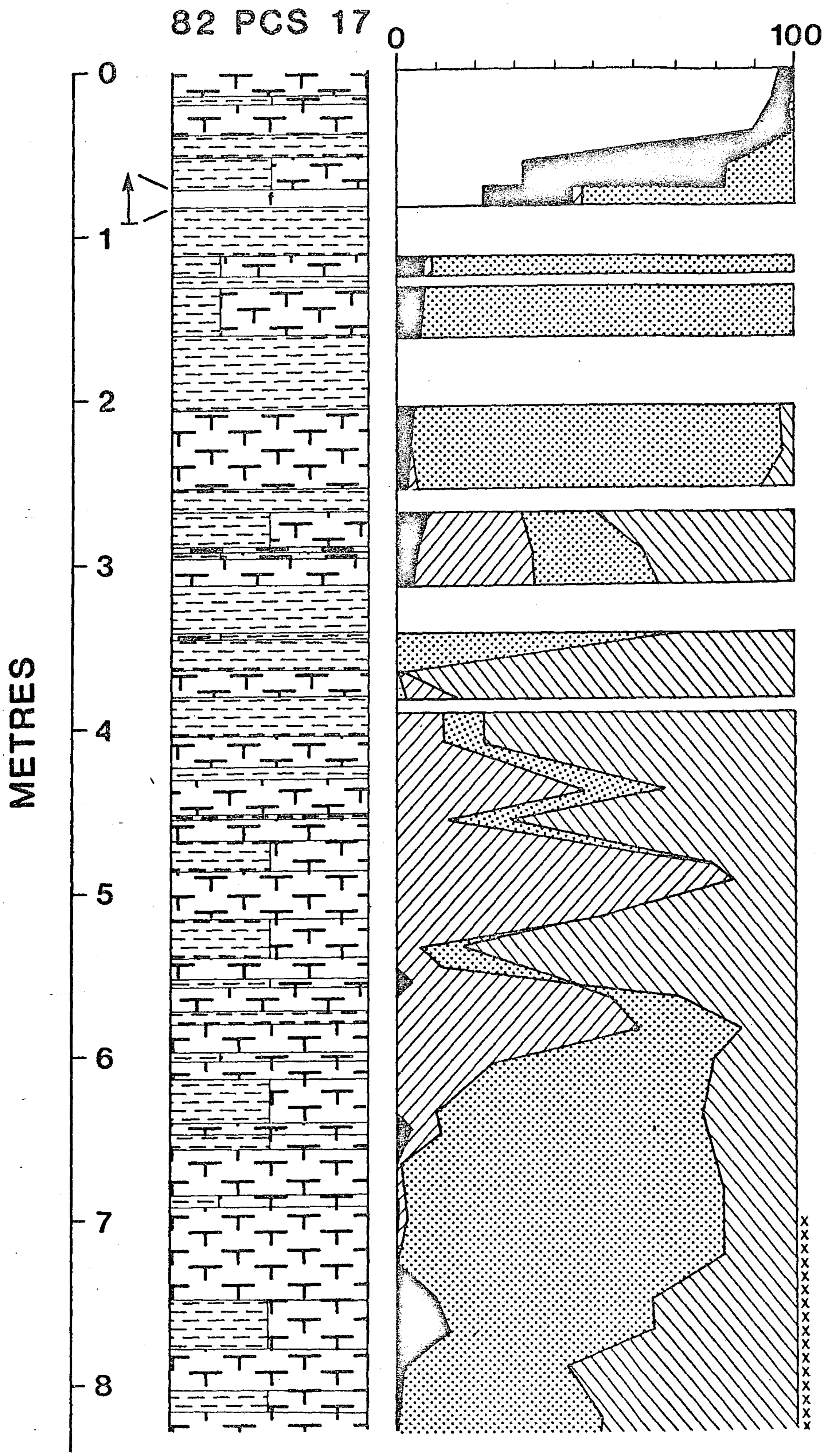
FIGURE CAPTIONS

Figure 1. Lithology of core 82PCS17 with percent abundance of six stratigraphically useful coccolith species. X=distribution of *C. macintyrei*. For key see Figure 2.

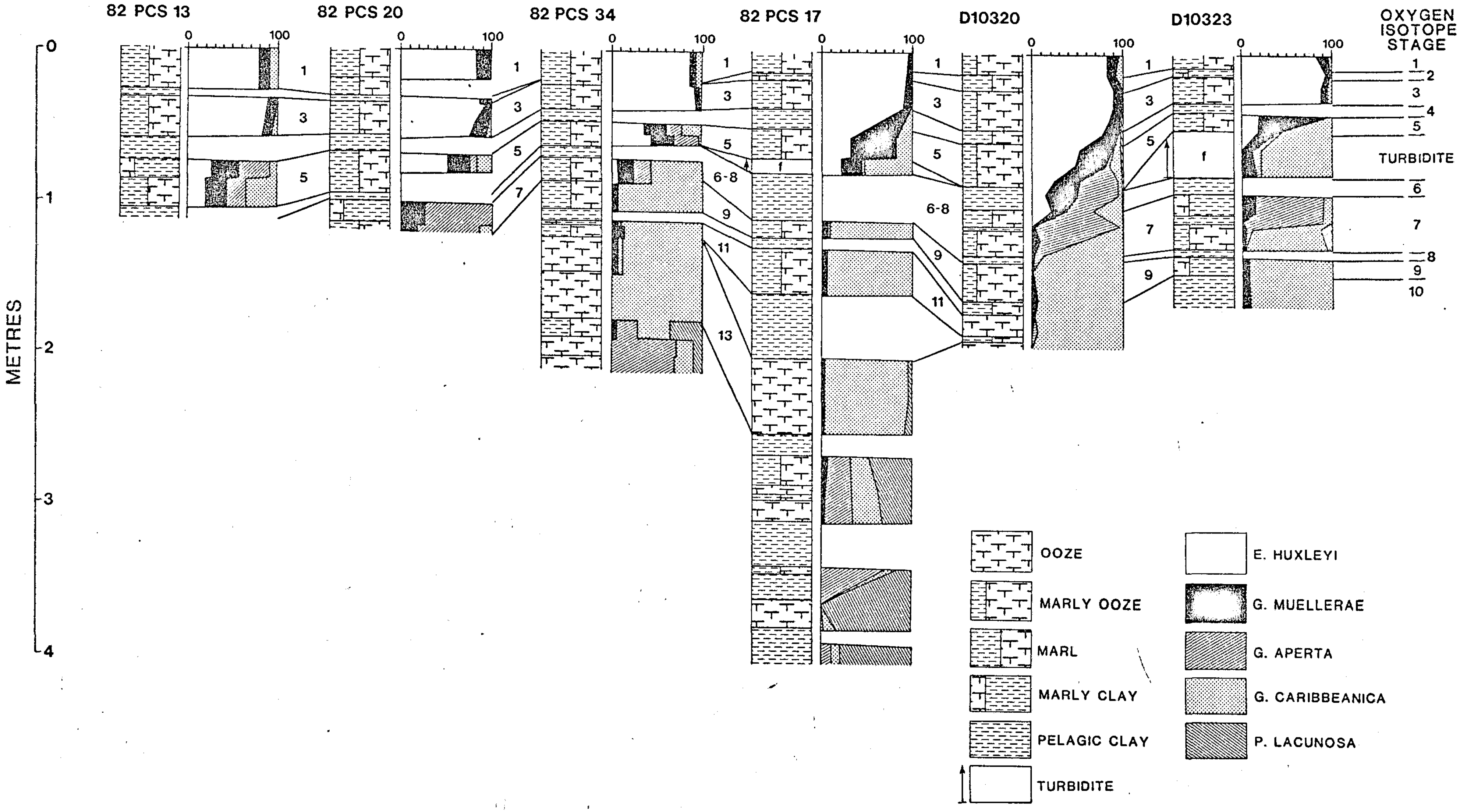
Figure 2. Pelagic intervals (non-turbidite) of cores 82PCS13, 20 and 34 compared to the upper half of core 82PCS17 and IOS cores D10320 and D10323. Oxygen isotope stages based on direct data in core D10320 and by analogy on alternating marl and clay intervals in the other cores.

Figure 3. Correlation of turbidite cores 82PCS13, 20 and 34. The correlation lines connect oxygen isotope stages (numbered) as in Figure 2. Turbidites which correlate in all three cores are numbered alphabetically from the top. Turbidites with numbered suffixes do not correlate in all cores. For key see Figure 2.

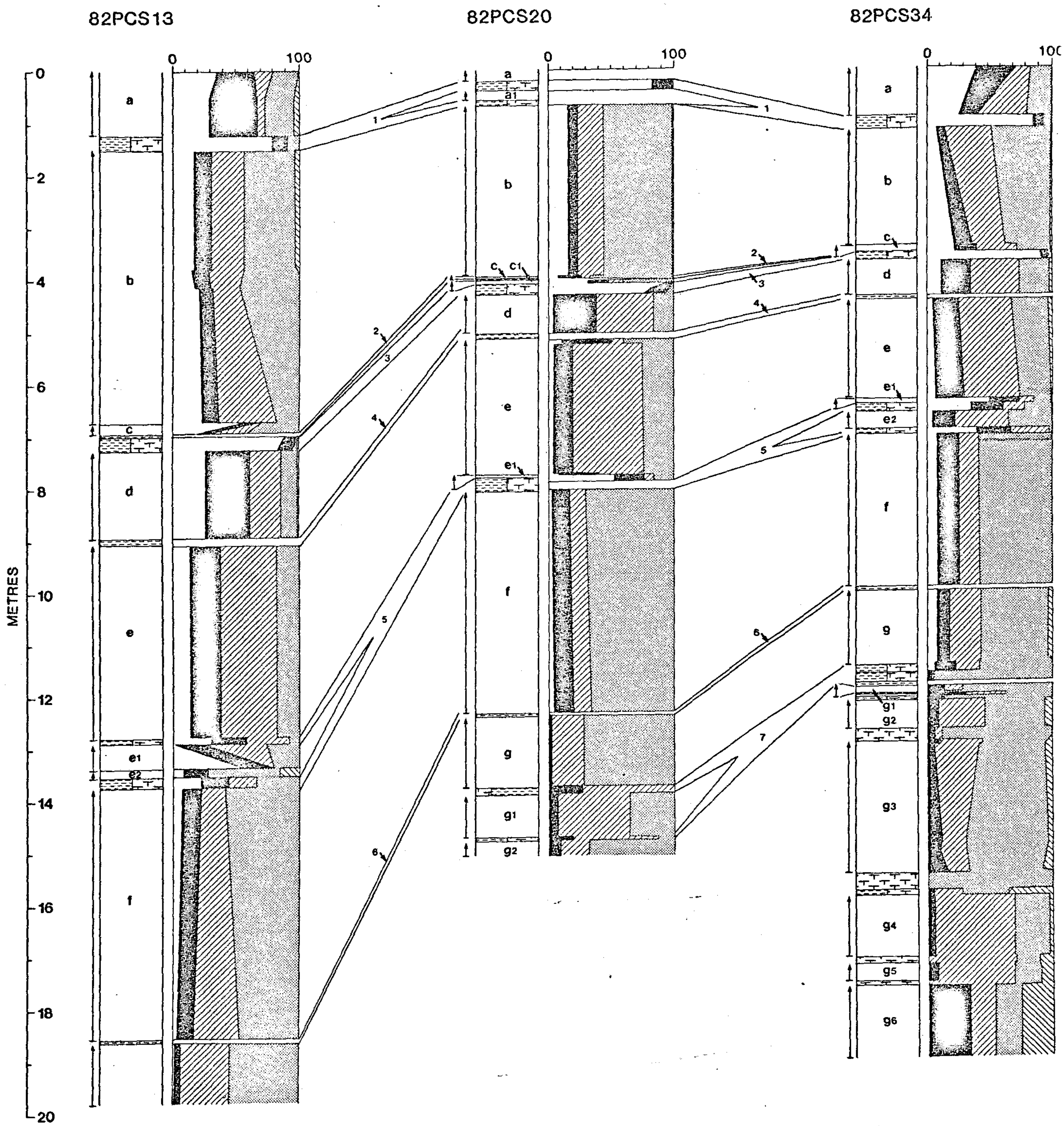
Figure 4. Pelagic (non-turbidite intervals) of cores 82PCS13, 20 and 34 showing positions where turbidites have been removed - identified by dashes on the left-hand side of each lithology log.



82 PCS 17
0
100
METRES
0
1
2
3
4
5
6
7
8



82 PCS 13
82 PCS 20
82 PCS 34
82 PCS 17
D10320
D10323
OXYGEN ISOTOPE STAGE
METRES
0
1
2
3
4
100
1
3
5
6-8
7
9
11
13
2
4
6
8
10
TURBIDITE
f
OOZE
MARLY OOZE
MARL
MARLY CLAY
PELAGIC CLAY
TURBIDITE
E. HUXLEYI
G. MUELLERAE
G. APERTA
G. CARIBBEANICA
P. LACUNOSA



82PCS13
82PCS20
82PCS34
METRES
0
2
4
6
8
10
12
14
16
18
20
0
100
a
a1
b
c
c1
d
e
e1
e2
f
g
g1
g2
g3
g4
g5
g6
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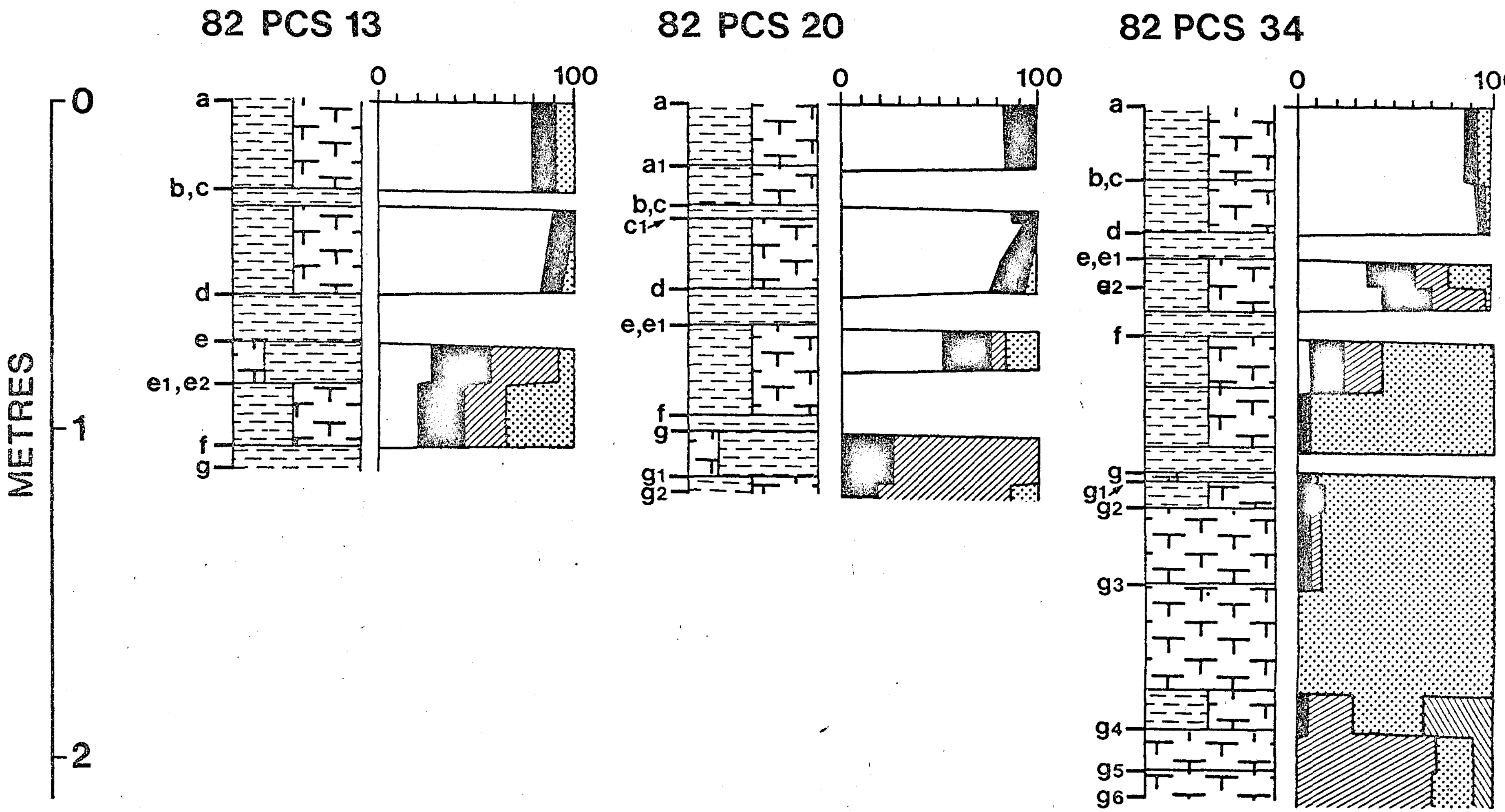
3
4
5
6
7


METRES
0
1
2
82 PCS 13
0
100
a
b,c
d
e
e1,e2
f
g
82 PCS 20
0
100
a
a1
b,c
c1
d
e,e1
f
g
g1
g2
82 PCS 34
0
100
a
b,c
d
e,e1
e2
f
g
g1
g2
g3
g4
g5
g6