PROVENANCE
– the search for a source.....

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with major contributions from
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Network Stratigraphic Consulting Ltd.

February 11th, 2020
West Midlands Regional Group,
Geological Society

From Thames Tideway to Thames Barrier.....

From royal paintings to mosasaur teeth.....

From murderers to unanswered questions.

After what is “it”? The question we get most frequently asked is - where did “it” live?

Once you’ve identified what you’ve got, you need to:

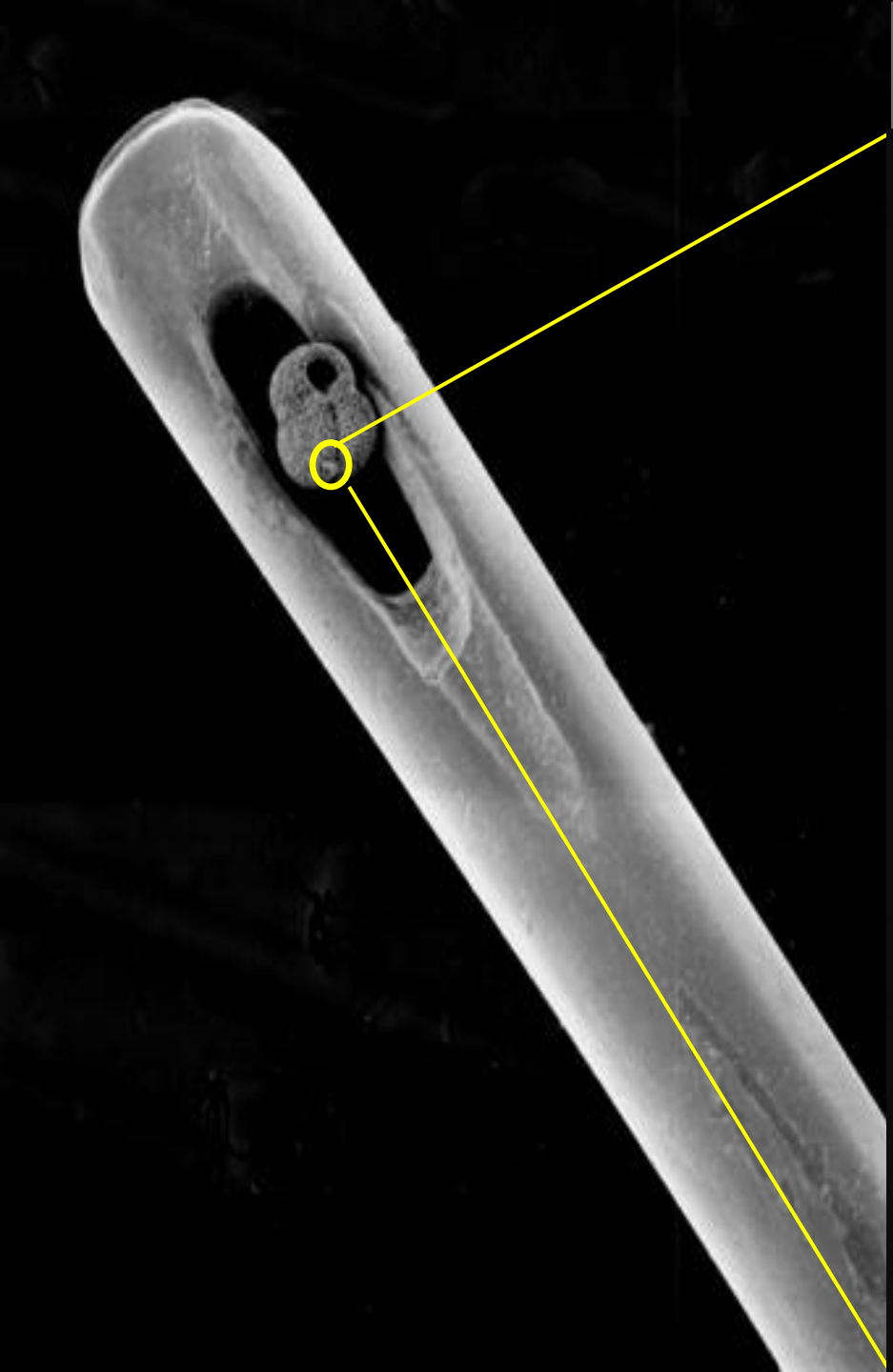
i) identify all the possible sources

ii) eliminate the improbable sources

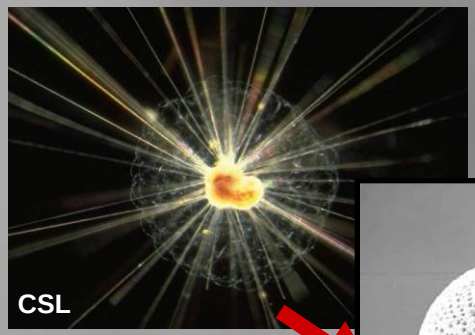
iii) establish a probable source

iv) then try to prove it!

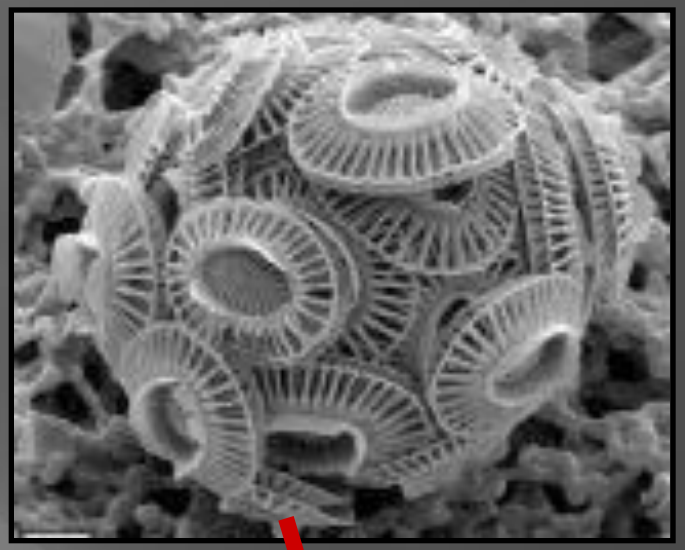
So in the Geological Society “Year of Life” let’s see how we can use a few dead things.....



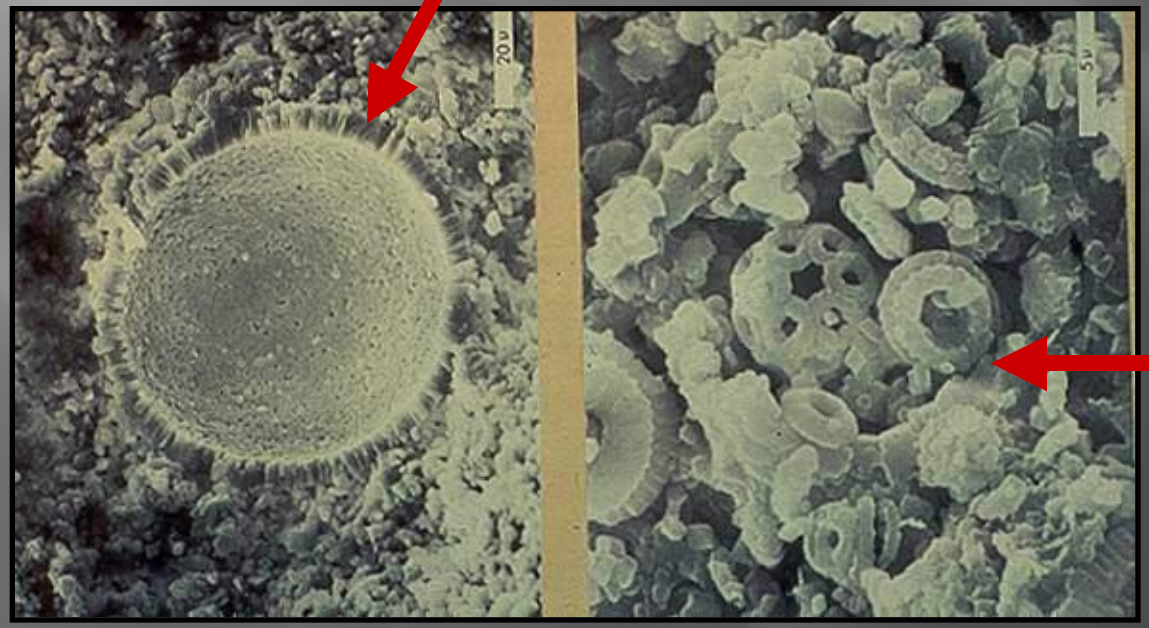
Chalk is initially coccolith-foram ooze



Modern foraminifera

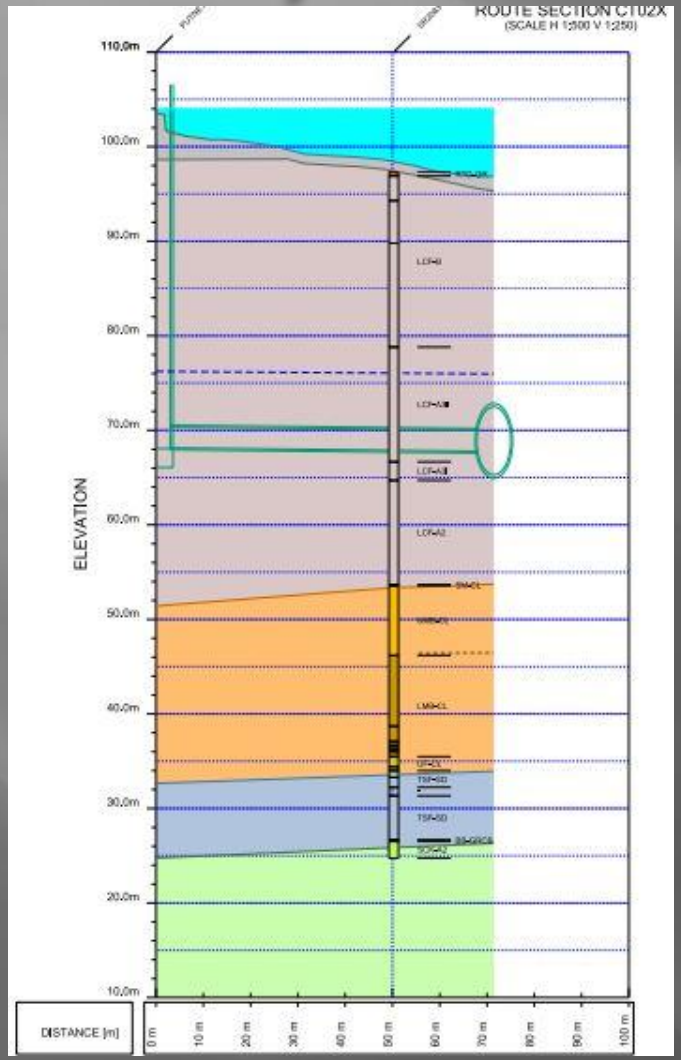


Modern coccolithophorid algae



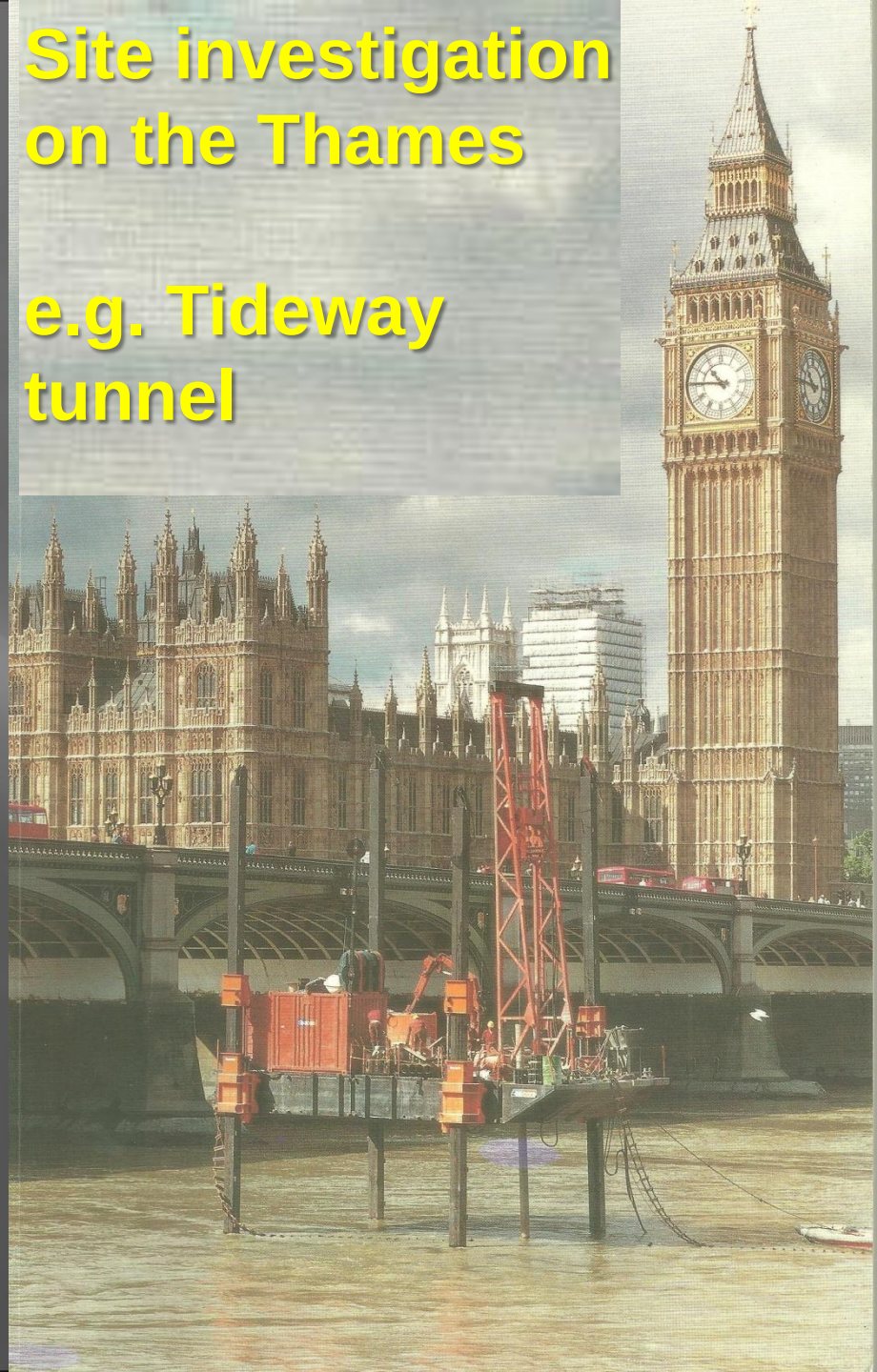
North Sea chalk, Ekofisk field

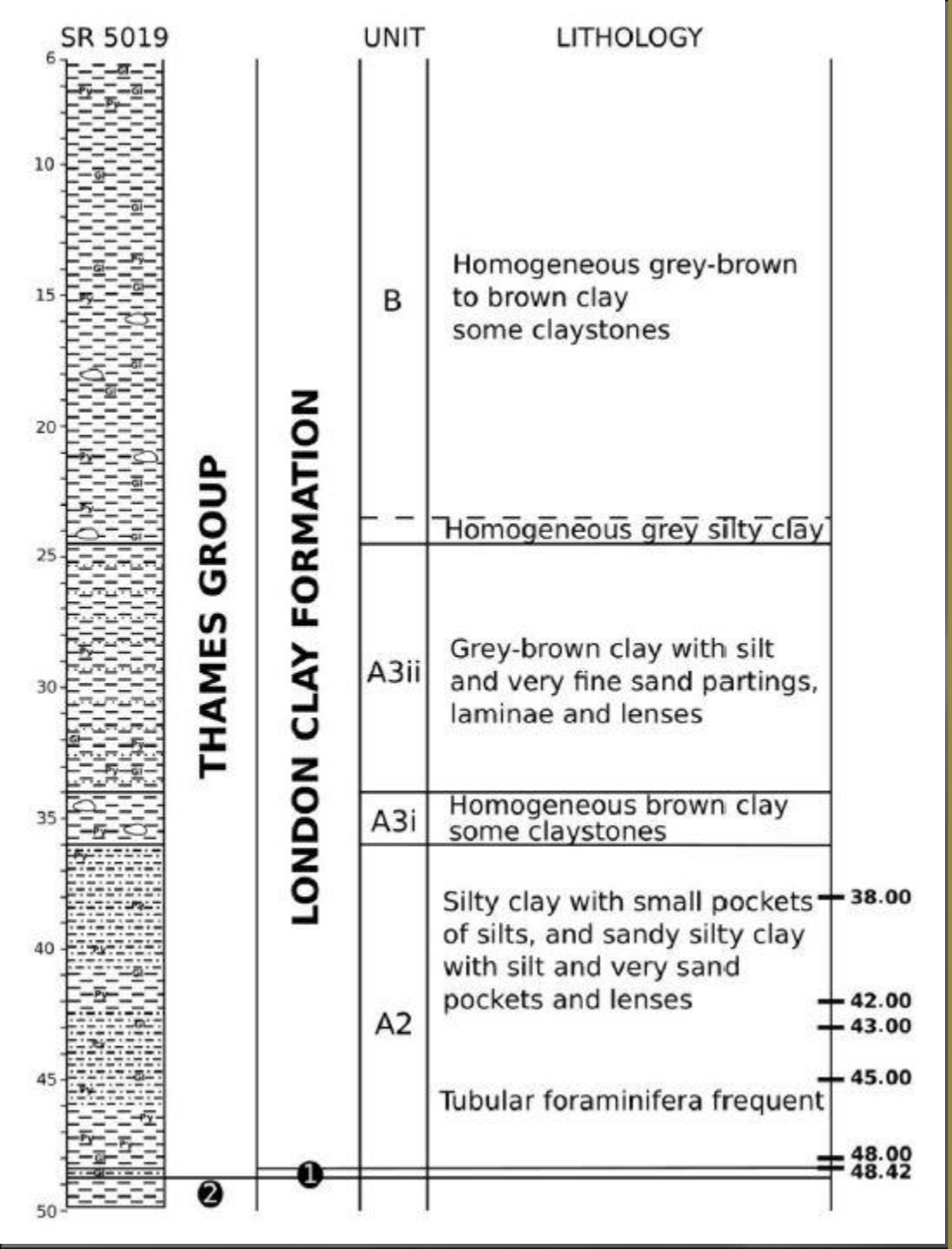
1. Oddball fossils in the Thames Tideway

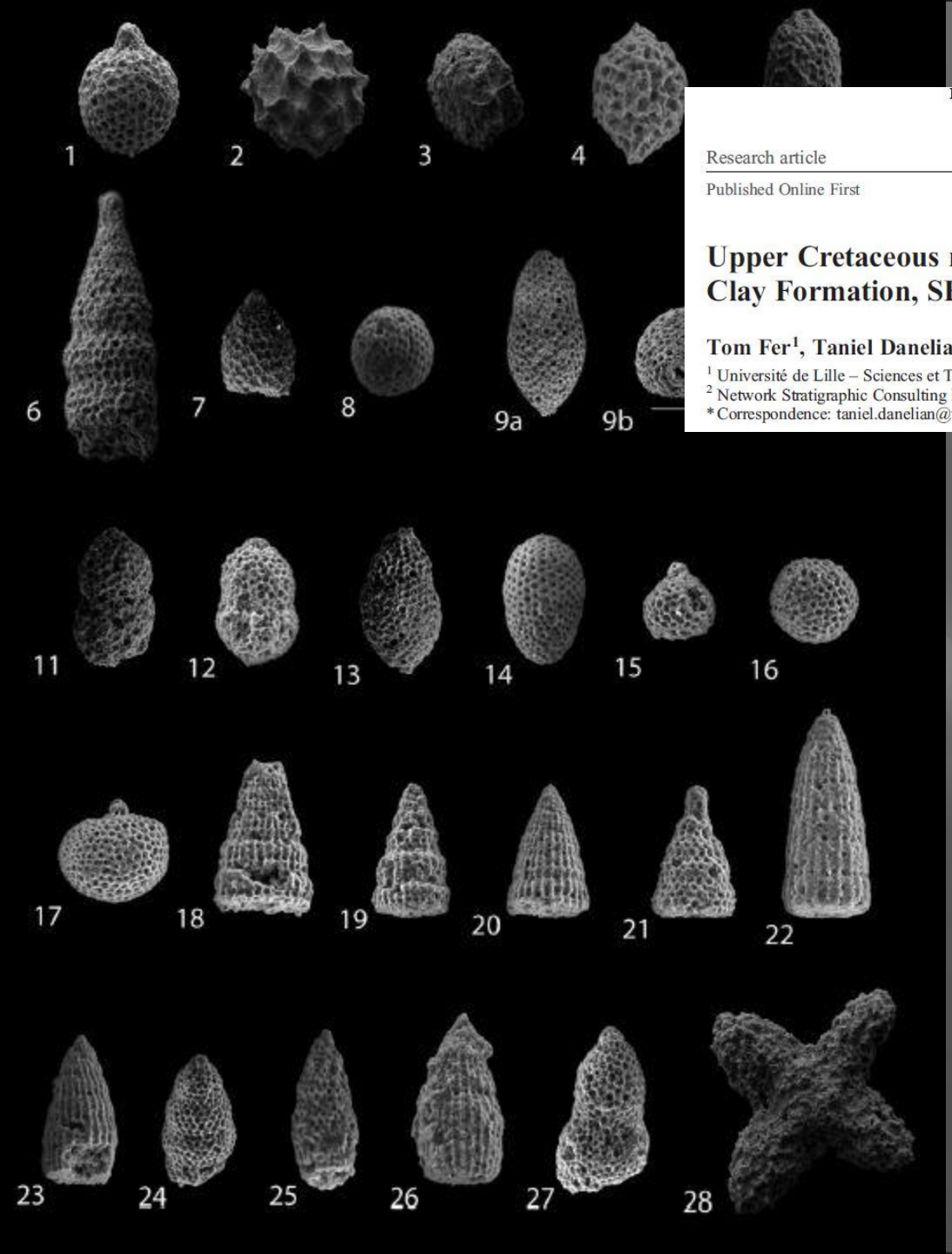


Site investigation on the Thames

e.g. Tideway tunnel




SR 5019
UNIT
LITHOLOGY
6
10
15
20
25
30
35
40
45
50
THAMES GROUP
LONDON CLAY FORMATION
B
Homogeneous grey-brown to brown clay some claystones
Homogeneous grey silty clay
A3ii
Grey-brown clay with silt and very fine sand partings, laminae and lenses
A3i
Homogeneous brown clay some claystones
A2
Silty clay with small pockets of silts, and sandy silty clay with silt and very sand pockets and lenses
Tubular foraminifera frequent
38.00
42.00
43.00
45.00
48.00
48.42
1
2



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Upper Cretaceous radiolarians reworked in the Eocene London Clay Formation, SE England

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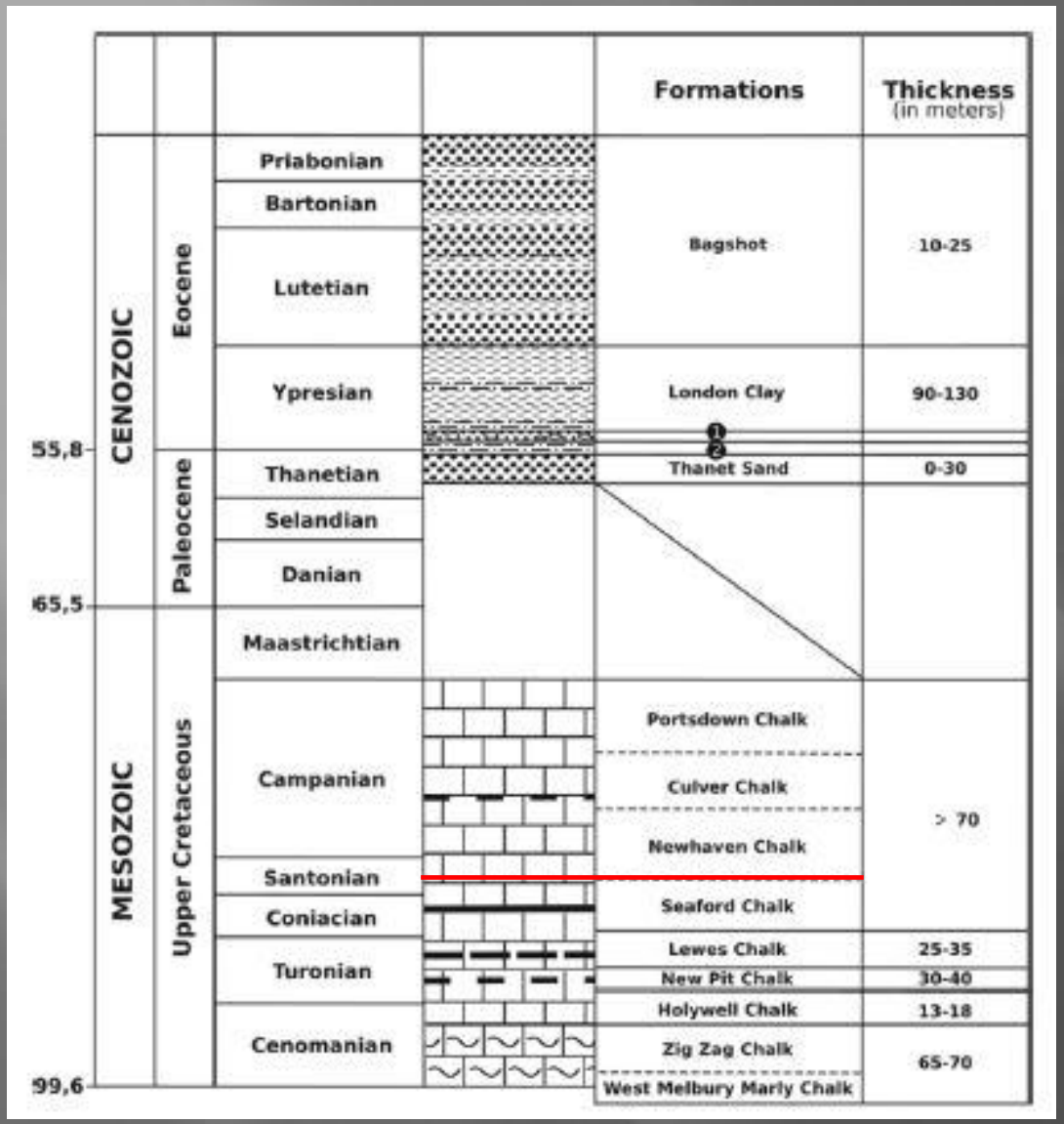


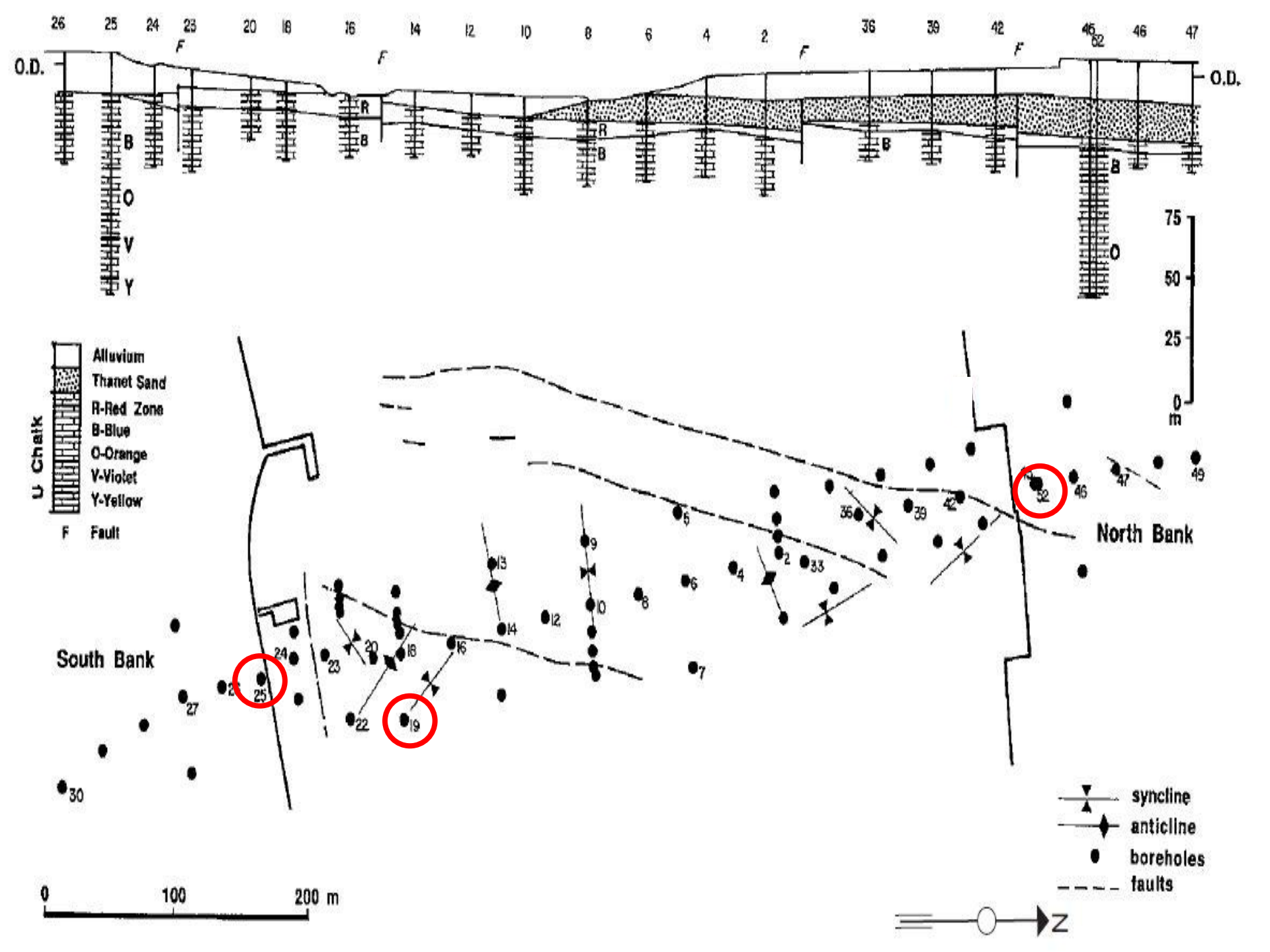
The radiolaria we'd found originated in sediments of Late Santonian – Campanian age.

However sediments of Late Santonian – Campanian age no longer exist in the London Basin.

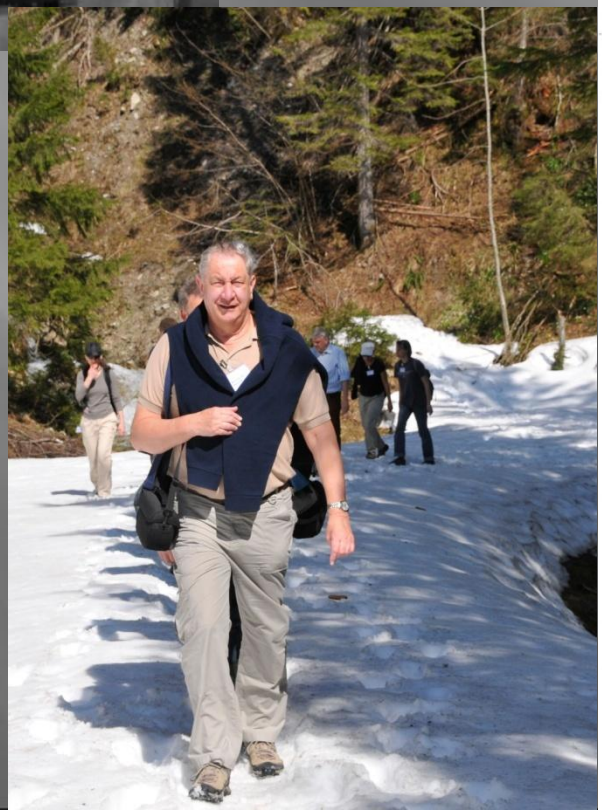
Basically – we've no idea where they came from....!


EastEnders
BBC

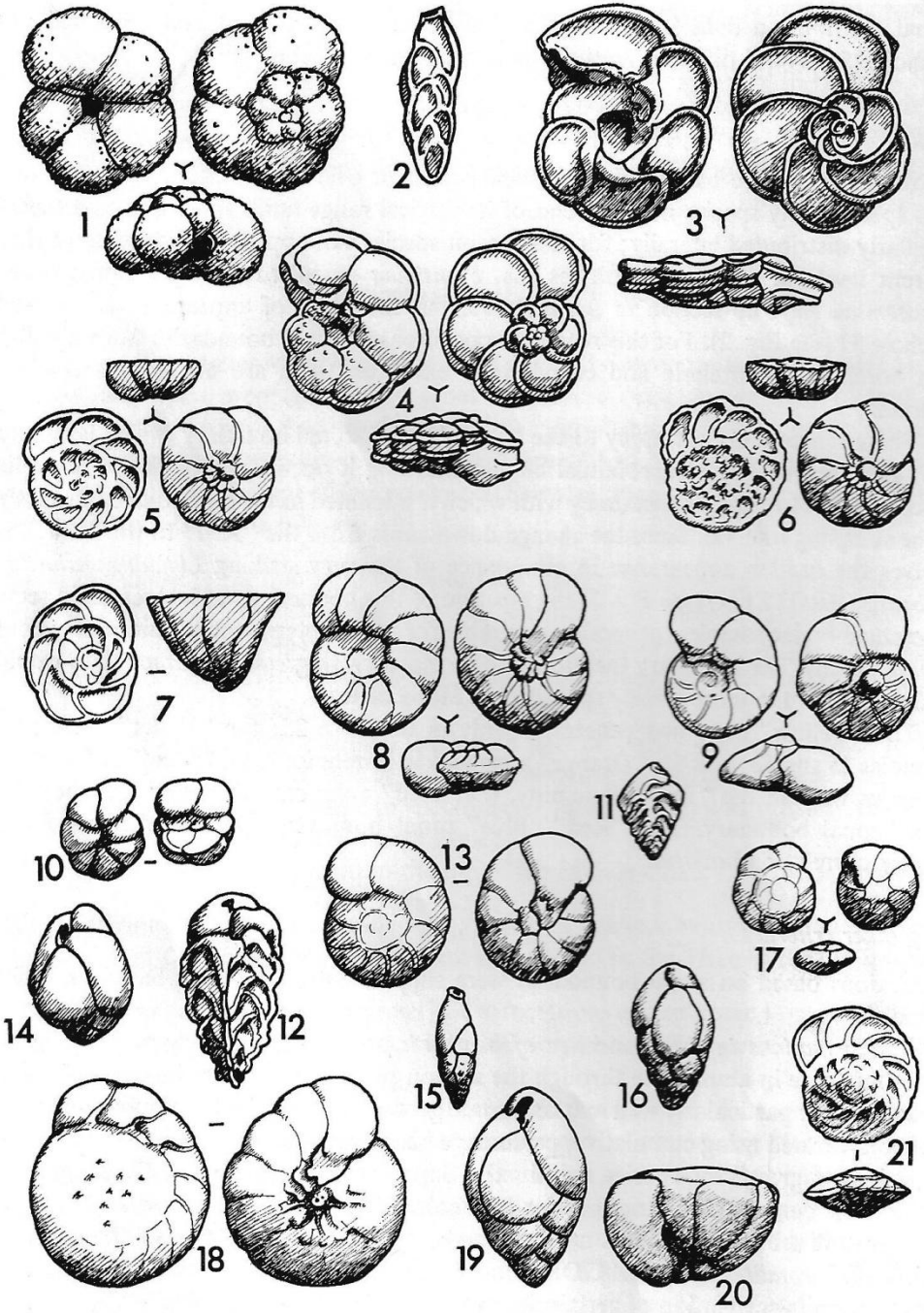
2. Microfossils helped to build the Thames Barrier – how?

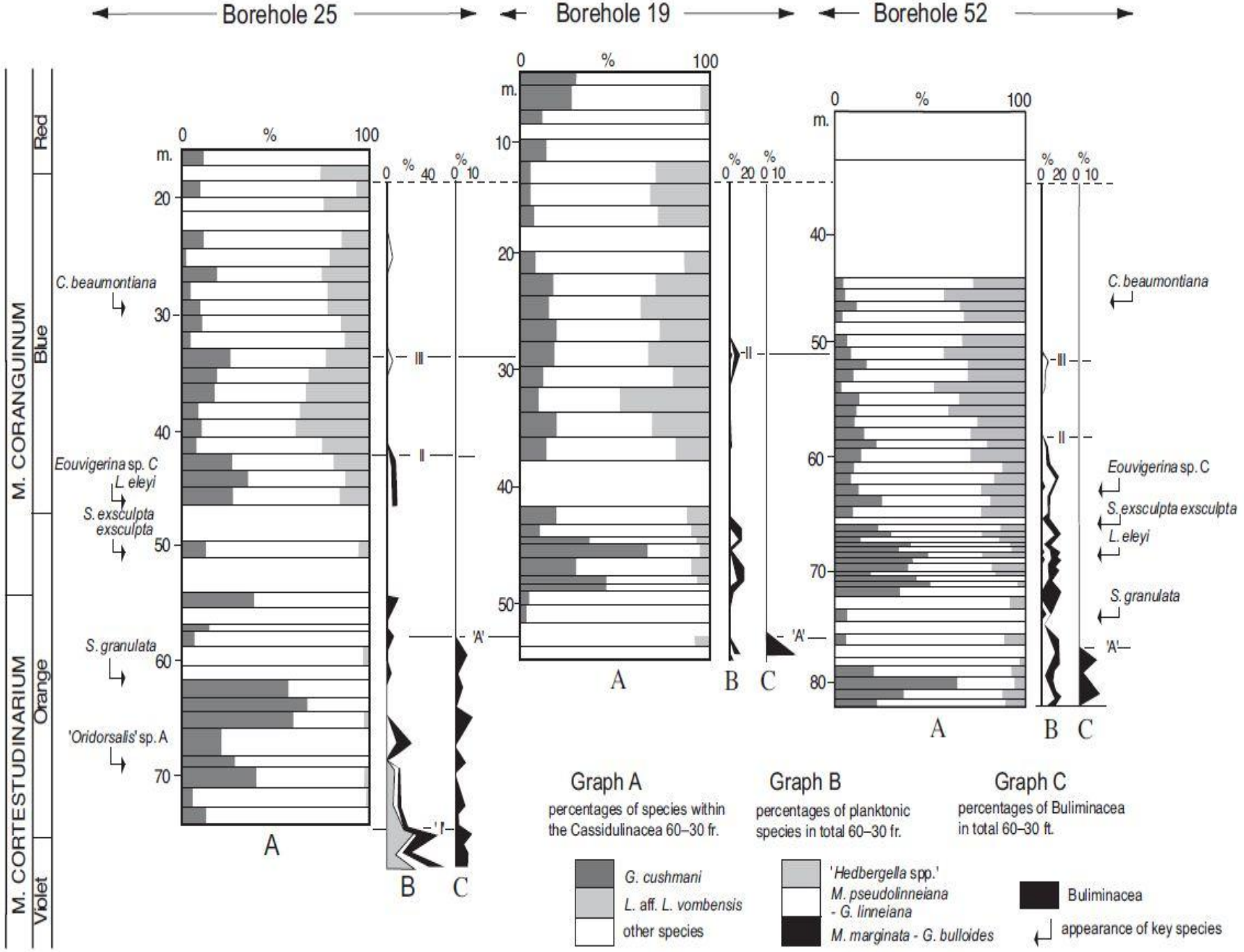

26 25 24 23 20 18 16 14 12 10 8 6 4 2 36 39 42 46 52 46 47
O.D.
O.D.
F
R
B
O
V
Y
75
50
25
0
m
U Chalk
Alluvium
Thanet Sand
R-Red Zone
B-Blue
O-Orange
V-Violet
Y-Yellow
F Fault
South Bank
North Bank
syncline
anticline
boreholes
faults
0 100 200 m
N

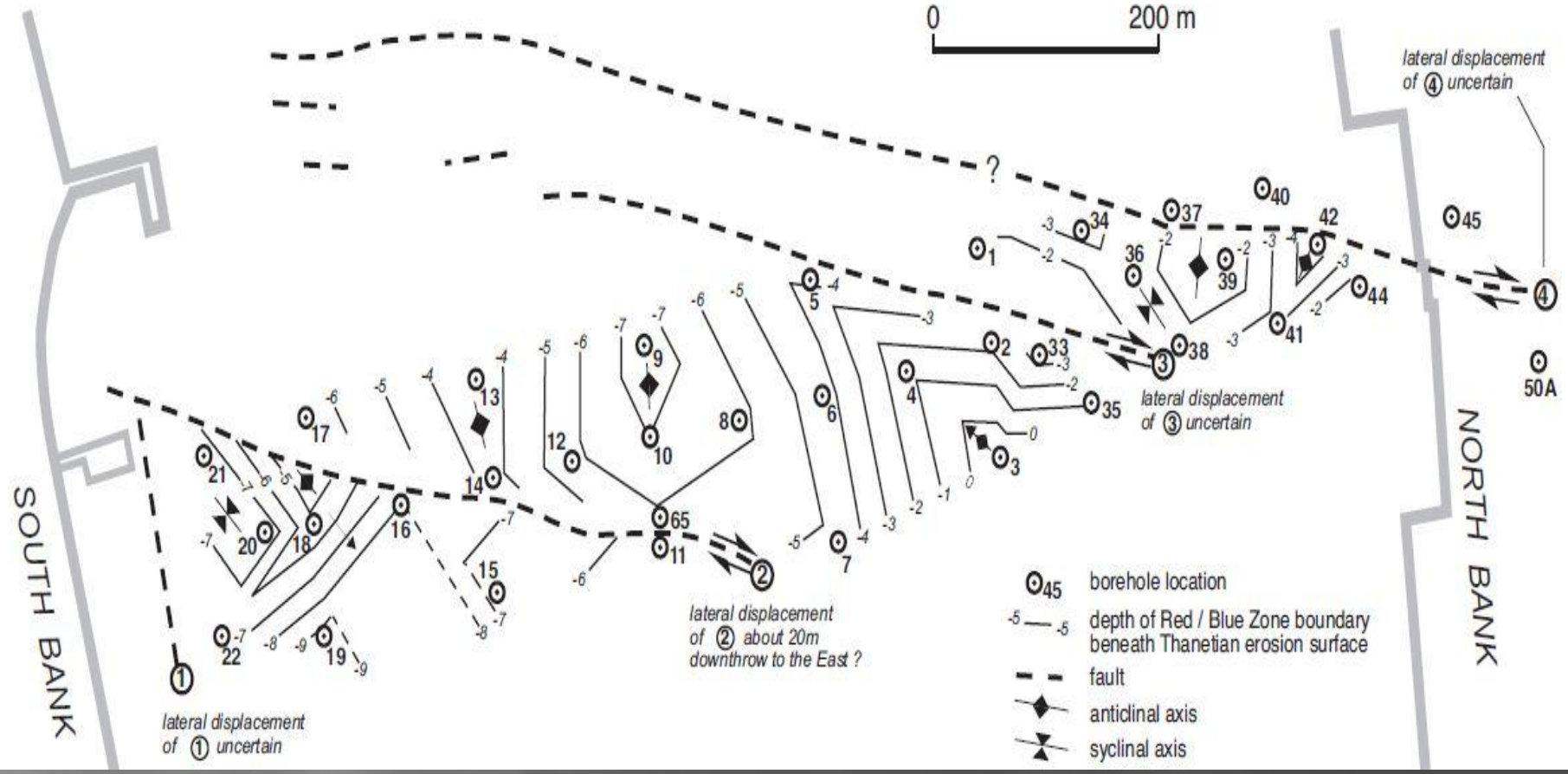
The "late" Dave Carter



The very extant Malcolm Hart



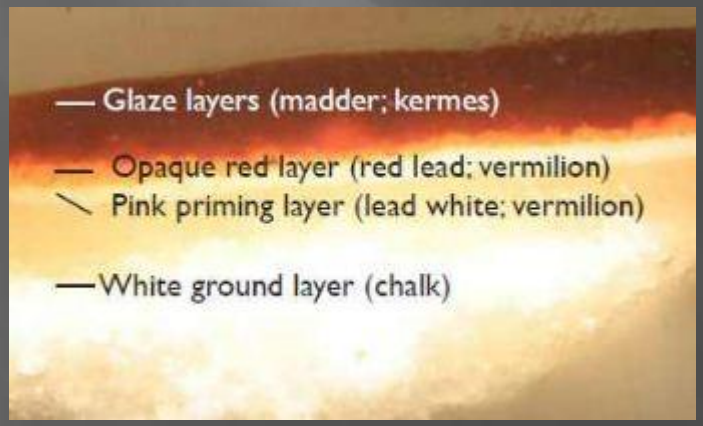

Borehole 25
Borehole 19
Borehole 52
M. CORANGUINUM
M. CORTESTUDINARIUM
Red
Blue
Orange
Violet
C. beaumontiana
Eouvigerina sp. C
L. eleyi
S. exsculpta exsculpta
S. granulata
'Oridorsalis' sp. A
'A'
A
B
C
Graph A
percentages of species within the Cassidulinacea 60–30 fr.
Graph B
percentages of planktonic species in total 60–30 fr.
Graph C
percentages of Buliminacea in total 60–30 ft.
G. cushmani
L. aff. L. vombensis
other species
'Hedbergella spp.'
M. pseudolinneiana - G. linneiana
M. marginata - G. bulloides
Buliminacea
appearance of key species



On the basis of Dave Carters work the site engineers were able to recognise faulting and folding structures within the *in-situ* chalk surface allowing the pier foundations to be securely sited.


8
9

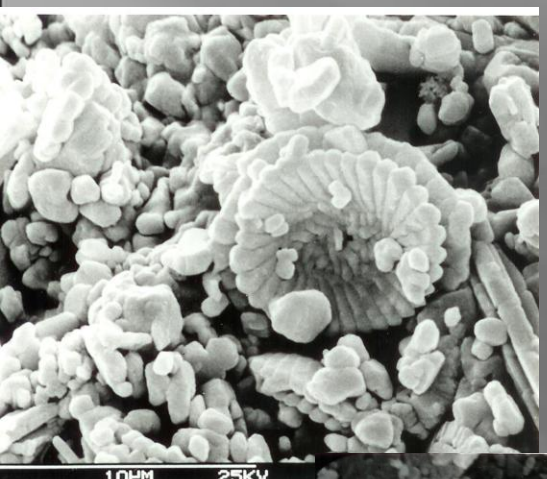
3. A Royal Tudor painting

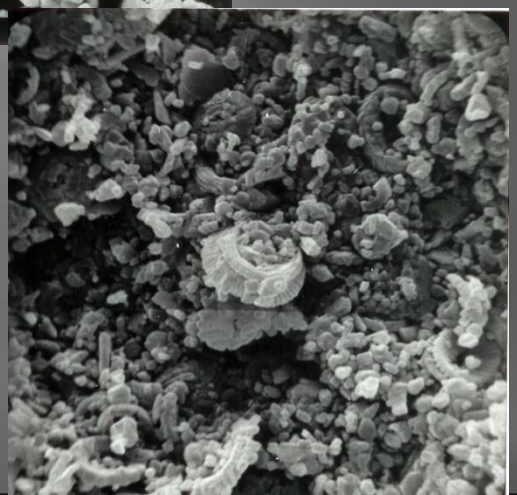


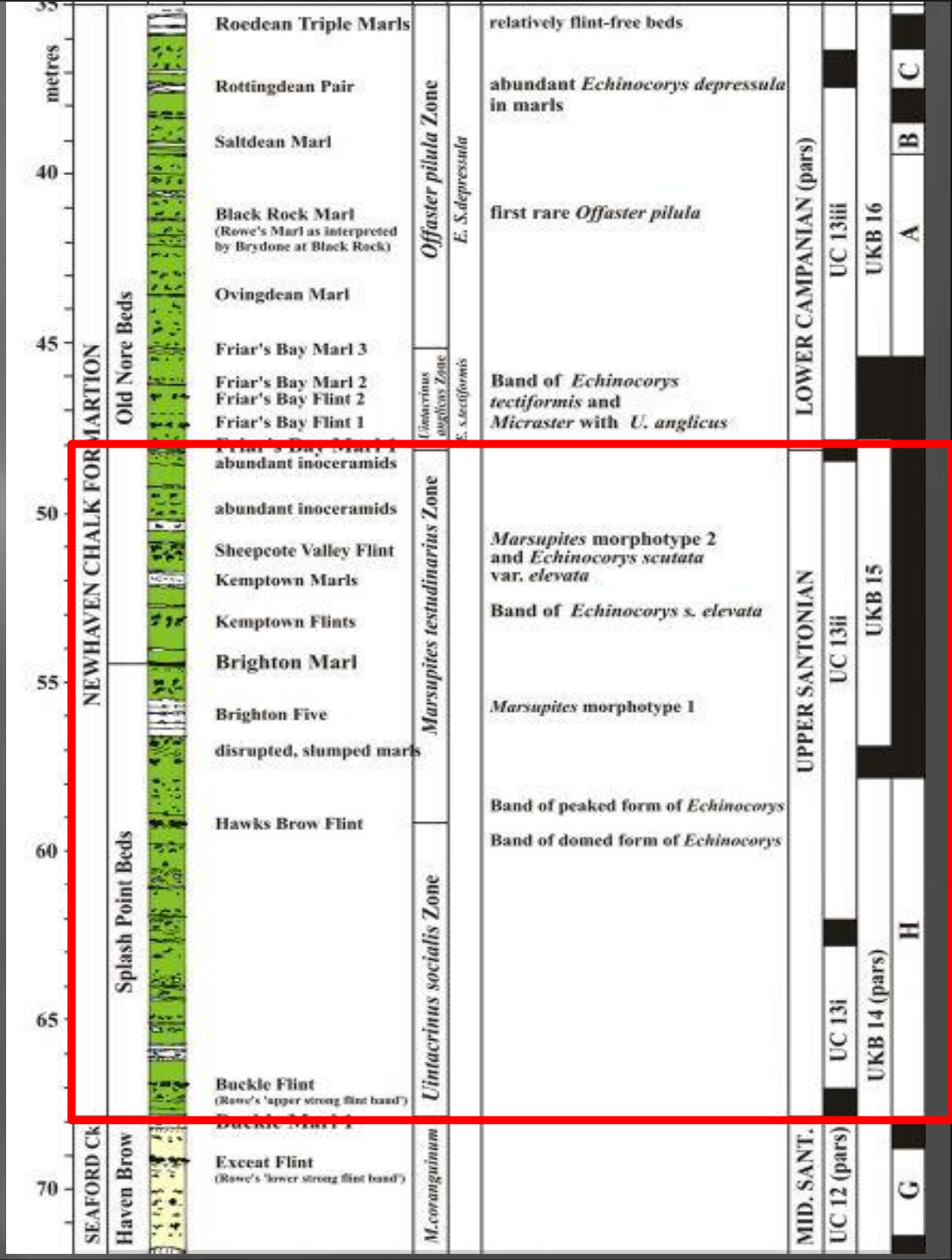
The portrait is painted on to a wooden base using soft white chalk paste as a lining before the painting is carried out.

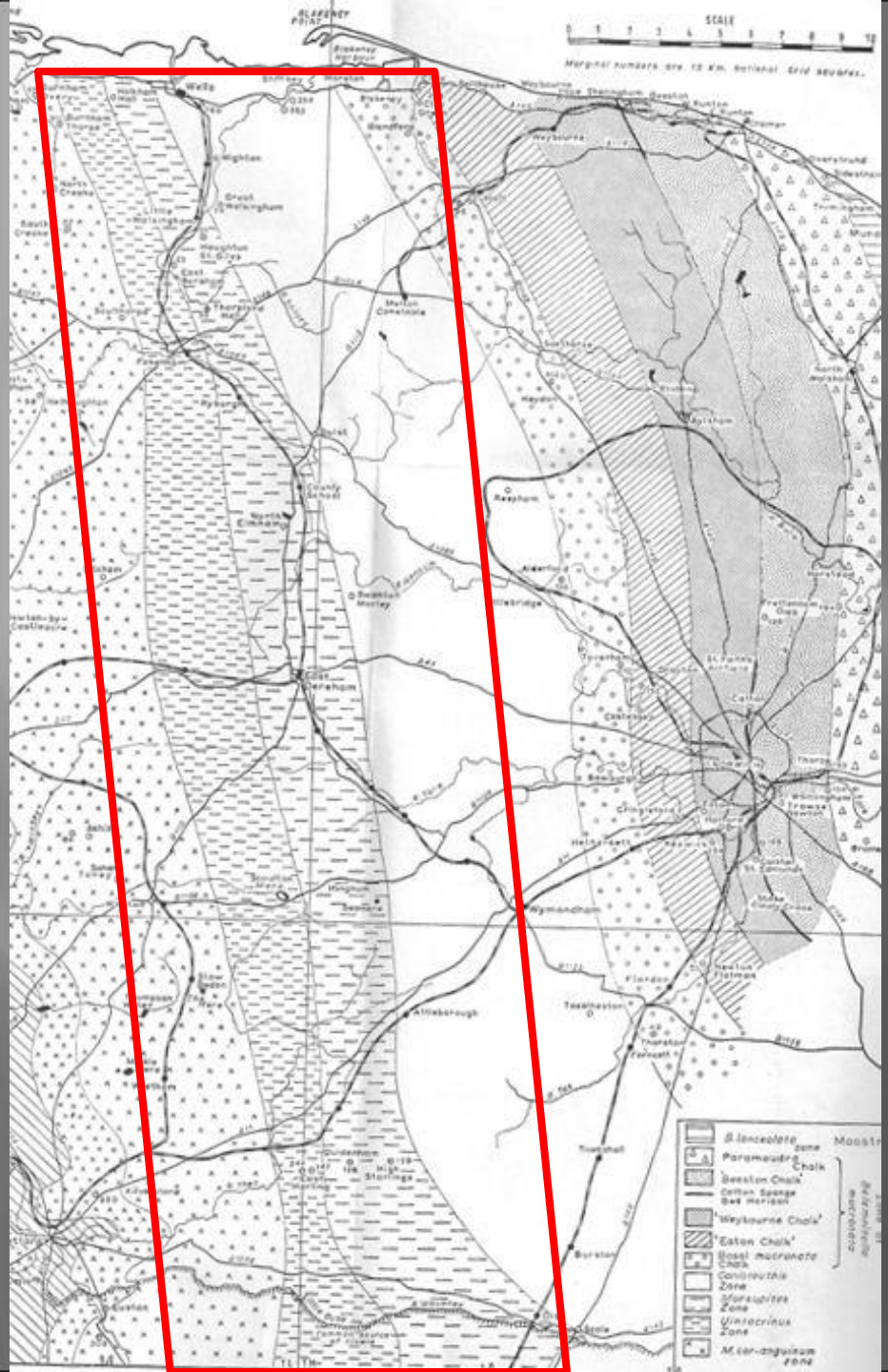
The nannoplankton assemblage recorded is typical of Middle – Late Santonian chalk (Subzones UC13i-ii)

i.e. *Uintacrinus – Marsupites* crinoid zones







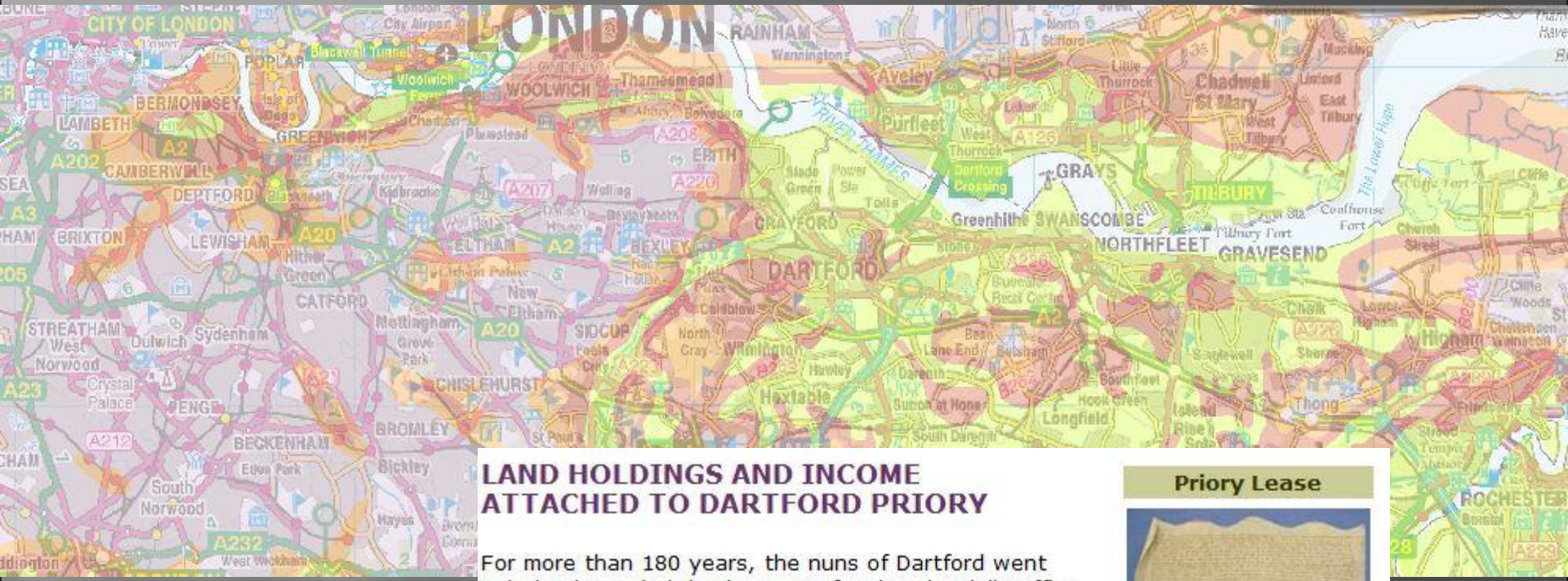


Option 1: Using the Peake & Hancock zonal map of Norfolk

The potential for working Tudor chalk pits in the proximity of Norwich, England's 2nd most important city in Tudor times, is considerable

Alternatively.....

Option 2: We have a London based artist who is accessing the base material for his painting from one of the nearby chalk pits on the North Downs of Kent.



LAND HOLDINGS AND INCOME ATTACHED TO DARTFORD PRIORY

For more than 180 years, the nuns of Dartford went quietly about their business, performing the daily office and serving God in the community. The prioress of Dartford owned extensive tracts of land, woodland, grazing marsh, chalk quarries, several mills, tenements and inns in North Kent and throughout the county of Kent. Additional properties, lands and church advowsons were held in Bedfordshire, Buckinghamshire, Dorset, Glamorgan, Herefordshire, Hertfordshire, the City of London, Norfolk, Suffolk, Surrey and Wiltshire. Much of the income from these lands and properties was diverted to King's Langley Priory. Dominican friars from King's Langley were based at Dartford to ensure that the daily business of the priory was conducted properly.

Priory Lease

Click for enlarged photos of the lease

Picture credit: Dartford Museum

The restored painting was displayed in the Royal Collection, Buckingham Palace, Summer, 2013 & is now on display at Hampton Court

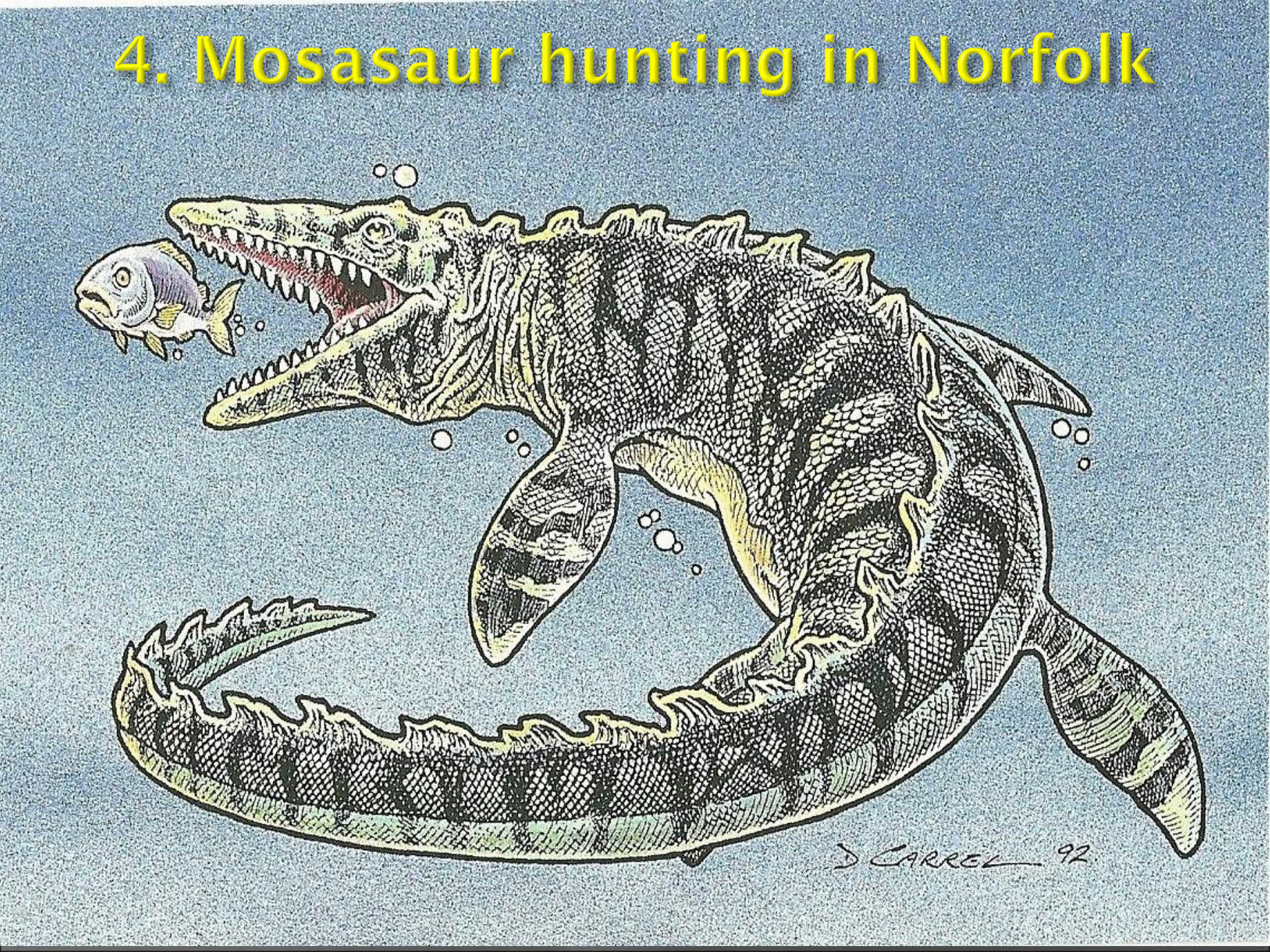
***Portrait of a Man in Red*, c.1530–50**
German or Netherlandish artist working in England

RC591 Printed in England

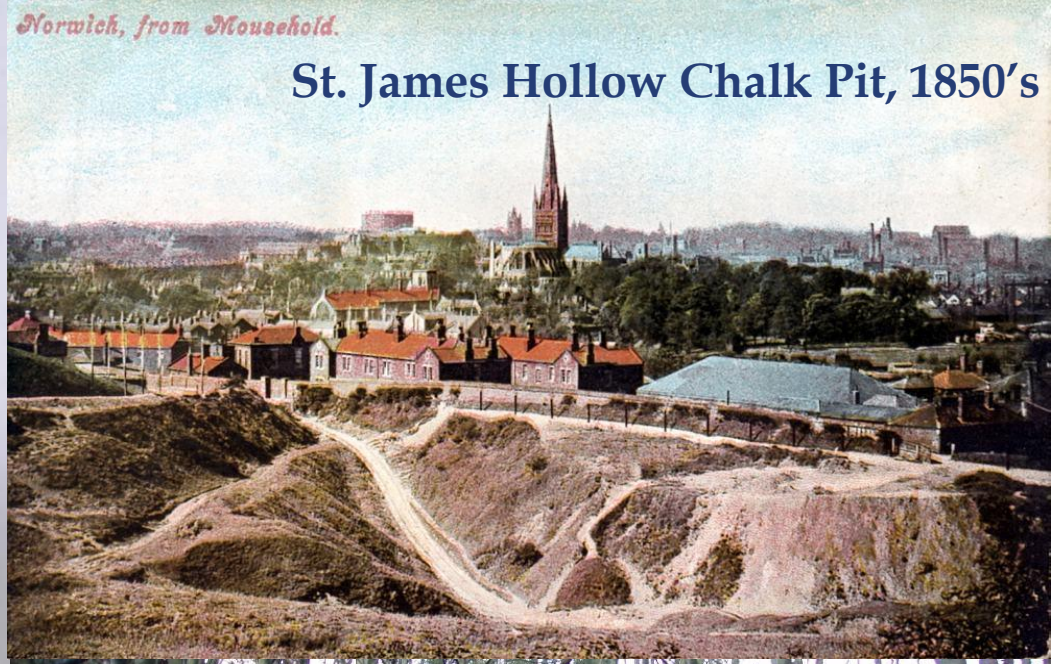
Again we have a couple of options

But my money's on Option 2!

4. Mosasaur hunting in Norfolk



Mosasaur tooth,
Ipswich Museum



St. James Hollow Chalk Pit, 1850's

St. James Hollow Chalk Pit; now

St. James Hollow Chalk Pit

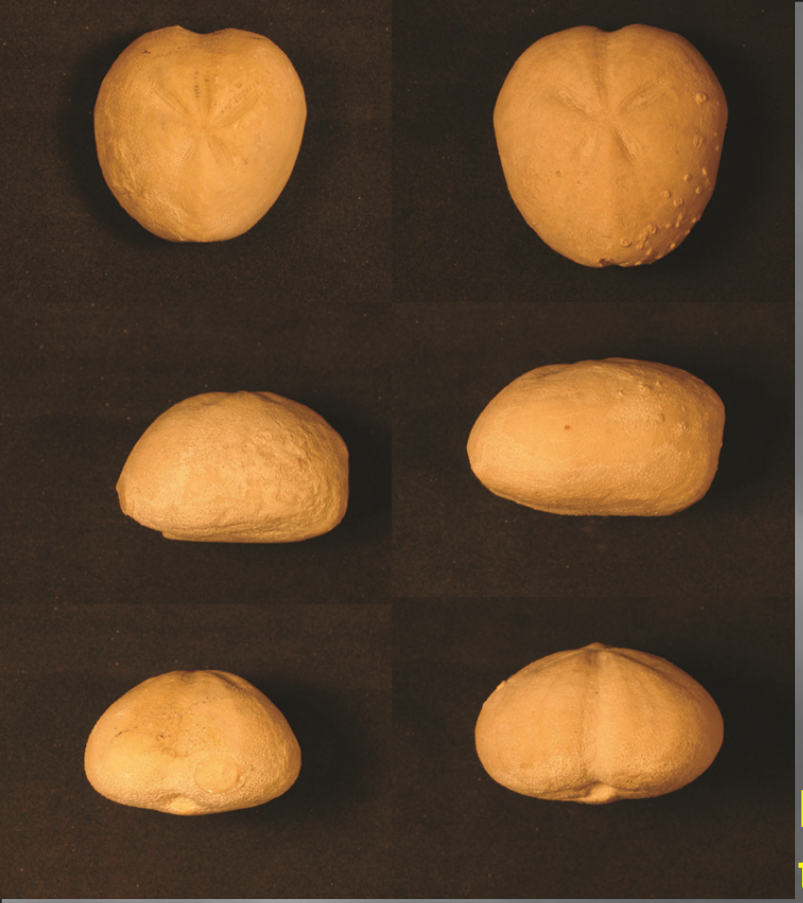
So yet again there are at least two possibilities...

There are either two separate specimens or…

The mosasaur died standing on its tail with it's skull in one nannoplankton subzone and one of its teeth in a slightly older subzone.

St. James Hollow Chalk Pit

STJH1 - STJH3	Late Cretaceous, Beeston Chalk Early Maastrichtian/ Late Campanian Nannofossil Subzone UC16i
Mosasaur remains Skull - Norwich M114241	Late Cretaceous, Paramoudra Chalk Early Maastrichtian Nannofossil Subzone UC16ii
Tooth - Ipswich M22844	Late Cretaceous, Beeston Chalk Early Maastrichtian/ Late Campanian Nannofossil Subzone UC16i



For every one of these you manage to find, the micropalaeontologist will be finding Hundreds, if not thousands, of these ……

So how can we make more use of them?

5.THE SOHAM CASE

- **The disappearance and subsequent murder of Holly Wells and Jessica Chapman (Aug., 2002)**

Network involvement did not start until 10 months later, in June 2003

INTRODUCTION TO THE SOHAM CASE

- 1ST Link – forensic geoscientist,
  Andrew Moncrieff (Hawkins Associates)
- Needed rapid examination of Chalk samples
- Ex – British Antarctic Survey: contacted colleagues there who recommended Prof. Rory Mortimore (Univ. Brighton)
- RM suggested using microfossil content and AM should contact Network Stratigraphic
- RM also implied Network would be capable of analysing the material in the short time then available: i.e. 2 – 3 days.

ACTUAL TIMETABLE - 1

- Wednesday, June 25th 2003, c.10.30 am – HWB was contacted re. “calcareous sponge spicules”

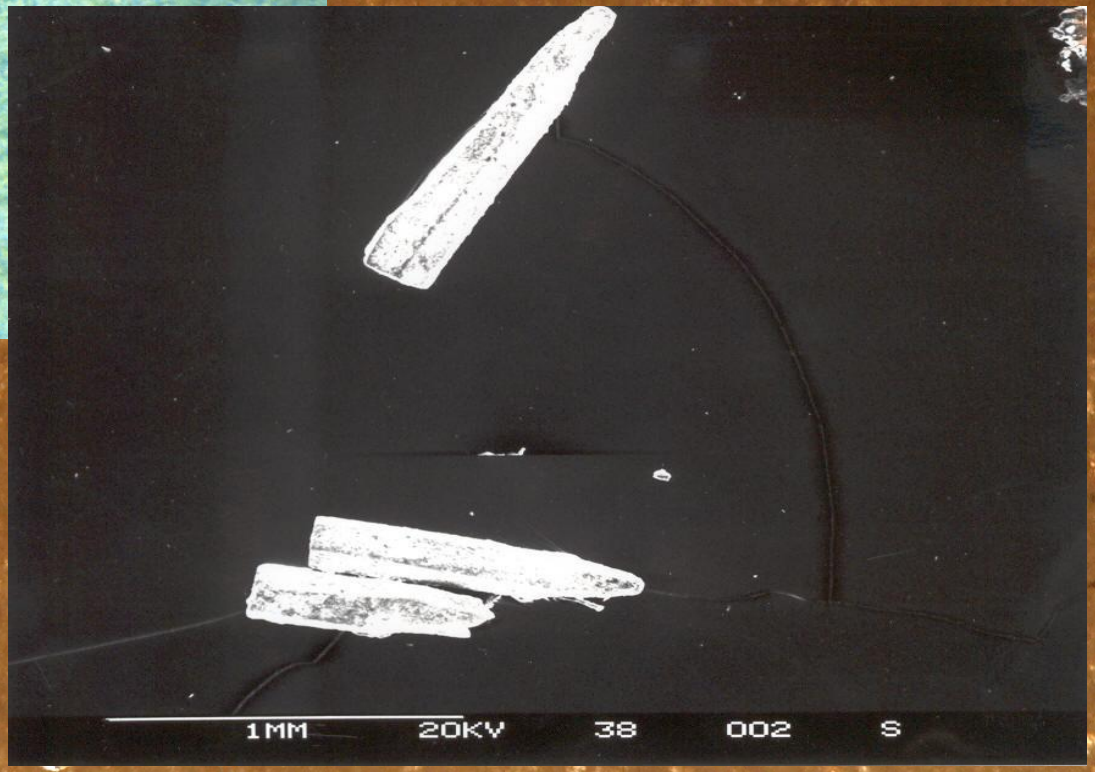
- Same day – early afternoon: 10 chalk samples were delivered to Network Stratigraphic office from Cambridge under a “blue flashing light”

ACTUAL TIMETABLE - 2

- 4 samples were to be examined for microfauna – HWB
- All 10 samples were to be examined for nannoflora - LTG
- Thursday, June 26th – analyses completed: HWB & LTG start talking to each other again
- Friday, June 27th am - Results collated into an integrated report.
- Friday afternoon report taken apart again.
- Friday evening – 2 detectives arrive; we convert report into separate witness statements.

Friday evening samples & slides taken away by detectives.

Are these calcareous sponge spicules?



No – they're inoceramid prisms

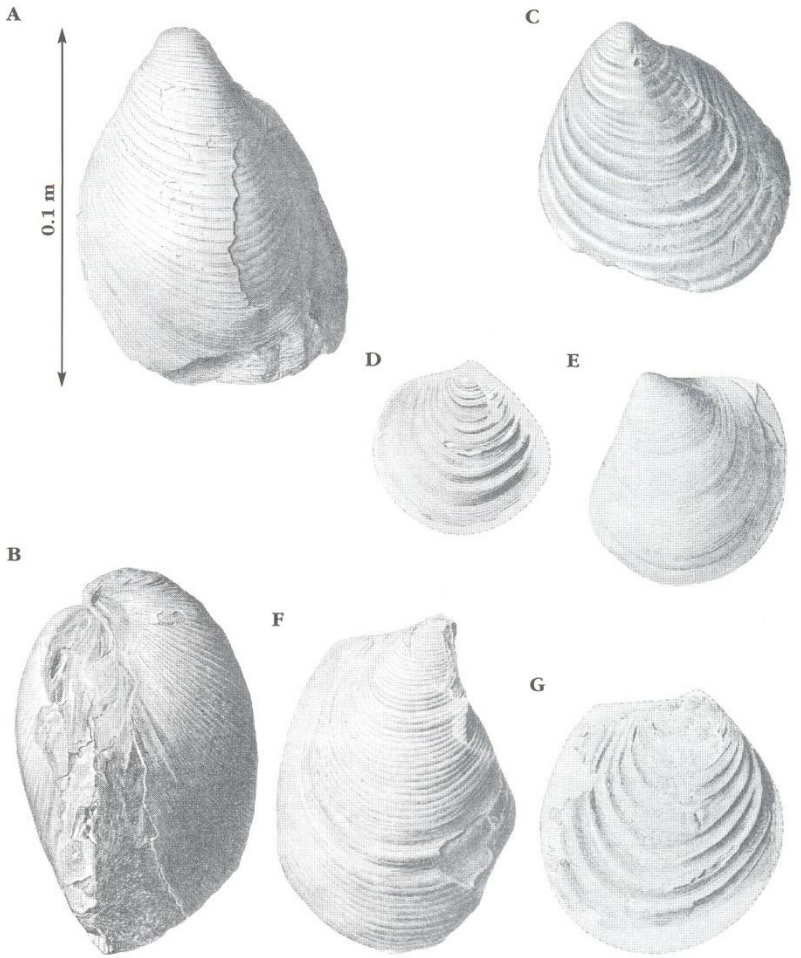
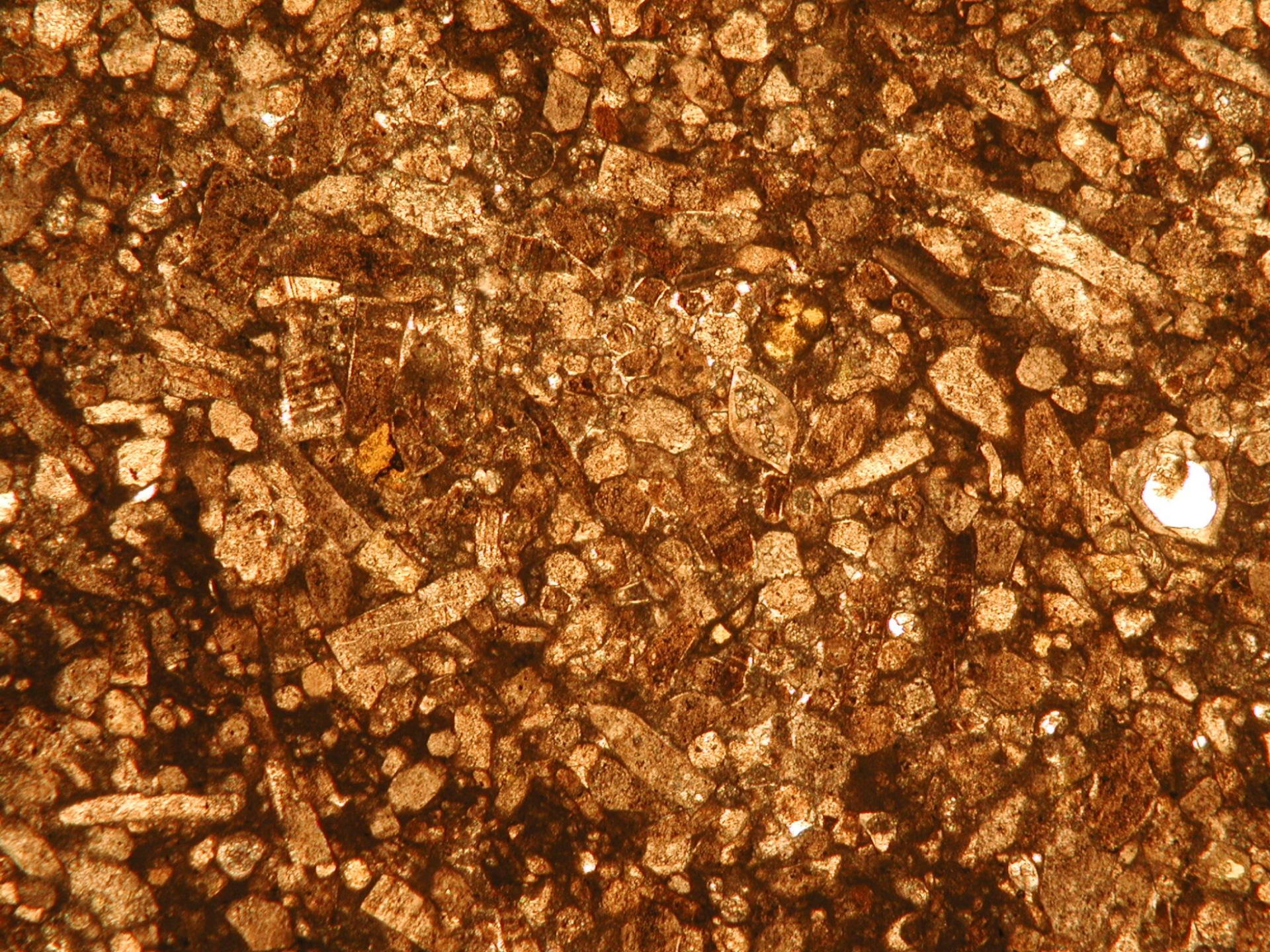


Figure 2.14 Cenomanian inoceramid bivalves. (A, B) Holotype of *Actinoceramus tenuis* (from Woods, 1911, text-fig. 31). (C) *Inoceramus crippsi* (from Woods, 1911, text-fig. 34). (D) *Inoceramus atlanticus* (from Woods, 1911, pl. 48, fig. 5). (E) *Inoceramus virgatus scalprum* (from Woods, 1911, pl. 49, fig. 3a) typical of the Lower Cenomanian 'Bank' of limestones. (F) *Inoceramus pictus* (from Woods, 1911, pl. 49, fig. 5) typical of the Plenus Marls Member and the basal few metres of the Melbourn Rock, Upper Cenomanian. (G) *Inoceramus atlanticus* (from Woods, 1911, pl. 49, fig. 1), typical of the Middle Cenomanian '*atlanticus*' flood. Scale bar applies to all specimens.



SAMPLE ORIGINS – unknown to us at the time of the analyses

- A solid chalk sample from a ditch at Blackdyke Farm, near to Lakenheath, Suffolk

  Analyses - Nannoplankton & Foraminifera

- Chalk samples from roadway known as Common Drove, near Lakenheath – the site where the bodies of Holly Wells and Jessica Chapman were found. Chalk from the Blackdyke Farm ditch had been used to "pave" Common Drove during 2001 & 2002

  Analyses - Nannoplankton & Foraminifera

Sample origins:

- Chalk/sand residue collected from the front suspension arm of the Ford fiesta driven by the suspect Ian Huntley

  Analyses - Nannoplankton & Foraminifera

- Several small fragments of sediment collected from the carpet in the drivers foot well of the Ford fiesta belonging to Ian Huntley

  Analyses - Nannoplankton only

- Several extremely small fragments of sediment collected from the vacuum cleaner used by Ian Huntley to clean the carpet in the drivers foot well of the Ford fiesta

  Analyses - Nannoplankton only

A - Common Drove

B - Pile of Chalk by road side

C - Ditch alongside Common Drove

D - Test Fiesta on chalk pile

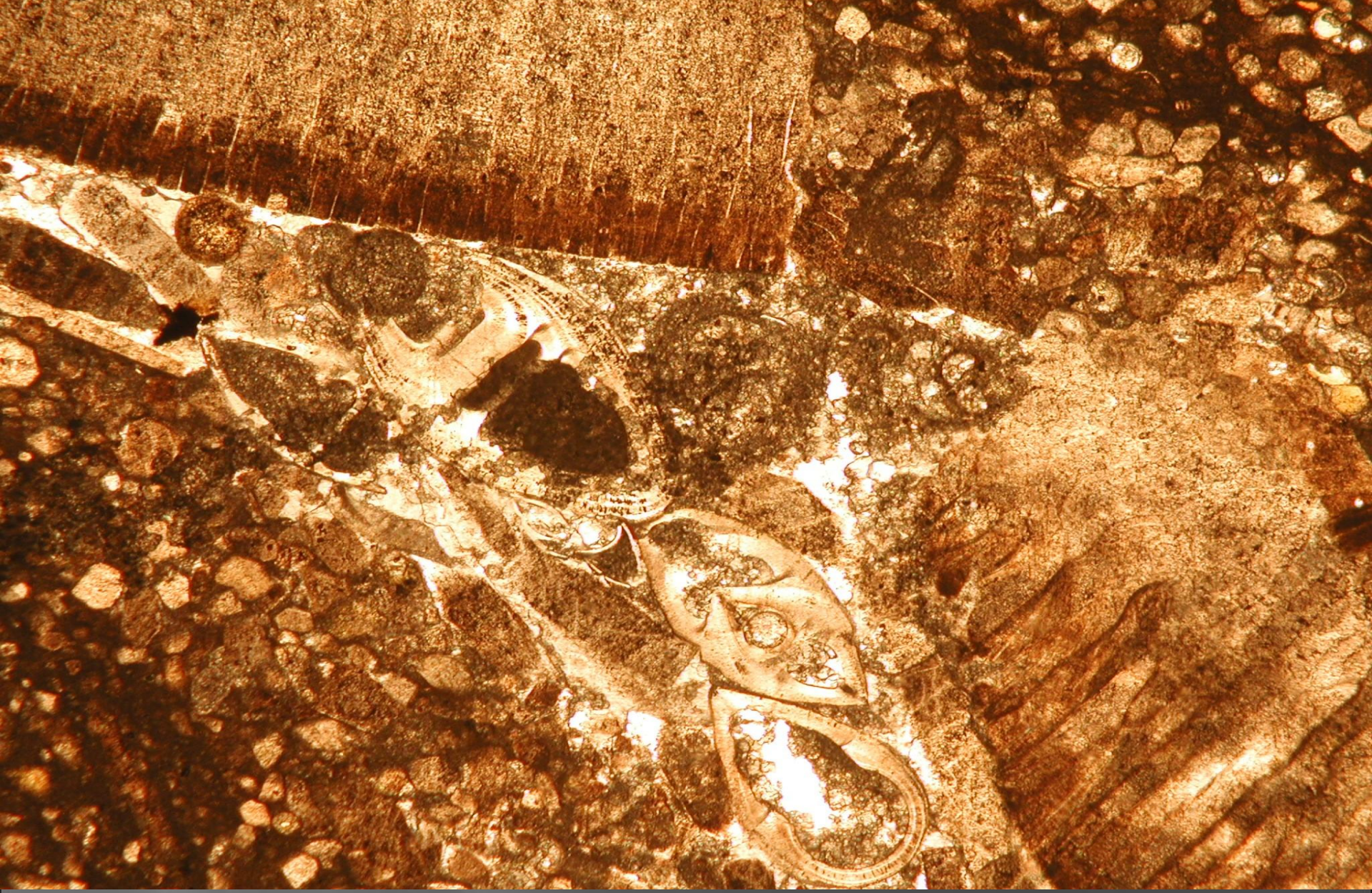
E - Chalk on Fiesta suspension arm

Fig. 2 - Common Drove:

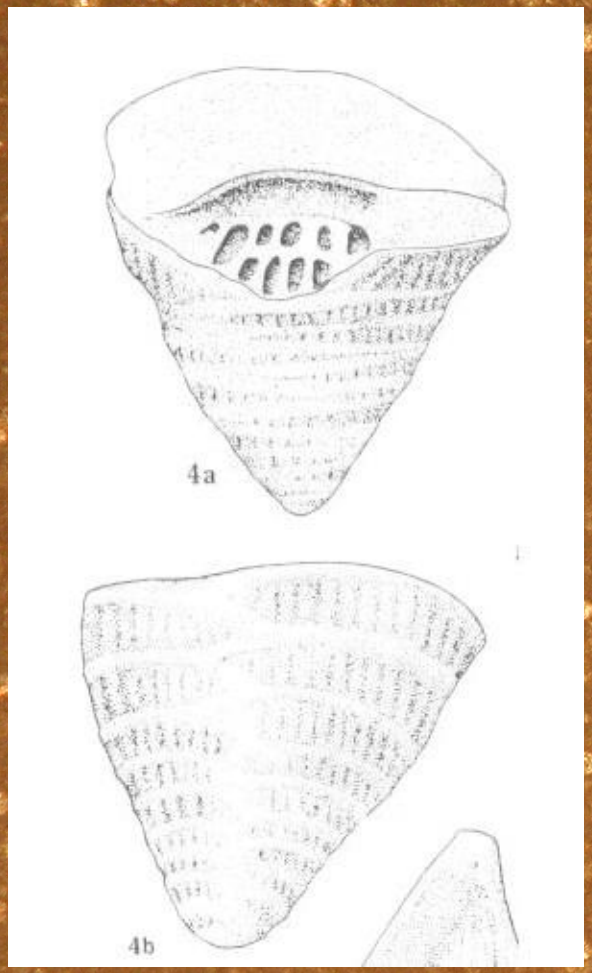
THE EVIDENCE

- All the samples examined, all the slides produced, both microfaunal and nannofloral, were taken by the police as exhibits. We retained nothing.

- All the case exhibits (which filled two warehouses during the investigation) to the best of our knowledge, have now been destroyed – except for thin section photographs and a few shots of the nannoplankton!

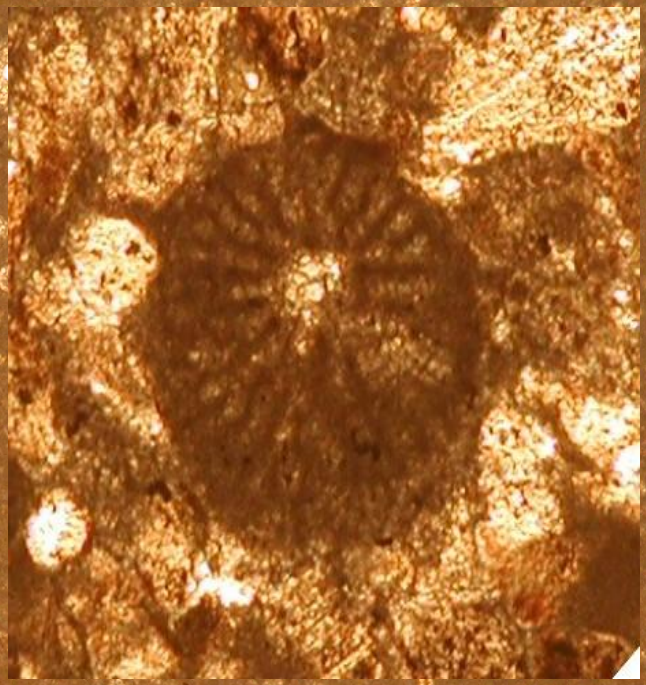


Typical inoceramid (bivalve) rich chalk from Soham samples, with benthonic foraminifera (*Lenticulina*)



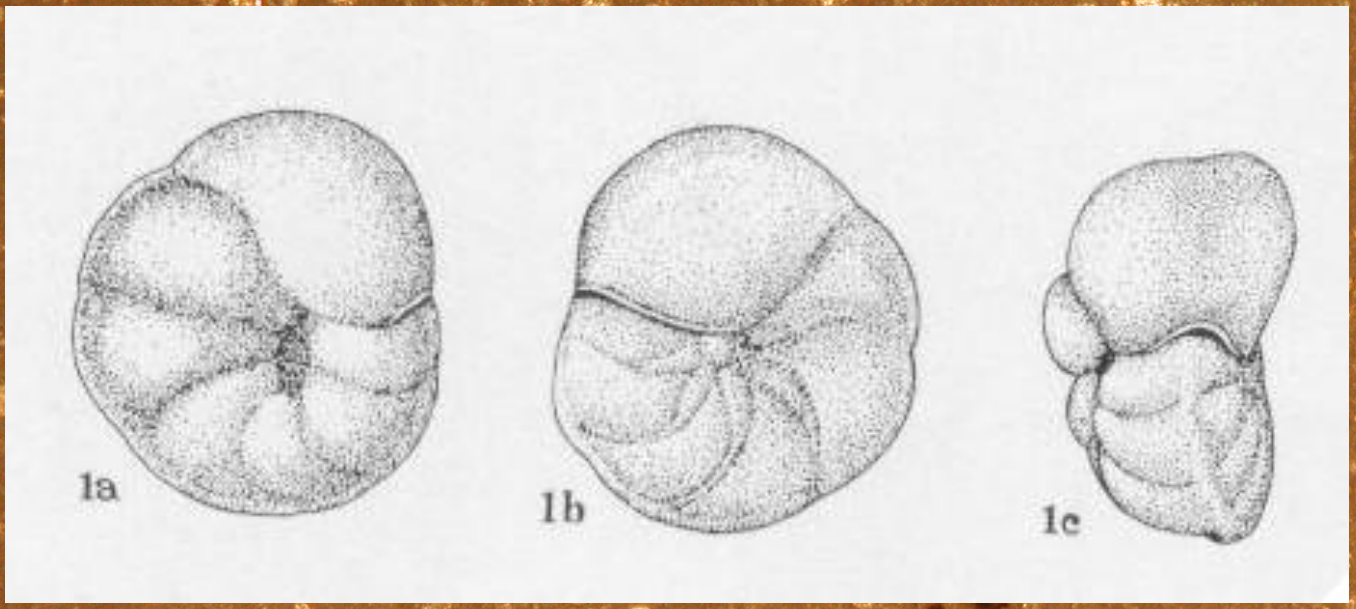
P. cretosa from Poland - Note internal cell structure

P. cretosa from southern England



P. cretosa from Soham samples Same internal cell structure

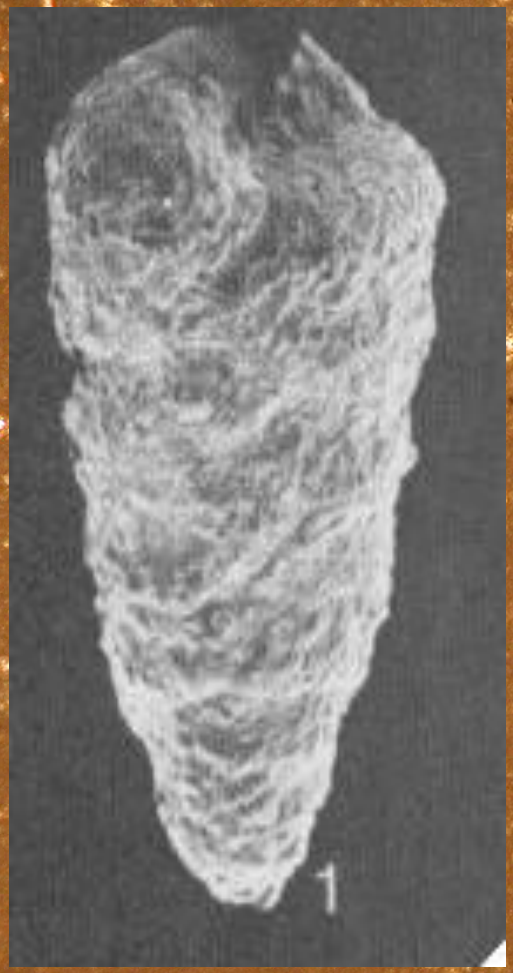
Pseudotextulariella cretosa



L. jarzevae – Poland

L. jarzevae from Soham

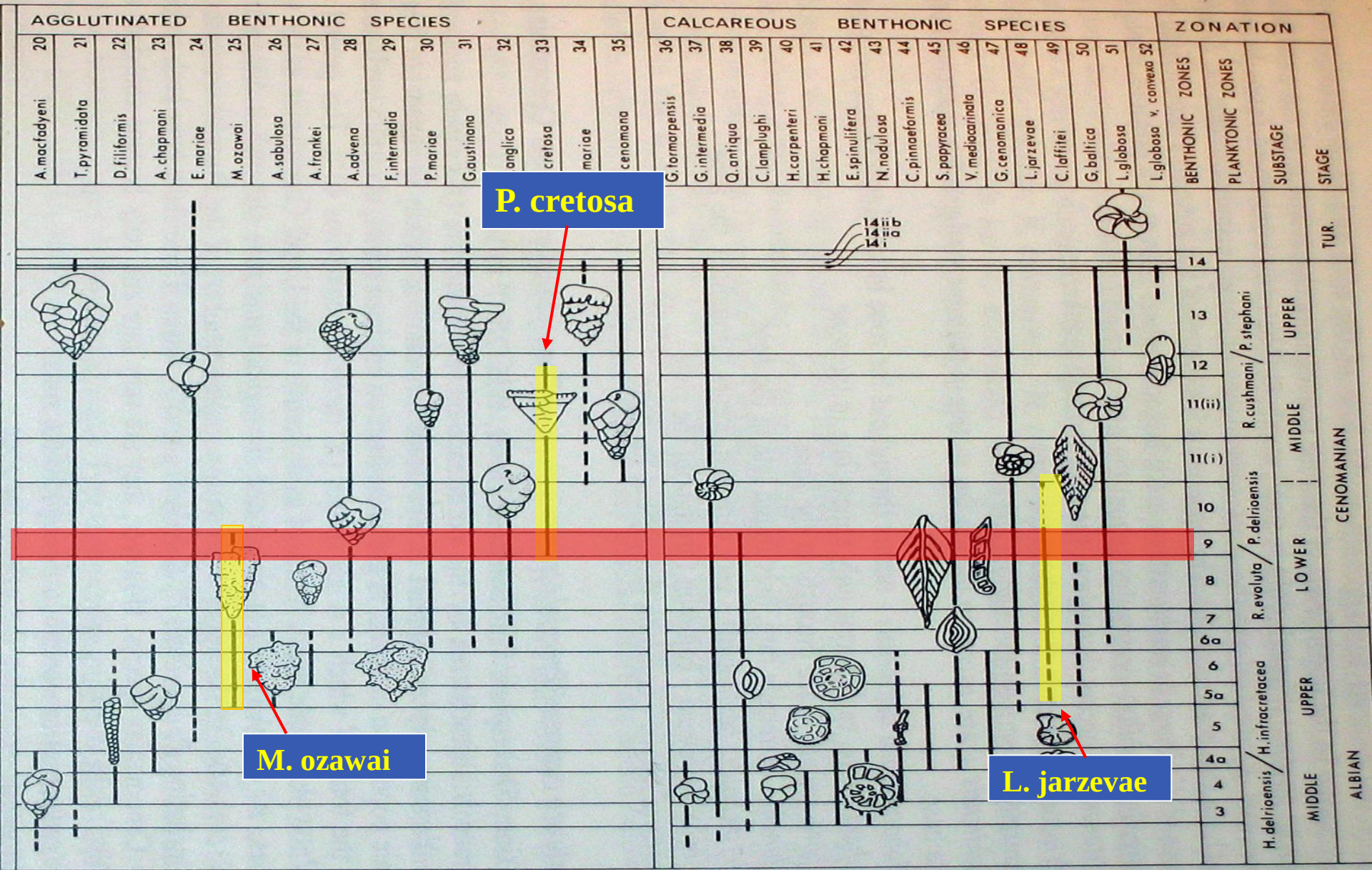
Lingulogavelinella jarzevae

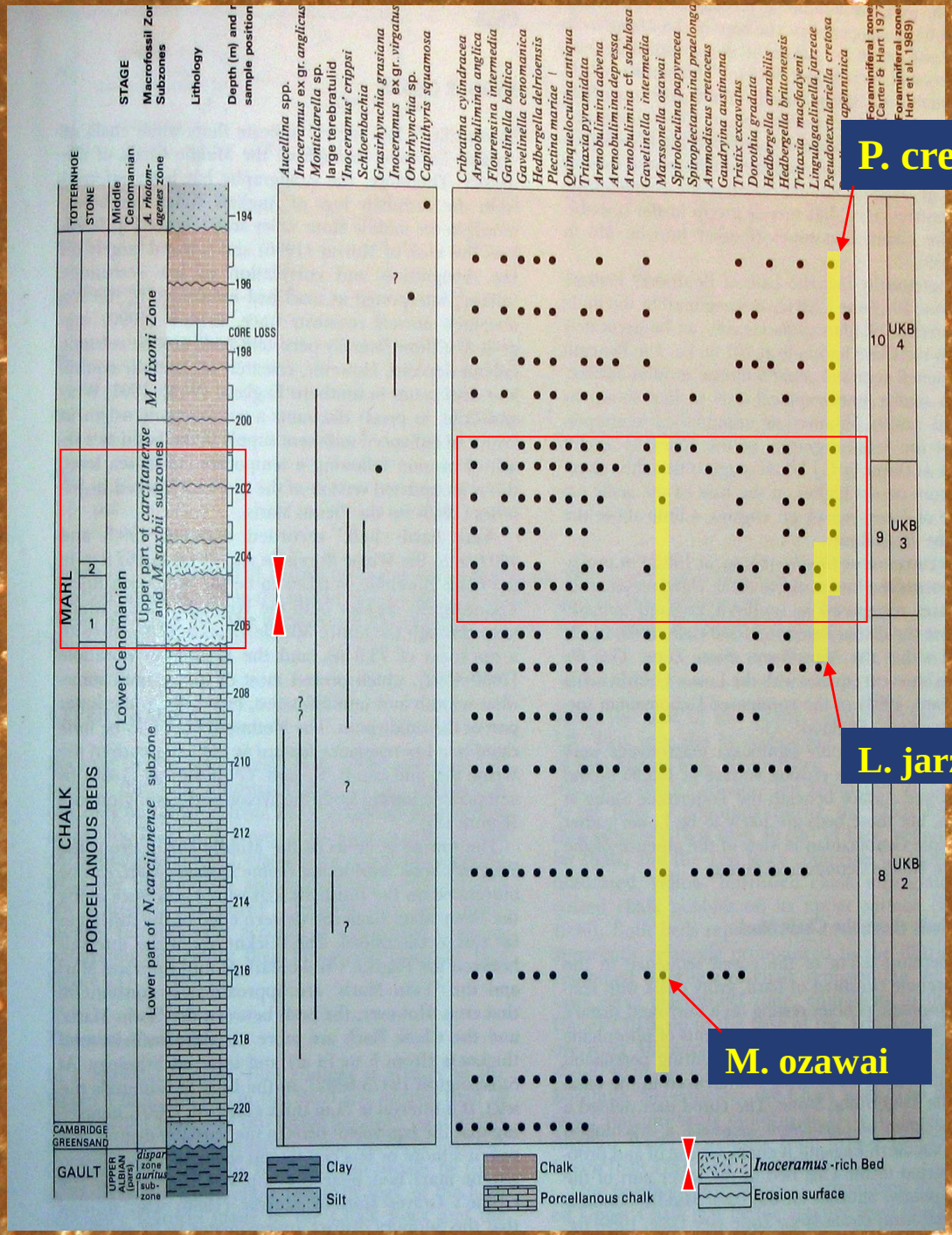


M. ozawai from southern England Hart & Carter, 1977

Marssonella ozawai

Zone of overlap for *P. cretosa*, *M. ozawai* and *L. jarzevae*




P. cretosa
L. jarzevae
M. ozawai
Foraminiferal distribution from the Clare borehole, Suffolk
38 kms to the south of the Common Drove site.
CHALK
PORCELLANOUS BEDS
MARL
TOTTERNHOE STONE
Middle Cenomanian
Lower Cenomanian
GAULT
CAMBRIDGE GREENSAND
STAGE
Macrofossil Zones Subzones
Lithology
Depth (m) and sample position
Upper part of carcitanense and M. saxbii subzones
M. dixoni Zone
Lower part of N. carcitanense subzone
A. rhotomagense zone
CORE LOSS
Clay
Silt
Chalk
Porcellanous chalk
Inoceramus-rich Bed
Erosion surface
UKB 4
UKB 3
UKB 2

The foraminiferal evidence pointed towards a single zone:

Zone 9 of Carter & Hart (1977)

Equating to Zone UKB3 of Hart *et al.* (1989)

Within the range of the upper part of the Lower Cenomanian *N. carcitanense* and *M. saxbii* ammonite subzones.

Equivalent to a 5 - 6 metre section in the Clare Borehole –

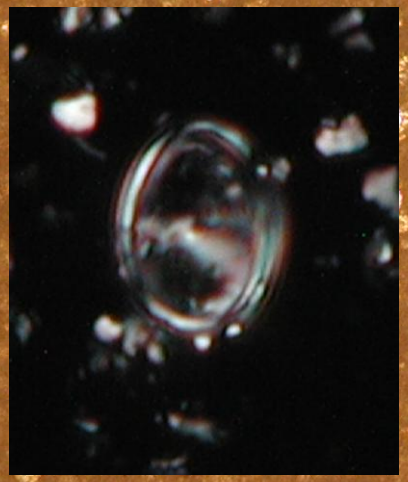
this could be reduced to c. 2m if the inoceramid rich beds are included.

Calcareous Nannofossils

A basic smear preparation was made for each sample

The original chalk sample from the ditch at Blackdyke Farm and the two samples from Common Drove contained directly comparable nannofloral assemblages:

Corollithion kennedyi



Gartnerago theta

Gartnerago nanum

Rhagodiscus achlyostaurion

Helicolithus anceps

Radiolithus planus

And so did chalk from the front suspension arm of the car.....

and the carpet of the drivers foot well.

CONCLUSIONS

- Foraminifera from Blackdyke Farm ditch, Common Drove and the front suspension arm of Ian Huntleys car were all from Zone UKB3, i.e. around the *carcitanense-saxbii* ammonite subzonal boundary & within the range of the two Lower Cenomanian inoceramid rich levels.

- Nannoplankton from the farm ditch, Common Drove road, the front suspension arm of the car and the carpet of the drivers foot well were from Subzone UC1d, i.e. also close to the *carcitanense-saxbii* ammonite subzonal boundary; a section of c.2.5m thickness.

- The Ford fiesta driven by Ian Huntley had to have been driven through chalk derived from nannoplankton Subzone UC1d.

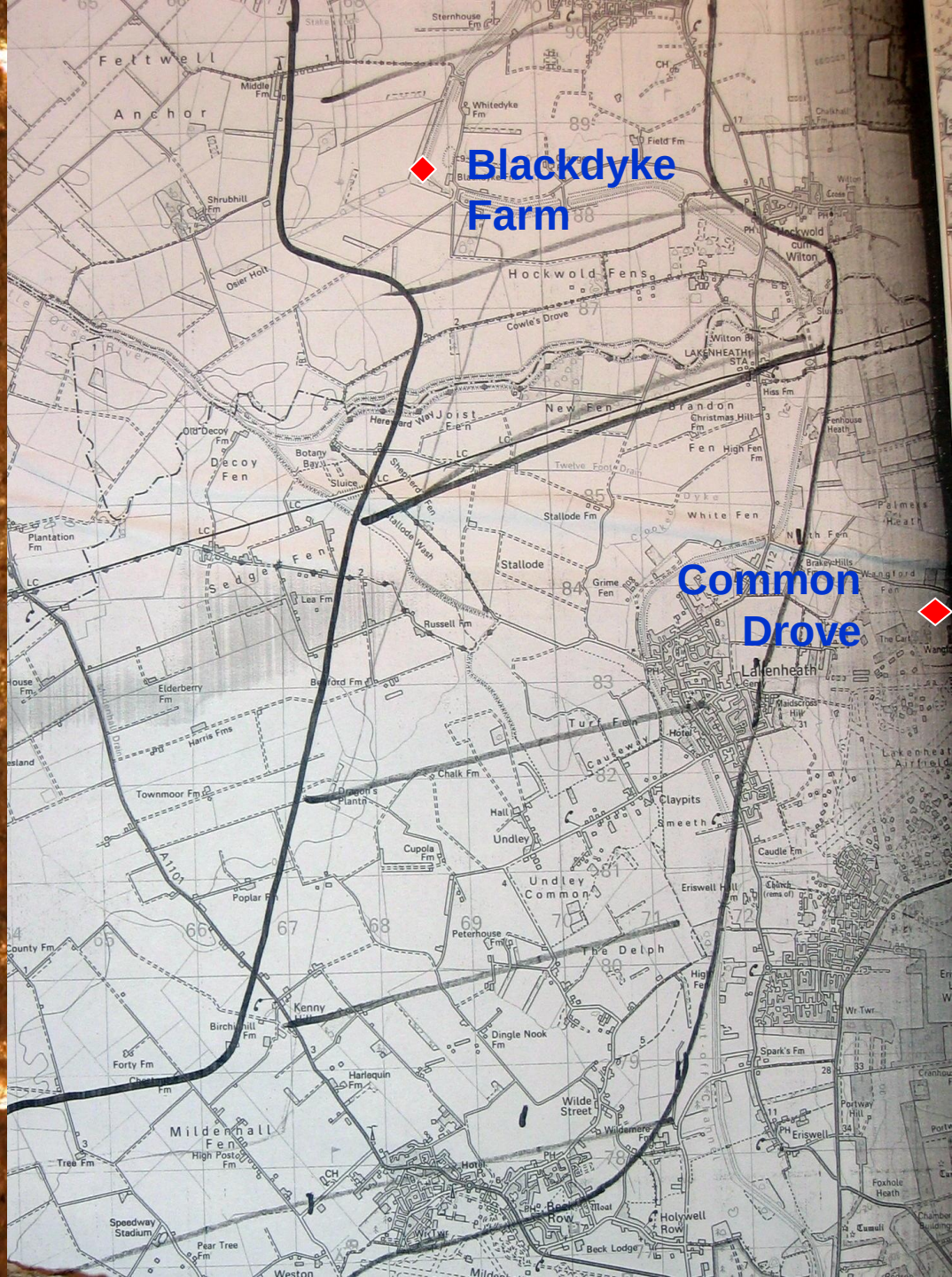
- This subzone subcrops only over a very narrow belt around Lakenheath. It does not outcrop anywhere in the area and is not exposed anywhere locally other than that used to “pave” Common Drove.

- Ian Huntley’s Ford fiesta must have been driven along Common Drove.

Further analyses:

- In order to rule out the possibility that similar results could be obtained from other unmade roads in the area, Chris Wood drew up a map of the ammonite subzonal subcrop and police were sent out to collect chalk from unmade roads up to a ½ mile to either side of the subcrop for analysis.

- These proved that the consistency of results seen from Common Drove could not be obtained from other sites.



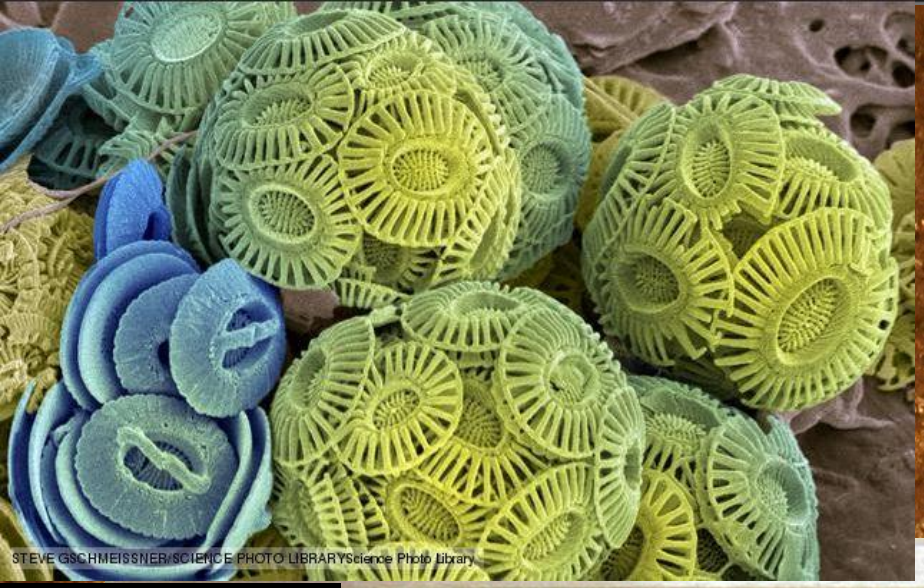
Further analyses:

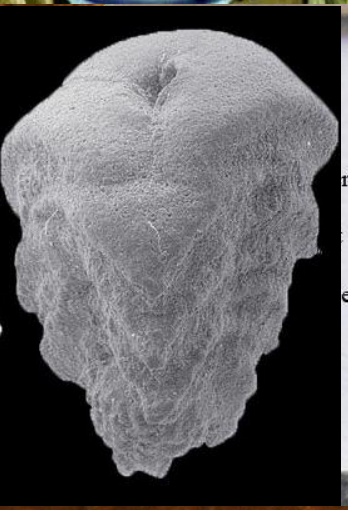
- A similar exercise was carried out with the police, under the guidance of Chris Wood, collecting the inoceramid rich beds at Hunstanton.

- Andrew Moncrieff had these & the Lakenheath samples thin sectioned & established sufficient variations in the mineralogy to prove that the samples from the car could not have originated from having been driven across “Northern” province chalks, e.g. Lincolnshire

Outcome

- Following submission of the full prosecution evidence to the defence team and detailed examination of it by the defence geological expert, the micropalaeontological evidence was accepted unchallenged – Drs. Bailey & Gallagher were subsequently stood down as witnesses.
- At this point, after discussion with his counsel, Ian Huntley made a series of admissions; one of which was that he had driven along the Common Drove during the period in question.
- Ian Huntley was later found guilty of the two murders and sentenced to a double life sentence. He will serve a minimum of 40 years in prison.





However, as Andrew Moncrieff said at the end of the Soham case – "when I commit my next murder, I'll make sure I don't bury the body on the Chalk!"

Thank you – any questions?