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Late Cretaceous development of the Atlantic Continental Margin off south-west England

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Analysis of the foraminiferal assemblages recovered from DSDP Sites 548-551 (Goban Spur), coupled, with the use of geophysical well-logs, has allowed a palaeoenvironmental analysis of the N Atlantic Continental Margin. The use of borehole material from various palaeodepths has confirmed the presence of late Cenomanian, Santonian and late Campanian "anoxic events". The late Cenomanian event affected all the Sites, together with the greater part of the NW European Continental Shelf. The Santonian and late Campanian events only affected the deepest Sites; the shelf successions being relatively unaffected.

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Introduction

In recent years the late Cretaceous oceans have attracted considerable attention from micropalaeontologists, sedimentologists and palaeoceanographers, especially those interested in the development of oxygen-depleted water masses. The concept of well-developed, and expanded, oxygen minimum zones (Schlanger and Jenkyns 1976; Schlanger *et al.* 1987; Arthur *et al.* 1987) at times in the late Cretaceous has now become well entrenched in the literature. Graciansky and Poag *et al.* (1985), Hart (1985, 1987) and Hart and Ball (1986) have drawn attention to the presence of anoxic(?)/dysaerobic sediments of late Cenomanian, Santonian (?) and late Campanian (?) age on the Goban Spur (Fig. 1), which was drilled by DSDP Leg 80 in 1981. Many of the models being developed by Jenkyns (1980), Hart and Ball (1986) and Jarvis *et al.* (1988) for oxygen depleted, stratified, water masses in the Cretaceous oceans require confirmation by use of suitable vertical profiles across continental margins. The northern edge of the Bay of Biscay, which rifted from the northern margin of the Iberian Peninsula in the earliest Cretaceous (Masson *et al.* 1985), preserves an appropriate series of borehole sections for such an analysis. As shown in Fig. 2, the four sites drilled by DSDP Leg 80 extend from almost true shelf environments (Site 548) to oceanic depths (Site 550/550B) by way of sediment starved mid-slope escarpments (Site 551). Detailed foraminiferal analyses (Ball 1985; Hart 1985, 1987a; Hart and Ball 1986; Leary and Hart 1988) have been published already, and recent work by one of us (AD) on the dinoflagellate assemblages have led to a detailed understanding of the late Cretaceous microfauna and microflora. Also available for Sites 548-550 are detailed geophysical well logs and some of these are shown in Fig. 3. Using these gamma ray logs (in conjunction with the caliper, sonic and resistivity logs) and the micro-palaeontological data it is possible to understand more fully the development of this continental margin as well as the palaeoceanographic history of this part of the North Atlantic Ocean.

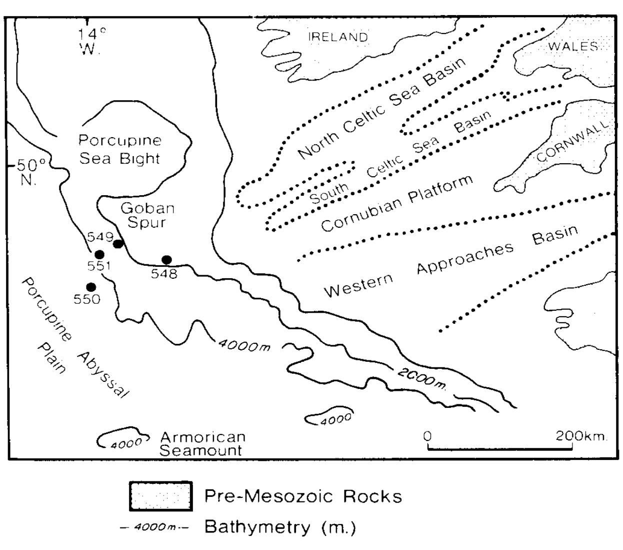

Figure 1. Locality map of DSDP Leg 80 Sites on the Goban Spur.

Geological history

The most dramatic of the "anoxic events" in the late Cretaceous is that in the latest Cenomanian (Jarvis *et al.* 1988 - and references therein). This appears to be of widespread occurrence (Funnell 1987; Hart and Leary 1989) throughout many continental areas and oceanic basins. It can be correlated across the N W European Continental Shelf by means of gamma ray logs (see Hart 1985, Fig. 3). The late Cenomanian event is present at Site 551, but was, unfortunately, not geophysically logged. At Site 549 it gives rise to a distinctive gamma ray signal and there is a strong possibility that the same event is responsible for the strong peak in the log for Site 550B (Core 154). The dark, organic-rich clays from this level in the core have not yielded unequivocal stratigraphic data. The fact that this synchronous (Hart and Leary 1989) event can be correlated from Sites 551, 549 and (?)550B all across southern England and the North Sea Basin shows how well-developed the late Cenomanian event was and how far it extended up into the water column.

Stratigraphically above this level at Site 550B is a succession of clay-rich sediments that contain very poor Coniacian(?) and Santonian foraminiferal assemblages. These are lacking most benthonic taxa and the planktonic foraminifera, when present, are badly preserved. This event is not recorded at Site 551, where an hiatus removed all record of this interval.

Site 549 may preserve a weak signal of this Coniacian/ Santonian event but elsewhere on the shelf there are no geophysical, geochemical or sedimentological indications of its existence. It is however recorded (Hart and Ball 1986, Figs 1 and 9) as having an affect on the evolution of the planktonic foraminifera.

At Site 551 (Hart 1985, 1987a; Hart and Ball 1986) there is also some evidence of a late Campanian event and this has also been reported from the US Atlantic Margin (Nyong and Olsson 1984;

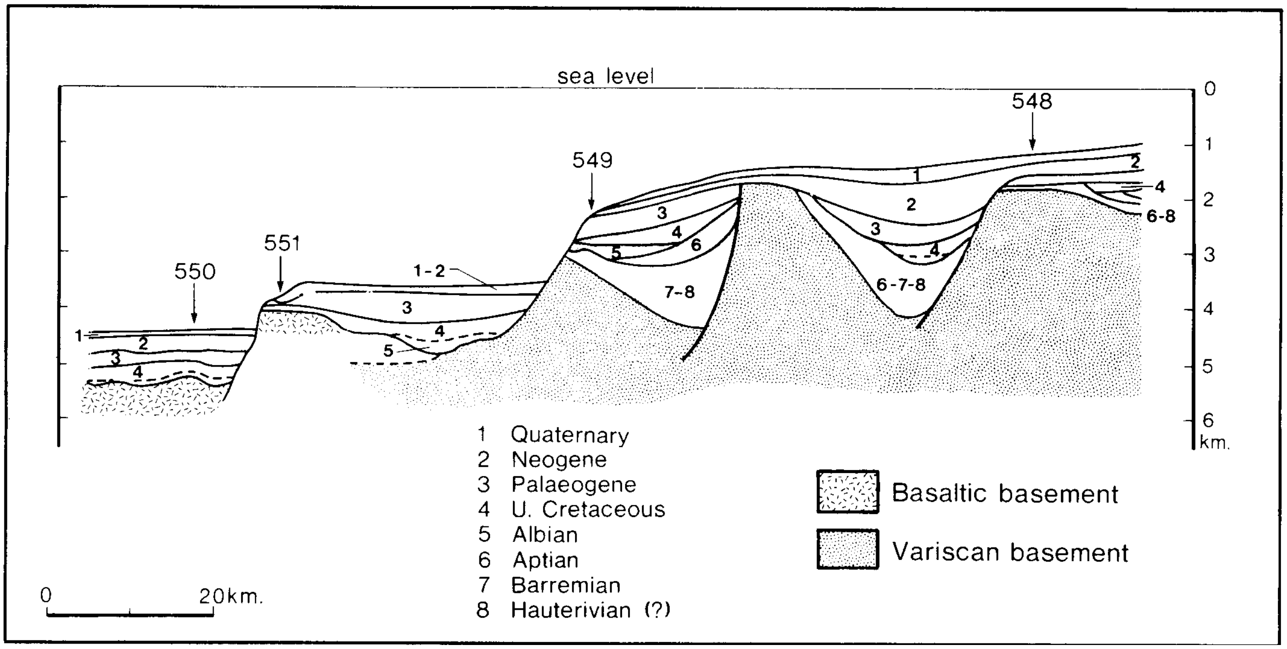

Figure 2. Schematic profile of the Goban Spur showing location of the drilled sites and the geological succession (taken from Hart 1985).

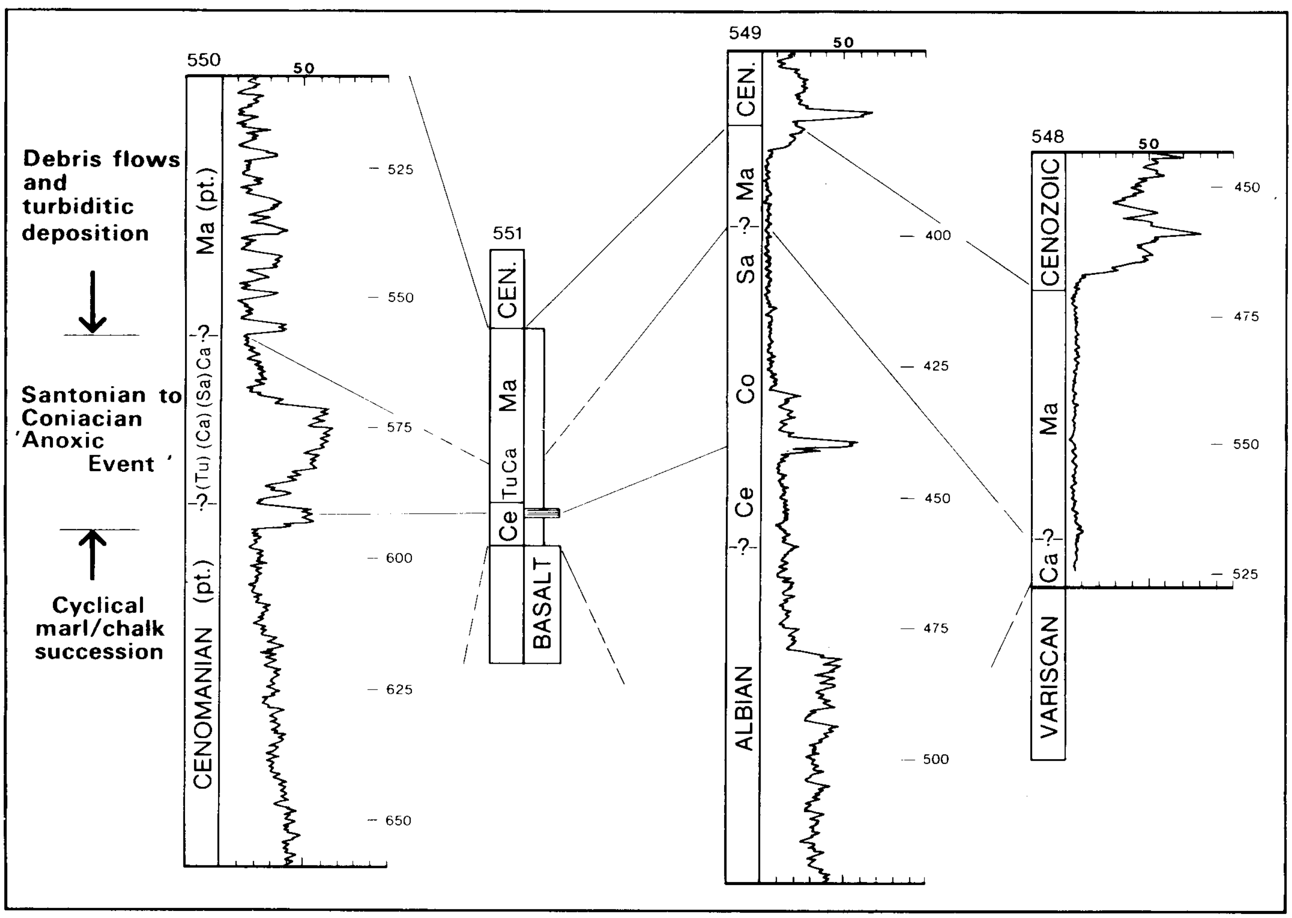

Figure 3. Gamma ray logs for DSDP Sites 548, 549 and 550B (Site 551 was not logged on the cruise) plotted against the outline chronostratigraphy. Borehole depths are recorded in metres. The highly condensed succession of Site 551 is shown in outline only; for details see Hart (1985, 1987a).

Olsson and Nyong 1984) and elsewhere in the USA (Gautier *pers comm.).* This event may just be giving a geophysical signal at Site 550B but it is not seen at Site 548, or anywhere else on the NW European Continental Shelf.

Investigations of the Goban Spur profiles also show up two other distinctive sedimentation styles, well away from possible "anoxic events". In the Cenomanian of Site 550B a distinctive chalk/marl periodite succession is recorded. Analysis of the cycle spacings (see Hart 1987b,c) gives two peaks at 30cm and 70cm which may, by comparison to the UK Lower Chalk succession represent the 23,500 and 41,500 year periodicities. A similar sequence is seen at Site 549 where the clay content is less well developed, and hence one obtains a slightly reduced gamma ray signal (see Fig. 3).

The Maastrichtian succession, which tends to blanket much of the area is also very informative. At Site 548 there is an almost pure chalk succession (very low gamma ray signal) with reasonably diverse and well-preserved foraminiferal fauna. The planktonic:benthonic ratio (Ball *pers comm.) is* above 70-75% throughout the succession. At Site 549 the fauna is almost identical and in the same proportions. Site 551 has a Maastrichtian fauna that is well over 80% planktonic with, in places, values of over 95%. At Site 550, in much deeper water, the preservation is poor to moderate, with only occasional samples recording well-preserved individuals. The levels in which preservation is moderate to good appear as chalks or marly chalks on the logs and show up as the peaks with low gamma ray values on the well logs (Fig. 3). Using the sonic logs in conjunction with the gamma ray log (as done in the North Sea by Hatton 1986) it is possible to recognise these more marly units as allochthonous. This conclusion was also reached by Gracianksy and Bourbon (1985) using sedimentological and geochemical data. It would appear that transport of coeval chalky sediment from the shelf edge into deeper water environments was commonplace at this time, and this may account for the rather thin Maastrichtian succession at Site 549.

Summary

The recognition of "anoxic events" of late Cenomanian, Santonian and late Campanian age in the Goban Spur successions and their relative strengths vis a *vis* their position in the water column is quite important. It allows us to test their effects on the global biota (Hart and Ball 1986; Hart and Swiecicki 1988; Hart and Leary *in press).* It is becoming quite clear that while such events may not show up sedimentologically at any locality they have exerted a great influence on foraminiferal evolution throughout the late Cretaceous.

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