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Magnetostratigraphy of the Lower Cretaceous Vectis Formation (Wealden Group) on the Isle of Wight, Southern England

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Abstract: Magnetostratigraphic results are described from two sections within the Lower Cretaceous Vectis Formation (formerly Wealden Shales) of the Isle of Wight, Southern England. The sections are located at Shepherd's Chine and Yaverland, respectively.

In both of these sections a reliably-established reverse polarity magnetozone, herein defined as the Vectis magnetozone, occurs within the Shepherd's Chine Member. This magnetozone has a thickness of some 15 m and its upper boundary is well defined in the Yaverland section but is obscured in the Shepherd's Chine Section due to cliff slumping. The lower boundary is well established in both sections and lies some 15 m above the Barnes High Sandstone Member in the Shepherd's Chine section and 12 m above this unit at Yaverland. This boundary provides a useful chron-stratigraphic datum.

A comparison with established geomagnetic polarity timescales for the Cretaceous indicates that the Vectis magnetozone may be correlated either with Lower Aptian reverse polarity Chron CM-0 or with Lower Barremian Chron CM-1, with the former being the more likely. An important implication of this interpretation is that the base of the Aptian stage, as defined from Tethyan foraminiferal zones, must lie within the Vectis Formation, at least 25–30 m beneath the top of the Shepherd's Chine Member, rather than at the top of this member as hitherto commonly accepted.

Beds characterized by anomalously high intensities of magnetization, which occur at the base of the Vectis Formation and a few metres above the Barnes High Sandstone in the two sections, are tentatively interpreted as having a volcanogenic origin.

The mean stable palaeomagnetic vector (after inversion of reverse polarity vectors) defined in this study has a declination of 355° and an inclination of 39°. This inclination value is substantially shallower than that predicted for this locality from palaeomagnetic studies of other Western European Cretaceous formations and from plate tectonic reconstructions. This suggests the possible presence of a significant palaeomagnetic inclination error of some 10° to 20° in these sediments, possibly due to depositional or compactional processes. The presence of such an inclination error does not affect the validity of the magnetic polarity determination at these high palaeolatitudes. However the corresponding palaeomagnetic pole position, located at 61°N, 171.5°W, is likely to be unreliable for plate motion studies.

The magnetostratigraphic study described in this paper was undertaken to establish the stratigraphic extent of a reverse polarity magnetozone, previously recognized in the Vectis Formation (Wealden Shales) of the Isle of Wight by Hailwood *et al.* (1982). The identification of this distinctive reverse zone within an otherwise normal polarity section, and the precise locating of its lower and upper boundaries, offer potential for establishing a more exact correlation of different sections within the terrestrial Wealden deposits of Southern England and of these sections with the marine sections of Yorkshire, NW Germany and the Tethyan realm. Furthermore, a correlation of this distinctive magnetozone with the appropriate part of the geomagnetic polarity timescale provides an important new constraint on the possible position of the Barremian/Aptian stage boundary in the southern UK.

A further aim of the work was to attempt to determine a reliable palaeomagnetic pole position for the Lower Cretaceous of Southern England, since few palaeomagnetic data exist for the Lower Cretaceous of NW Europe. A previous palaeomagnetic study of the Wealden sediments of the Isle of Wight was carried out by Wilson (1959), who recognized a strong viscous magnetization component in these sediments. The presence of this component limits the utility of Wilson's palaeomagnetic data for plate-tectonic reconstructions. In the present study comprehensive alternating field (a.f.) demagnetization analyses were carried out on all samples, in order to assess the importance of such viscous magnetizations in these sediments. This treatment has allowed the successful separation of viscous components from the geologically-significant components of characteristic remanent magnetization. Although the results are believed to provide a meaningful Lower Cretaceous magnetostratigraphy, their reliability for plate motion studies is limited by the suspected presence of a palaeomagnetic 'inclination error' in the stable magnetization vectors.

Geology and local stratigraphy

On the Isle of Wight, sediments of the Lower Cretaceous Wealden Group are exposed in two main outcrops south of the axis of the Isle of Wight monocline, located in the south westerly and south easterly parts of the island, respectively (Fig. 1). At these outcrops, the uppermost 220 m of the more than 600 m total thickness of Wealden sediments

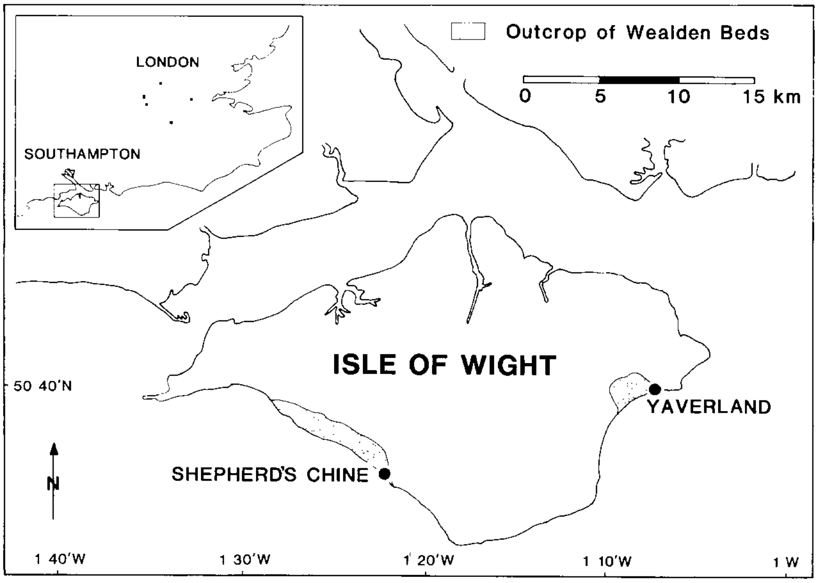

Fig. 1. The outcrop of the Wealden beds on the Isle of Wight and the location of the palaeomagnetic sampling sites.

found in the Arreton borehole (Falcon & Kent 1960) is exposed (Fig. 2).

The stratigraphic nomenclature for these sediments recently has been revised by Stewart (1978*b*) and Daley & Stewart (1979). The terminology of these authors is adopted in the present paper. The lower 170 m of the exposed sections comprises a sequence of fluvial origin, the Wessex Formation (formerly the Wealden Marls). This is overlain by the Vectis Formation (formerly the Wealden Shales) which comprises 50–60 m of sediments deposited in an environnment of increasing marine influence (White 1921; Daley & Stewart 1979: Melville & Freshney 1982). On top of the Vectis Formation lies the Perna Bed, which is commonly taken to mark the onset of the important marine transgression which heralded the start of the Aptian stage (e.g. Rawson *et al.* 1978; Simpson 1985).

A detailed lithological sub-division of the Wealden sediments on the Isle of Wight has been proposed by Daley & Stewart (1979) and Stewart (1981, 1983). However, biostratigraphic correlation of these sediments with the marine Lower Cretaceous of the Yorkshire Basin and NW Germany is still uncertain (Rawson *et al.* 1978). Hughes (1958), on the basis of a palynological study, dated the sediments of the Wessex Formation along the coast as Barremian and Anderson (1967) proposed that the sediments of the Vectis Formation belong to the *Cypridea valdensis* ostracod zone of presumed Upper Barremian age. The Perna Bed and the overlying Atherfield Clay have been biostratigraphically correlated with the standard Aptian ammonite zones of Casey (1961). A detailed stratigraphical study of the Atherfield Clay has been carried out by Simpson (1985). The lowest Aptian ammonite zone recognized is the *fissicostatus* zone, which corresponds, at least in part, with the *bodei* zone of NW Germany (Rawson *et al.* 1978).

Two sections in the Vectis Formation of the Isle of Wight have been sampled for the present palaeomagnetic study, one extending from Shepherd's Chine to Atherfield Point on the south-west coast (National Grid (NG) reference SZ 446798, 451790), and the other from Yaverland sea wall to Red Cliff on the south-east coast (NG reference SZ 622853, 613851) (see Fig. 1). Both sections, which are described in detail by White (1921), show a similar stratigraphic sequence with a total thickness of between 50 and 60 m. The third major section through the Wealden beds in this area, the Compton Chine section, was not sampled for the present study because large parts of it were obscured by cliff slumping at the time of the field work.

The lower part of the Vectis Formation at Shepherd's Chine comprises a sequence of clays and sandy clays with a thickness of 10–12 m, which is termed the Cowleaze Chine Member by Daley & Stewart (1979). On top of this member occurs a sandstone unit, the Barnes High Sandstone Member. This unit is between 2 and 3 m thick and has been interpreted by these authors as representing the deposits of a mouth-bar distributary which entered a quiet lagoonal area. The overlying Shepherd's Chine Member comprises all of.the Vectis Formation from the top of this sandstone unit to the base of the Perna Bed. This member consists of fining-upward cycles of sands, silts and clays, which are believed to have formed in a quiet lagoon with episodic river influence (Daley & Stewart 1979). Within the Shepherd's Chine Member hard calcareous beds, rich in fossil detritus, occur. These beds are the Cyrena, Oyster and Beef Beds of White (1921). In the present study, only the Cyrena Bed could clearly be identified in the Yaverland section.

Abundant throughout the two sections are fossils indicating a freshwater environment, such as *Unio* and *Cypridea*, and a freshwater fish fauna. However, the presence of *Ophiomorpha* burrows inidicates a marine influence (Stewart 1978*a*). Towards the top of the sections Ostrea and other brackish to marine organisms become more frequent.

In the Shepherd's Chine section the beds dip at 2° to 5° to the south-east, while in the Yaverland section they generally dip to the north at about 7° in the southern part,

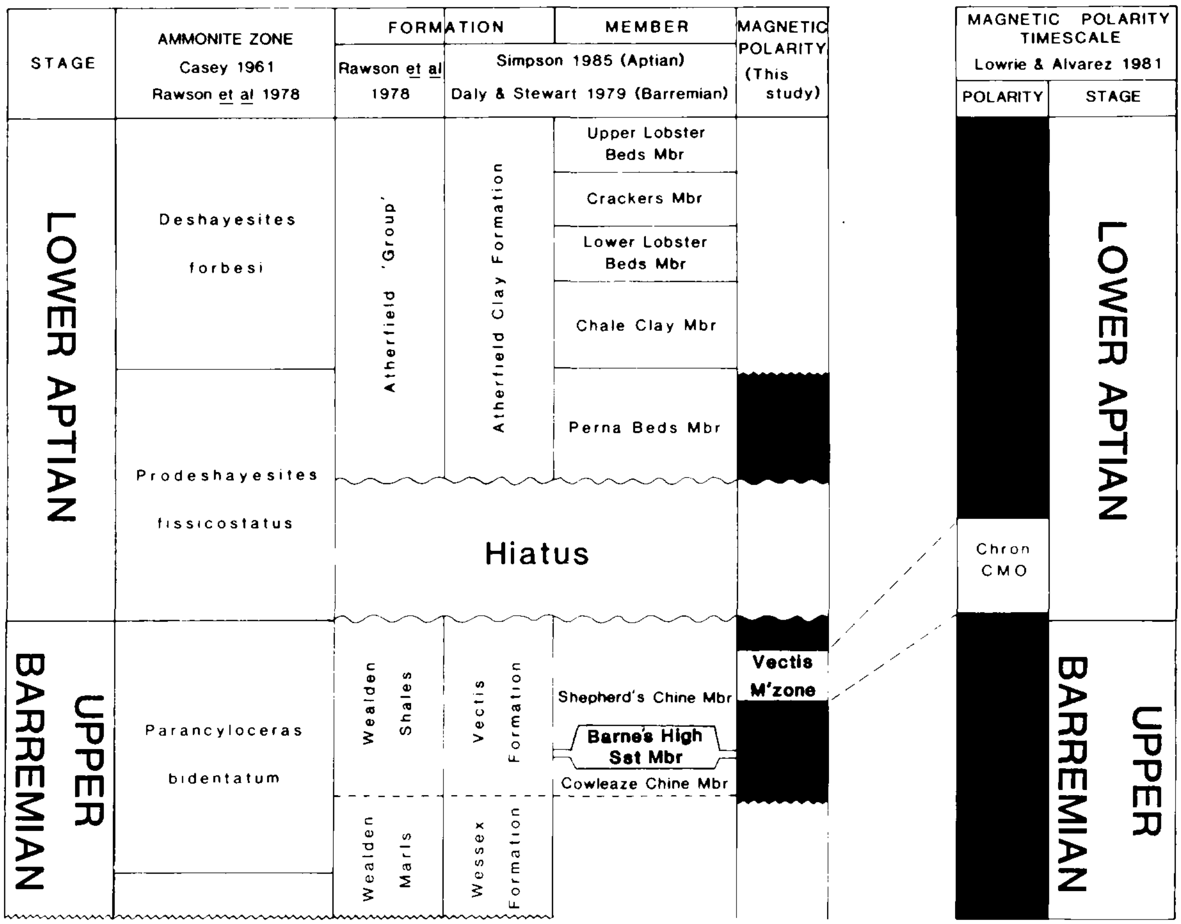

Fig. 2. Stratigraphic subdivisions of the Upper Barremian and Lower Aptian on the Isle of Wight. Polarity stratigraphy from the present study is shown, together with the proposed correlation with the Magnetic Polarity Timescale of Lowrie & Alvarez (1981) (right-hand side).

and at about 22° in the northern part of the section. Landslides frequently occur at both localities, so that parts of the section, particularly the upper part of the Shepherd's Chine section, were not exposed at the time of sampling.

Method

At each sampling level at least two separately orientated samples were taken, the stratigraphic separation of sampling levels averaging 1.5 to 2.5 m. Shales were sampled by insertion of 25 mm diameter copper tubes using light hammer blows. The copper tubes were then orientated by means of a specially constructed orientation table which incorporates a magnetic compass and clinometer. In the laboratory, the samples within the copper tubes were extruded and cylindrical specimens, normally 25 mm in length, were cut from the cores. The specimens were then wrapped in cellophane film. The Barnes High Sandstone and the Perna Bed were hand-sampled and 25 mm cores were drilled from the hand samples in the laboratory. In the Shepherd's Chine Section 48 samples were taken from 23 stratigraphic levels and in the Yaverland section 70 samples from 31 levels.

The natural remanent magnetization (NRM) of the specimens was measured with a Molspin spinner magnetometer based on the design described by Molyneux (1971). To check the reliability of the determinations triplicate measurements of the magnetization were carried out regularly and the 95% confidence limit (α_{95}) of the mean direction was calculated (Fisher 1953). Ater a time span of 2–6 weeks the NRM was re-measured to check on the possible acquistion of components of viscous remanent magnetization in the laboratory.

Two specimens from each sampling level were then subjected to stepwise alternating field (a.f.) demagnetization in peak applied fields up to 35 milliTesla (mT) using increments of 5 mT. The demagnetization behaviour of each specimen was analysed by means of 'vector end point' diagrams (As 1960; Dunlop 1979) (see Fig. 4). The behaviour of most specimens was consistent with the progressive removal of a low stability component of viscous magnetization during demagnetization. When such low-stability components had been completely removed the magnetization vector reached a 'stable end point'. The latter was identified from a linear trend of the points on the vector diagrams towards the origin, accompanied by Palaeomagnetic Stability Index (PSI) values (Symons & Stupavsky 1974) ≤ 200. Further details of the procedure adopted for the identification of stable end points in the present study are given by Kerth (1984).

Some reversely magnetized specimens did not attain a demagnetization stable end point, but the directions of remanent magnetism after successive demagnetization steps were distributed along great circles when plotted on a stereographic projection. Since such great circle (planar) trends result from the step-by-step removal of a component with low coercivity (i.e. low magnetic stability) from a component of higher coercivity, the common point of intersection of the set of great circles from a number of such samples defines the direction (and polarity) of the higher coercivity component (Creer 1962; Halls 1976, 1977).

Isothermal remanence (IRM) acquisition experiments were carried out on eight specimens from each section using applied field increments of 0.05 T, up to a maximum field of 0.6 T. The susceptibility of all specimens was measured with a Highmoor susceptibility bridge, and the susceptibility anisotropy of 23 specimens from the Shepherd's Chine section (one from each sampling level) was measured with a low field torque magnetometer.

Results

The NRM intensities of the majority of the specimens lie in the range 0.1–10 milliAmperes per metre (mA m^{-1}) and the values show a logarithmic Gaussian distribution with a median value of about 1 mA m^{-1}. A few samples have significantly higher intensities, in the range 10–100 mA m^{-1} and clearly these do not belong to the same simple Gaussian population (Fig. 3). This suggests that their magnetomineralogical composition may be different from that of the other, lower intensity, samples. During triplicate measurements the more weakly magnetic specimens often showed a decay of intensity by up to 20% of the initial value, within the magnetically-shielded sense region of the magnetometer. In both sections a conspicuous NRM intensity peak occurs 4–8 m above the top of the Barnes High Sandstone (see Fig. 10). A further peak occurs at the base of the Yaverland section and smaller, less-distinct intensity peaks occur at a number of other stratigraphic levels in the two sections.

After storage in the laboratory for several weeks, most specimens acquired a viscous remanent magnetization (VRM), indicated by changes both of the intensity (up to 50%) and the direction (up to 20°) of the remanence vectors.

Responses of representative samples to a.f. demagnetization are illustrated in Fig. 4. Figure 4a shows the

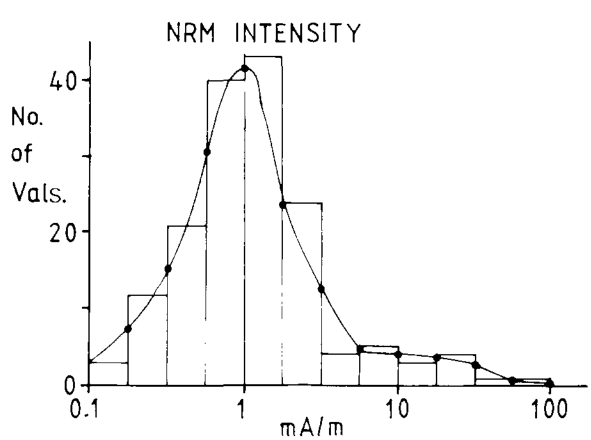

Fig. 3. Distribution of NRM intensities of all specimens measured.

behaviour characteristic of a high proportion of the normal polarity samples. Small directional changes during the first few demagnetization steps are consistent with the removal of a viscous component aligned approximately along the present field direction. At high demagnetization levels the points on the vector plot generally show a simple linear decay towards the origin, indicating the successful identification of a demagnetization stable end point (SEP). In weaker samples this linear trend is partially obscured by instrumental noise, but in the majority of cases an acceptable SEP is defined. Figure 4b is representative of many of the reverse polarity samples. The removal of a downward-directed (normal polarity) viscous component during the first few demagnetization steps is often accompanied by a small increase in resultant intensity, as the antiparallel reverse polarity vector is progressively isolated. Sample YL 27/2B (Fig. 4b) exhibits a reasonably well-defined SEP, whilst sample SC36/2A (Fig. 4c) shows a directional change along a great circle trend on the stereographic projection without reaching a SEP. Figures 5a and b show the sets of great circle trends identified in samples from the Shepherd's Chine and Yaverland section, respectively, displaying this type of behaviour. For both sections the great circles show a concentration of intersections in the vicinity of a southerly upward-directed end-point, as would be expected for a reverse polarity characteristic magnetization.

In Fig. 6a the demagnetization behaviour of one of the distinctive high-intensity shale specimens is illustrated on a vector plot. In contrast to the other shale specimens (e.g. YL 30/1A in Fig. 4a), the high intensity specimens show a more continuous decrease of intensity and a higher directional stability of the remanence vector. The Barnes High Sandstone Specimen (Fig. 6b) and the Perna Bed specimens could not be readily a.f. demagnetized.

During IRM acquisition experiments, most shale specimens acquired a saturation magnetization in fields of between 0.1 and 0.3 T with saturation magnetization values between 100 and 400 mA m^{-1} (Figs 7a & b). Nevertheless, a few specimens seem to carry a high coercivity component which does not saturate in the maximum field applied. Specimens from levels SC 25, YL 1 and YL 13, which have anomalously high NRM intensity values, also show very high saturation magnetizations of about 1–4 A m^{-1}. Saturation in these specimens is attained in fields of about 0.2 T (Fig. 7c). The specimens from the Barnes High Sandstone and the Perna Bed do not reach saturation in the maximum field applied, but show a very strong initial increase in fields below 0.3 T (Fig. 7d). The volume susceptibility values of the specimens range from 0.5 to 7.2 SI units. The directions of the minimum susceptibility axes of the 23 specimens measured from the Shepherd's Chine section show a close grouping near to the vertical with only a few values having inclinations less than 70° (Fig. 8).

Interpretation of results

1. *Magnetic intensities and carriers of remanence*

Both the a.f. demagnetization behaviour and the IRM acquisition curves of the shale specimens indicate magnetite as the main carrier of the remanent magnetization, with a significant proportion of very low coercivity, most likely

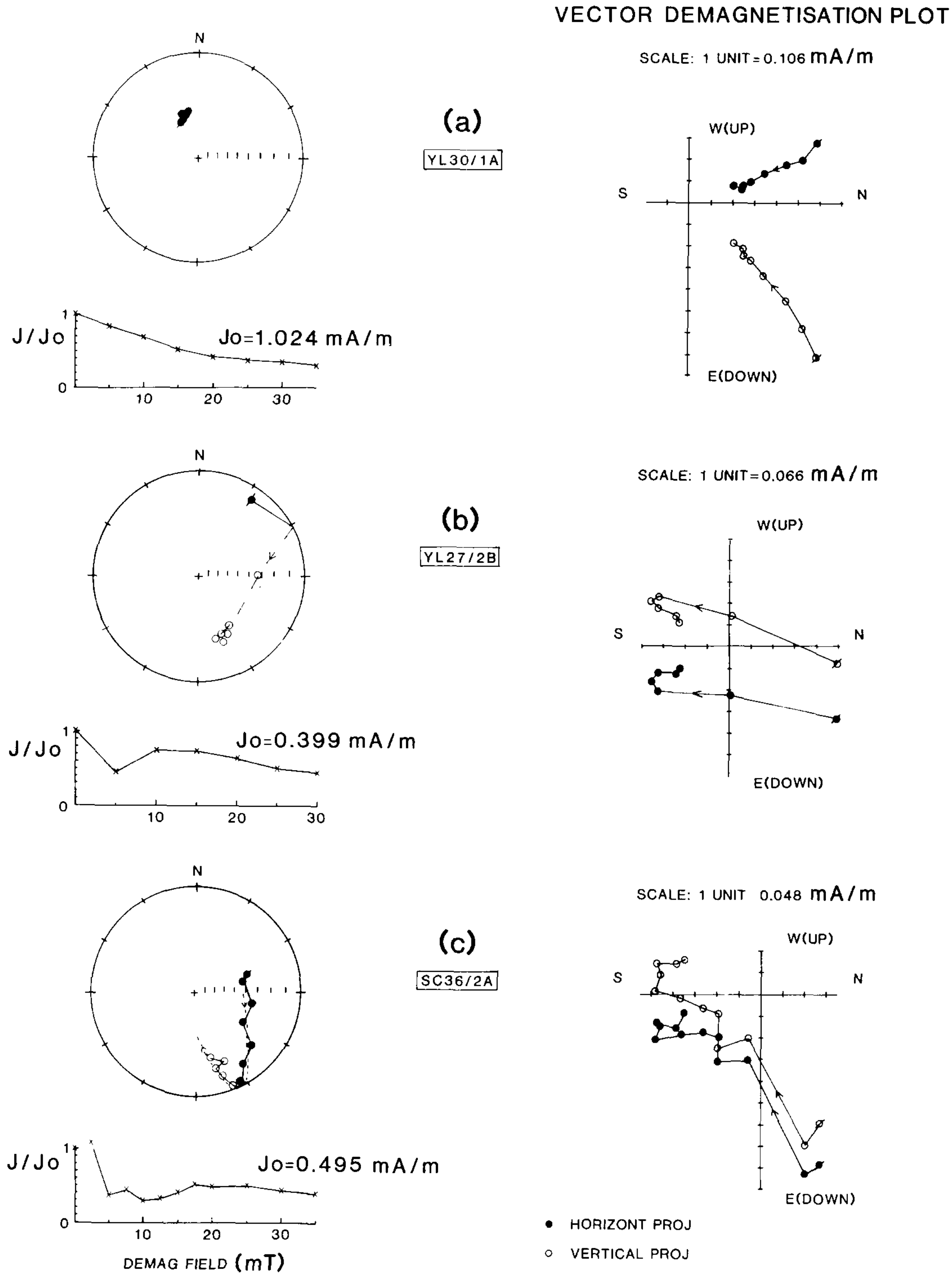

Fig. 4. Representative examples of responses to alternating field demagnetization. (**a**) Normal polarity specimens from the Yaverland section displaying a clearly-defined demagnetization stable end point. (**b**) Reverse polarity specimen from the Yaverland section. After removal of a normal polarity overprint in a 15 mT applied field a reverse polarity stable end point is reached. (**c**) Reverse polarity specimen from the Shepherd's Chine section. Removal of a normal polarity overprint results in a progressive directional change along a great circle trend (indicated by dashed line on stereographic projection) towards a reverse polarity vector, but a stable end point is not reached. On the stereographic projections shown at the left-hand side, closed circles represent points in the lower hemisphere (positive inclinations) and open circles points in the upper hemisphere (negative inclinations). J/J_0 in the intensity of the remanent magnetism after each demagnetization step, normalized by the NRM intensity (J_0). For explanation of Vector End Point diagrams shown at the right, see Dunlop (1979). On these diagrams and on the stereographic projections the NRM direction is indicated by a symbol with a slash.

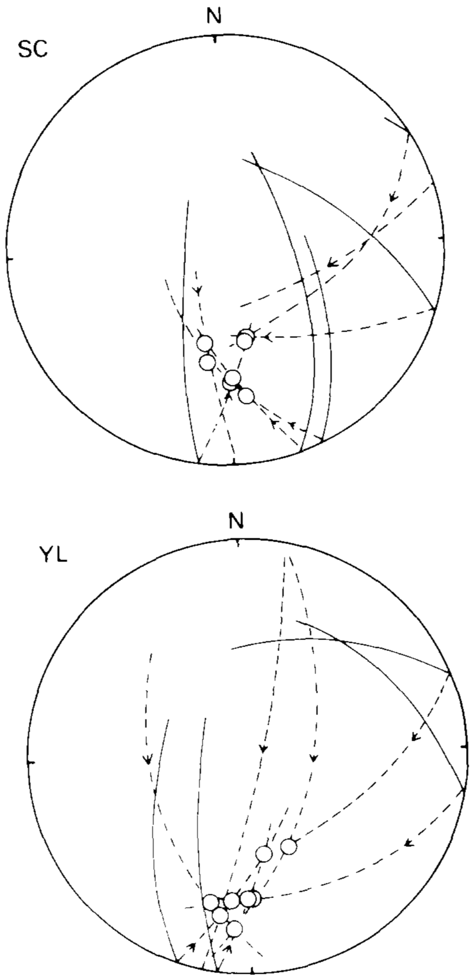

Fig. 5. Great circles defined by demagnetization trends of reversely magnetized specimens from the Shepherd's Chine and Yaverland sections, respectively. Intersections of great circles in the upper hemisphere of the stereographic projection are shown as open circles (after application of bedding correction).

multidomain, grains being present. Nevertheless, some high coercivity magnetic constituent (goethite or hematite) is present in many of the shale specimens, especially those from levels SC 23, YL 8 and YL 10, as evidenced by the lack of saturation on the IRM curves (Fig. 7). For the latter two specimens this may be due to their proximity to the Barnes High Sandstone, which according to the a.f. demagnetization and the IRM-acquistion data, contains both magnetite and hematite (or goethite). Presumably the shales above and below the sandstone layer were deposited in a more oxidizing environment than the other shales, as would be expected during sedimentation of the coarser-grained sandstone. This would lead to an increase in Fe(III) oxides. The Perna Bed specimens in the Shepherd's Chine section show a behaviour similar to that of the Barnes High Sandstone specimens although the IRM curves suggest that a smaller proportion of high coercivity material is present (Fig. 7d).

The main carrier of magnetization in the high intensity specimens SC 25, YL 1 and YL 13 is believed to be titanomagnetite. However the very high NRM and IRM saturation intensities, together with the distinct demagnetization behaviour of these specimens, suggests a titanomagnetite grain size and composition which is different from that of the other shale specimens. Beds characterized by such strong magnetic properties occur at the base of the Vectis Formation (Site YL 1), about 4 m above the Barnes High Sandstone at Yaverland (Site YL 13) and 8 m above this unit at Shepherd's Chine (Site SC 25) (see Fig. 10). These properties can best be explained in terms of a volcanogenic origin for these particular shale horizons. Bentonites, of presumed volcanogenic origin, have been described previously by Jeans *et al.* (1977, 1982) from within the Lower Cretaceous sections of the Wealden District, so that evidence for possible volcanic activity within the Wealden Group of the Isle of Wight is not altogether unexpected.

2. *Direction of remanence*

The fact that the minimum susceptibility axes of most specimens lie close to the vertical (Fig. 8) suggests the presence of a primary-style magnetic fabric in these sediments, which has not been strongly disturbed after sedimentation (e.g. Hamilton 1967).

The direction of the mean stable magnetization vector for each sampling level and those of the mean locality vectors, before and after bedding correction, are shown in Fig. 9. The locality-mean values are also listed in Table 1.

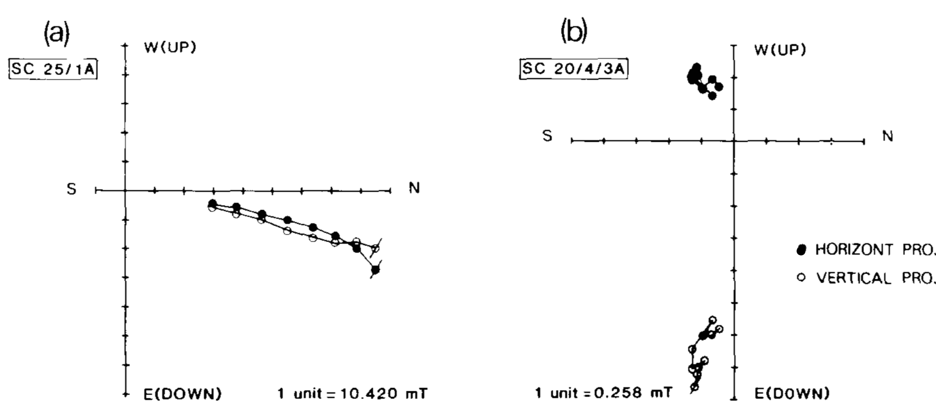

Fig. 6. Vector end point plots for (**a**) typical high intensity shale specimen and (**b**) Barnes High Sandstone, both from the Shepherd's Chine section.

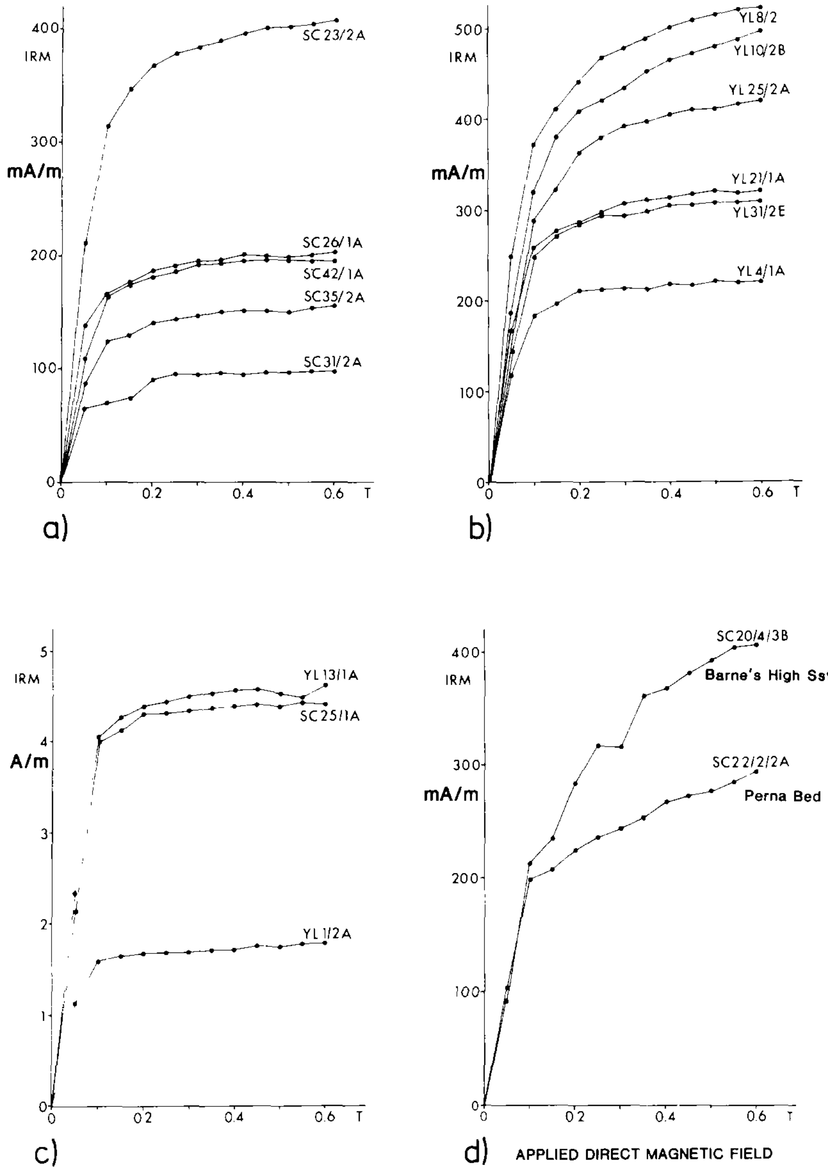

Fig. 7. IRM acquistion experiments. (**a**) Shale specimens from the Shepherd's Chine section. (**b**) Shale specimens from the Yaverland section. (**c**) High remanence intensity specimens. (**d**) Barnes High Sandstone (SC 20/4/3B) and Perna Bed (SC 22/2/2A) specimens from the Shepherd's Chine section. Note different scale for IRM axis in (**c**). These diagrams show the growth of remanent magnetism in response to the application of progressively stronger magnetic fields in the laboratory.

For both sections there is general conformity between the mean magnetization directions for the reverse polarity samples (Figs 9c and d) and the corresponding clusters of great circle intersection points (Fig. 5).

In the Yaverland section the mean magnetization directions for the reverse and normal polarity samples are closely antiparallel (Figs 9b & d). Within this section the bedding dip varies from about 7° to 22° and a palaeomagnetic fold test (Graham 1949) can be applied, to investigate whether the magnetization was acquired before or after folding. However the precision parameter, k, and the α_{95} value (Fisher 1953) are virtually unaffected by application of the bedding correction (Table 1). Therefore the fold test for the Yaverland section is inconclusive.

In the Shepherd's Chine section the mean magnetization directions, calculated for the normal and reverse polarity sample groups separately, are less closely antiparallel (Figs 9a & c). Since the Shepherd's Chine section has a nearly constant bedding dip throughout, a fold test cannot be applied to the paleomagnetic data from this section.

The inconclusive result of the fold test for the Yaverland section is probably related to the fact that the remanence vectors do not appear to represent a very precise definition of the Lower Cretaceous geomagnetic field direction. The inclination of the mean stable remanent magnetization vector derived from this study (39°) is significantly shallower than the value predicted for this locality from compilations of previously published European palaeomagnetic data and from plate tectonic reconstructions for this period (e.g. Smith *et al.* 1981). Such predicted values typically lie in the range 55° to 60°. It is believed that this discrepancy is most likely to be due either to the presence of a depositional palaeomagnetic 'inclination error' (King 1955) or to post-depositional compaction effects in the rapidly-deposited terrigenous sands and shales of the Vectis Formation.

It should be emphasized that although palaeomagnetic

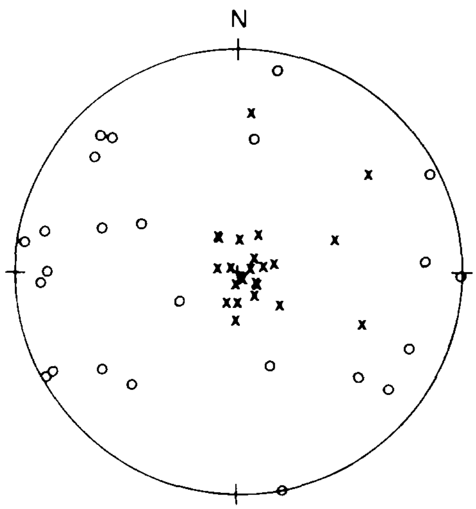

Fig. 8. Susceptibility anisotropy of specimens from the Shepherd's Chine section. Upper hemisphere equal area stereographic projection. Circles represent direction of maximum susceptibility, and crosses direction of minimum susceptibility for each sample.

inclination errors and/or compaction effects severely limit the utility of palaeomagnetic data for plate reconstruction purposes, they do not affect the reliability of polarity determinations. Thus palaeomagnetic data of this type can still provide a meaningful magnetic polarity stratigraphy.

3. *Polarity stratigraphy*

The stratigraphic variations of stable declination and inclination values for all samples which exhibit a demagnetization stable end point are shown in Fig. 10. The lower and uppermost parts of both sections are characterized by positive (downward-directed) inclinations and northerly declinations, defining a normal polarity stable magnetization. However a distinct zone, characterized by negative (upward-directed) inclinations and southerly declinations, representing a reverse magnetic polarity, occurs in the upper half of both sections, within the Shepherd's Chine Member. The magnetic polarities of samples which do not show well-defined SEPs, but which exhibit systematic directional trends during demagnetization (e.g. SC 36/2A in Fig. 4c), conform to the polarity sequence deduced from the SEPs alone.

The relative position of the reverse polarity zone with respect to the top of the Barnes High Sandstone Member and the base of the Perna Beds member is very similar in the two sections. Assuming that the stable characteristic magnetization was acquired by these sediments at, or very close to, the time of deposition (i.e. that it is essentially primary), then the base and top of this magnetozone represent 'absolute' time planes which can be correlated between the two sections. The base is located at 13.0 ± 0.5 m above the bottom of the Shepherd's Chine member in the Yaverland section and at 15.5 ± 1.0 m above this level in the Shepherd's Chine section. The top of the magnetozone is located at 8.0 ± 1.5 m below the base of the Perna Beds Member at Yaverland. Because of a sampling gap due to cliff-slumping the top of this magnetozone is poorly defined in the Shepherd's Chine section, but it must lie somewhere within the interval 0.5–11.5 m beneath the base of the Perna Bed.

We propose the name 'Vectis Magnetozone' for this distinctive reverse polarity interval within the Vectis Formation. Its occurrence appears to contradict the currently-accepted Upper Barremian age for this unit, since no geomagnetic field reversal within the Upper Barremian has been reported in the most recent geomagnetic timescales for the Cretaceous (e.g. Lowrie & Alvarez 1981; Channell *et al.* 1982; Kent & Gradstein 1985). However these timescales are based largely on sections within the Tethyan realm in the Alps and Appenines, which are biostratigraphically dated by foraminiferal zones. Since these zones have not yet been directly correlated with the classical ammonite stages (Channell *et al.* 1979), and the type sections for the Lower Cretaceous have not been magnetostratigraphically studied, the correlation of the reverse polarity Vectis Magnetozone with the geomagnetic timescale is not entirely straightforward. Furthermore, the biostratigraphy of the Wealden Group itself is uncertain (e.g. Rawson *et al.* 1978).

However, two correlations are possible. Firstly, the

Table 1. *Summary of locality-mean and overall-mean stable remanence vectors and corresponding palaeomagnetic pole positions determined from this study*

	Before bedding correction					After bedding correction				Palaeomagnetic pole position	
	Dec	Inc	N	k	α_{95}	Dec	Inc	k	α_{95}	Latitude	Longitude
Shepherd's Cline Section 50.62°N, 1.37°W	352.0°	40.8°	16	18.1	8.9°	355.9°	43.4°	18.0	8.9°	64.5°N	172.7°W
Yaverland Section 50.67°N, 1.13°W	351.6°	47.7°	27	22.0	6.1°	354.0°	34.1°	21.1	6.2°	57.7°N	170.5°W
Mean for the two Sections			2			354.9°	38.8°			61.0°N	171.5°W

N is the number of stratigraphic levels. k is the Fisher precision parameter. α_{95} is the radius of the 95% confidence circle around the mean value (Fisher 1953). All reverse polarity vectors have been inverted in these calculations.

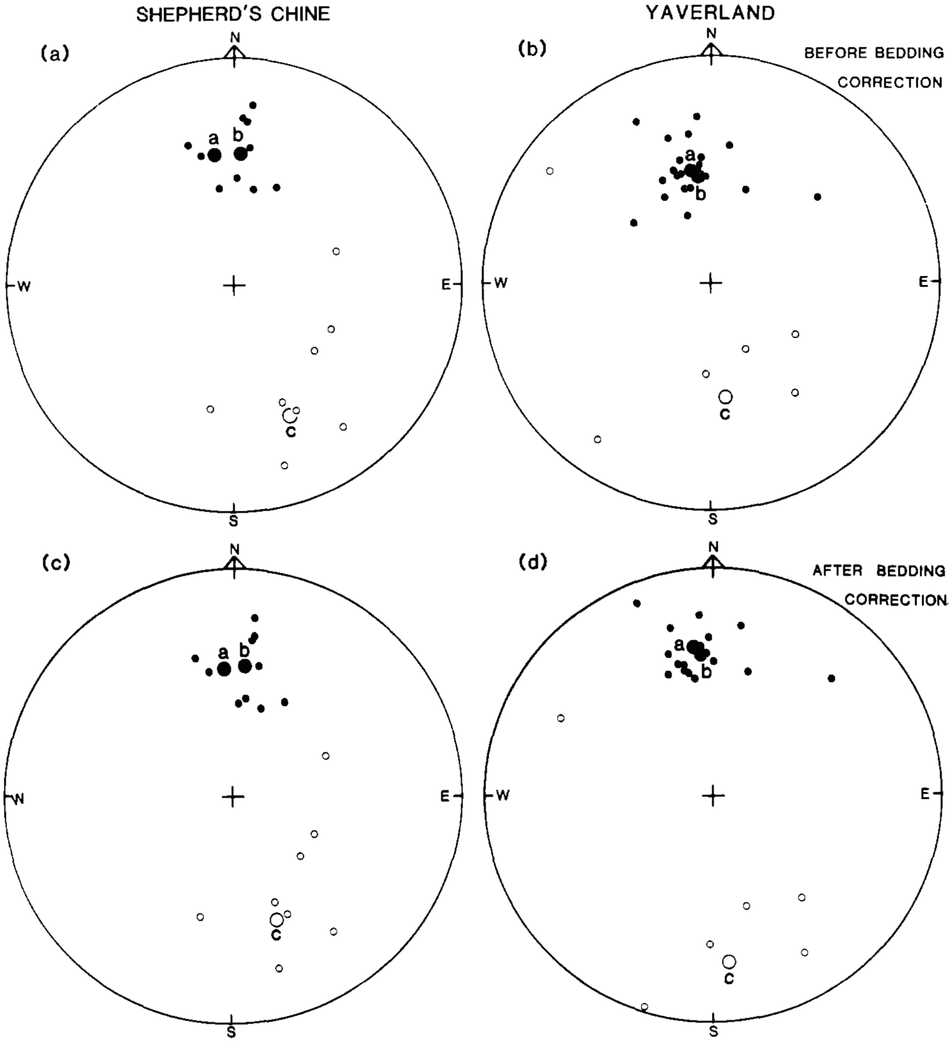

Fig. 9. Stable magnetization directions for each individual sampling level in the Shepherd's Chine and Yaverland sections (small circles), and mean locality directions (large circles). (**a**), (**b**) before, and (**c**), (**d**) after application of a bedding correction to restore the beds to their original horizontal attitude. Direction 'a' was calculated by combining the normal polarity and the inverted reverse polarity vectors, direction 'b' from normal polarity vectors only, and 'c' from reverse polarity vectors only. Solid circles represent vectors projected in the lower hemisphere and open circles in the upper hemisphere.

reverse polarity Vectis Magnetozone could correspond with magnetochron CM-1, of Lower to Middle Barremian age (Lowrie *et al.* 1980*a*, 1980*b*). Since the basal part of the *Prodeshayesites fissicostatus* zone, which is the oldest Aptian ammonite zone of the boreal Cretaceous, is missing in Southern England (Rawson *et al.* 1978), this interpretation would imply the occurrence of a large stratigraphic gap in these sections, spanning the Upper Barremian and the lowermost Aptian.

An alternative, and we believe more plausible, interpretation is that the reverse polarity Vectis Magnetozone represents magnetochron CM-0 of lowermost Aptian age (e.g. Lowrie *et al.* 1980*a*, 1980*b*; Channel *et al.* 1982). This interpretation (Fig. 2) requires an important revision of the stratigraphy of the Wealden beds and implies that the base of the Aptian stage (defined from Tethyan foraminiferal zones) must lie within the Shepherd's Chine Member of the Vectis Formation, at or below the base of the Vectis reverse polarity magnetozone. In contrast to the first correlation, this would require almost no stratigraphic gap, since all or part of the missing lowermost portion of the *fissicostatus* zone may be represented by the upper part of the Shepherd's Chine Member.

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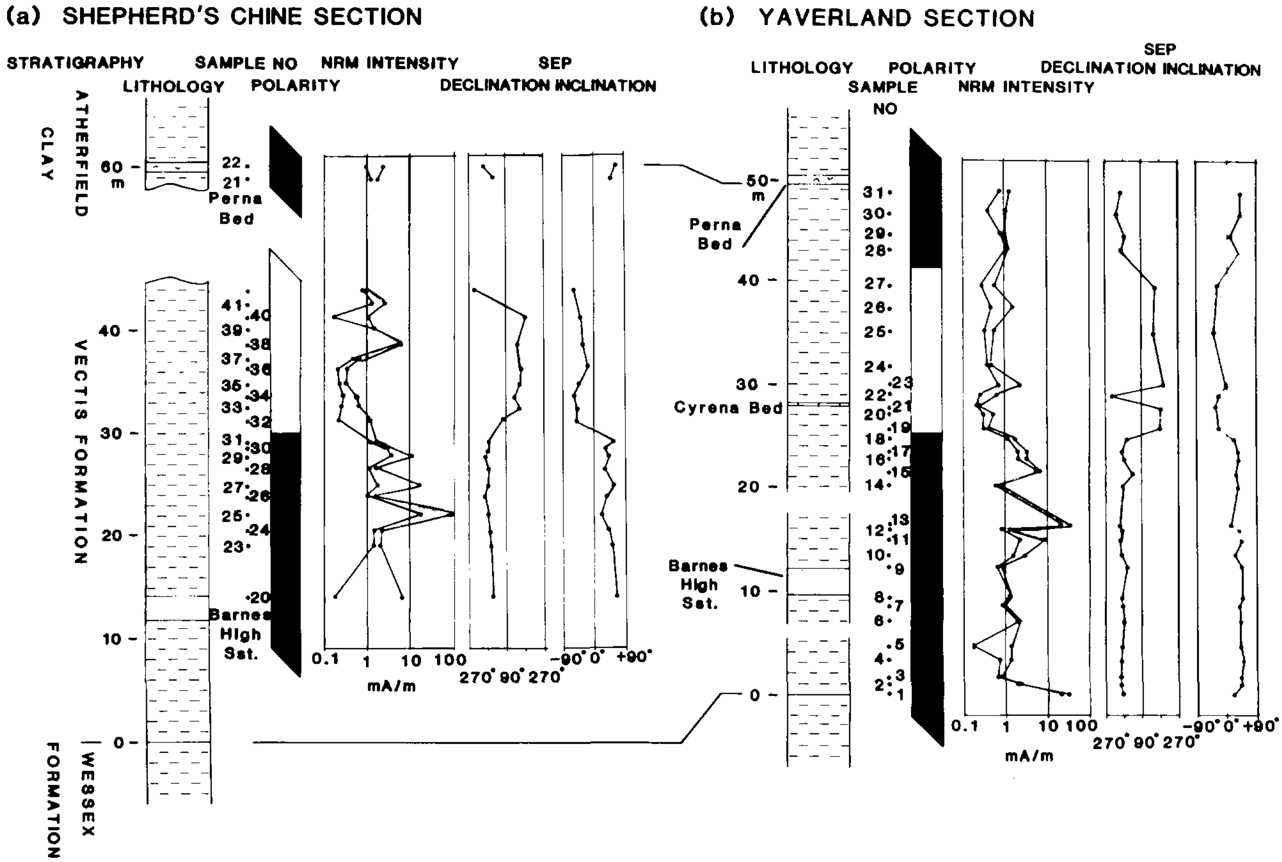

Fig. 10. Summary of stratigraphic, lithological and palaeomagnetic data for (**a**) Shepherd's Chine and (**b**) Yaverland sections. Black normal, white reverse polarity. The declination and inclination values plotted represent the mean stable end point values for each stratigraphic level. NRM intensity values are shown for the two separate samples at each level.

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