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Thrusts under Mount's Bay and Plymouth Bay

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A marine magnetic and high-resolution seismic survey off the Lizard Peninsula in Cornwall has been interpreted and found to be consistent with the existence of the Carrick, Veryan, Dodman and Normannian Nappes proposed from field mapping. Geophysical data in the eastern part of Plymouth Bay are reinterpreted and it is suggested that Start Point, Eddystone, and other inliers on the sea floor are klippen preserved at the tops of inselbergs of a submerged Permian topography.

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Introduction

The existence of Variscan thrust nappes in south Cornwall has been proposed by several authors, most recently by Leveridge et al. (in press) and Holder and Leveridge (1986) who propose a succession of thrusts. The earliest was the Normannian Thrust which carried continental crust over sedimentary rocks on the southern margin of the Gramscatho ocean basin floor. The Lizard Nappe is a thrust slice or horst below the Normannian Nappe consisting of ophiolitic rocks from the oceanic crust. The lowest thrust is the Carrick Thrust which carried the higher nappes onto the northern continental shelf. East of the Lizard Peninsula the Dodman and Veryan Thrusts developed between the Carrick Thrust and the Normannian and Lizard Thrusts.

Fig. 1 shows a simplified geological map after the work of the Geological Survey (Holder et al. 1983; Holder and Fletcher 1985; Holder and Leveridge 1986; Leveridge et al. (in press)). The Carrick and Dodman Thrusts are cut to the east at a NWSE fault which cuts the coast near Pentewan. The first part of this paper describes a survey designed to detect reflections from within a few hundred metres of the seabed to allow the outcrop of the thrusts offshore to be mapped. Earlier work (Leveridge et al. 1984; Day and Edwards 1983) proposed that a reflector mapped in the upper crust at two-way travel times of between 2 and 5 seconds is the Carrick Thrust, and so it was expected that reflections would be obtained from the thrust close to the surface.

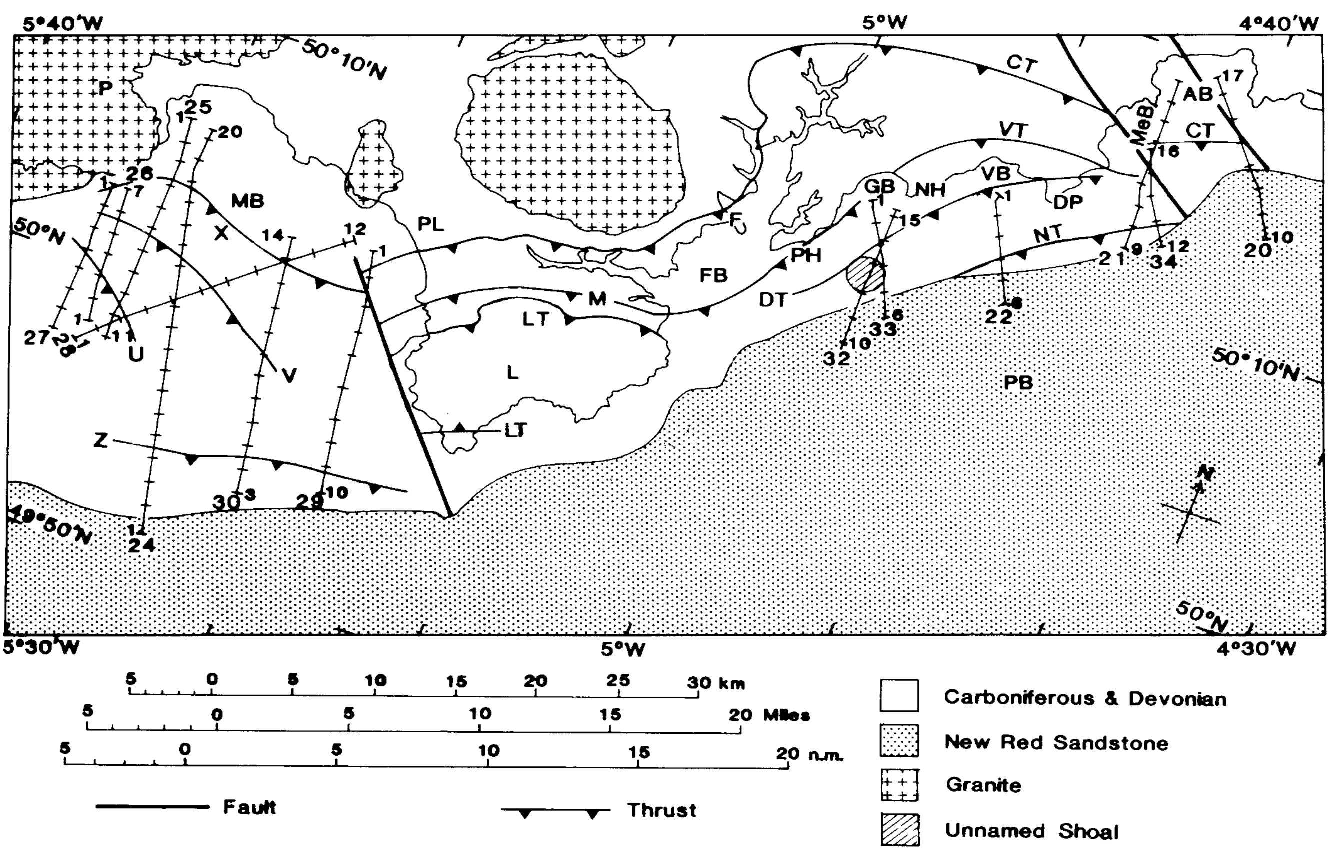

Figure 1. Geological map of South Cornwall, with the positions of the survey lines. Scale about 1:500000. AB - St. Austell Bay, CT - Carrick Thrust, D - shoal east of Portmellin Head, DP - Dodman Point, DT - Dodman Thrust, F - Falmouth, FB - Falmouth Bay, GB - Gerrans Bay, L - Lizard peninsula, LT - Lizard Thrust, M - Meneage, MeB - Mevagissey Bay, MB - Mount's Bay, NH - Nare Head, NT - Normannian Thrust, P - Penzance, PB - Plymouth Bay, PF - Pentewan Fault, PH - Porthmellin Head, PL - Portleven, U, V, **X**, **Z**, - Thrusts west of the Lizard Peninsula, VB - Veryan Bay, VT - Veryan Thrust. Large number indicate line numbers; small numbers indicate fix numbers.

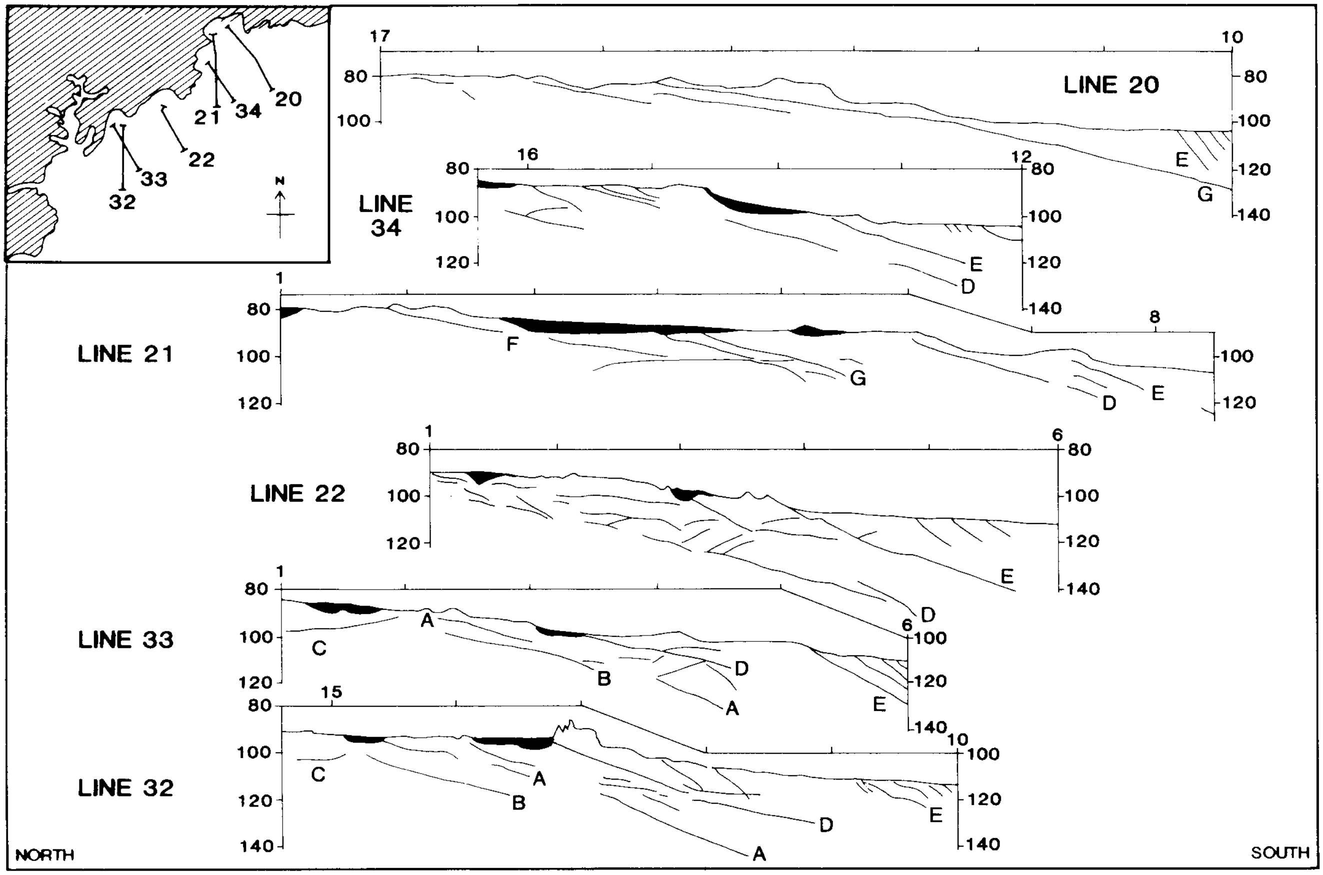

Figure 2. Line interpretations of seismic lines in Plymouth Bay. Unconsolidated deposit in black. Vertical axis is two-way travel times in milliseconds. Horizontal axis is marked in fix numbers 2km apart.

In 1983 thirteen high-resolution reflection seismic lines were surveyed in Mount's Bay and the western part of Plymouth Bay. The lines are summarised in Fig. 1, which for clarity shows only the parts of the lines interpreted here. Further details are available as charts and digitally (Edwards 1984). On all lines a pair of airguns and a 1kJ sparker were fired alternately (Brett 1984). The records from the sparker were found to be easier to interpret, and the interpretations in Figs 2 and 3 are taken from them. Despite the poor quality of the data, reflectors can be seen within the pre-Permian basement. Some are interpreted as thrusts and may be correlated with thrusts postulated on land, although it is not possible to distinguish tectonic contacts from conformal ones from the seismic evidence alone. Magnetic measurements were also made, and are shown in Fig. 4. Due to the shallow water, the magnetometer was towed 70m from the vessel which is closer than normal, resulting in the measurements being slightly too high. As the error is constant along a line, the profiles are valid. The profiles in Fig. 4 have not had a reference field subtracted, and the lay-back of the magnetometer has not been allowed for.

Gerrans Bay

The Veryan Thrust has been mapped onland north of Gerrans Bay, and proposed in the Meneage area, and its course offshore may be predicted. The Dodman Thrust is found on land north of Dodman Point, and offshore it might be expected to run parallel to the Veryan Thrust. Lines 32 and 33 cross south of Gerrans Bay a kilometre north of the outcrop of a reflector (D in Fig. 2), which corresponds to a marked change in the morphology of the seabed, and is interpreted here as the Dodman Thrust. To the south there is a steep-sided shoal which may have been an island during a period of lower sea-level. The hydrographic chart shows that it is approximately circular with a diameter of 1.7km and centred 3.4km east of Porthmellin Head. Line 32 runs over its eastern edge. It is separated from The Bizzies shoal to the north-west by a channel which may mark the location of the Dodman Thrust. The aeromagnetic map (Institute of Geological Sciences 1977) shows an anomaly over the western part of the shoal, but no magnetic anomaly was found on line 32 (Fig. 4), implying that the rocks making up the shoal vary petrologically, and that basic rocks are present in the western part of the shoal. Reflectors A, B and C below the Dodman Thrust cannot be explained by known thrusts, and may be conformal boundaries within the Veryan Nappe. Reflector C dips northwards, and is unlikely to be the Veryan Thrust, which may be only a short distance offshore, and not crossed by line 33.

Veryan Bay

Line 22 started in Veryan Bay a few hundred metres south-east of the predicted crop of the Dodman Thrust. The line shows a coherent reflector (D on Fig. 2), which is interpreted as the Dodman Thrust. The apparent dip of the thrust on the section varies as the vessel was turning for a few minutes after fix 1. The lines shows a higher reflector (E), which reaches the seabed at a change in its morphology, and may be the base of the New Red Sandstone. The New Red Sandstone is characterised by closely spaced reflectors, and on lines 32 and 33 they can be seen immediately above reflector E, but on lines 22, 21, and 34 they can only be seen a kilometre or two south-east of reflector E. It is possible therefore that reflector E on lines 22, 21, and 34 is the Normannian Thrust (Leveridge et al. in press) which has determined the location of the basin on a regional scale. However, a sample of red conglomerate or breccia (sample no. 2 in degree square 50°N 5°W) collected from the seabed 1.1km west of fix 5 of line 22 between reflector E and the lowest of the

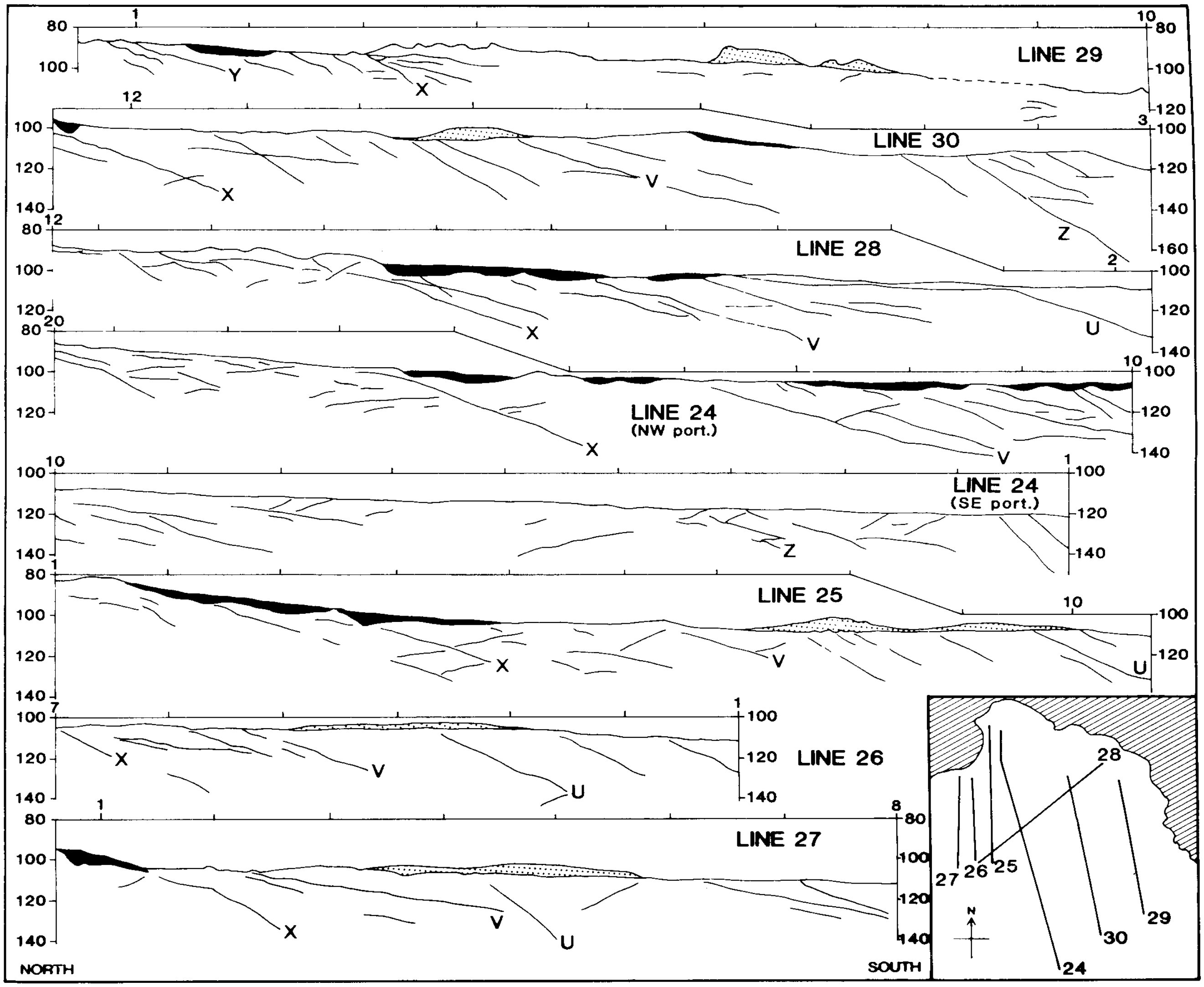

Figure 3. Line interpretations of seismic lines in Mount's Bay. Unconsolidated deposits in black; sandwaves stippled. Vertical axis is two-way travel times in milliseconds. Horizontal axis is marked in fix numbers 2km apart.

closely-spaced reflectors, suggests that this interpretation is incorrect, and that reflector E is the base of the New Red Sandstone on all lines.

Mevagissey Bay and St Austell Bay

Lines 21 and 34 cross in Mevagissey Bay close to where, from extrapolation of the land geology, the Dodman Thrust is cut by the Pentewan Fault. There are breaks in reflectors between fixes 5 and 6 on line 21, and fixes 14 and 15 on line 34, which may be due to the Pentewan Fault. Reflector D is interpreted as the Dodman Thrust. The direction of movement on the Pentewan Fault is not known. Parallel faults have a cumulative dextral displacement (Arthaud and Matte 1977; Day et al. in press), but the horizontal offset of these dipping reflectors across a single fault may be small, and so reflector G is interpreted as the Carrick Thrust. Reflector F may be from the base of the basic volcanics found at Black Head. A fault has been proposed on land parallel to the Pentewan Fault and by extrapolation is expected to cross line 20, which it may do at a break in reflectors between fixes 14 and 15. The coherent reflector with a shallow dip (G) may be the Carrick Thrust. The northern ends of lines 20 and 21 show low amplitude, high spatial frequency magnetic anomalies, which may be caused by dolerite dykes of the same suite which is found at the coast around St Austell Bay.

Mount's Bay

Seven lines were shot in Mount's Bay (Fig. 3), and structures mapped on land can be correlated with reflectors seen on the lines, though with less certainty than is possible on the lines on the other side of the Lizard Peninsula. The south-western boundary of the Lizard Complex has been mapped as a straight line, and is therefore likely to be a steeply dipping fault. Extrapolating to the north-west, the fault cuts line 29 near fix 3, and there is indeed a change in morphology of the sea-bed at this point. Reflector X may be the Carrick Thrust on the southwestern side of the fault, and reflector Y the same thrust on the other side of the fault.

The other six lines have one important feature in common: at the north-western end of each line there is a magnetic anomaly with a large amplitude and long spatial wavelength (Fig. 4), and a dipping reflector close to the southern edge of the anomalies (marked X on Fig. 3). The cause of the anomalies may be lavas within the Mylor Formation, similar to those found on land

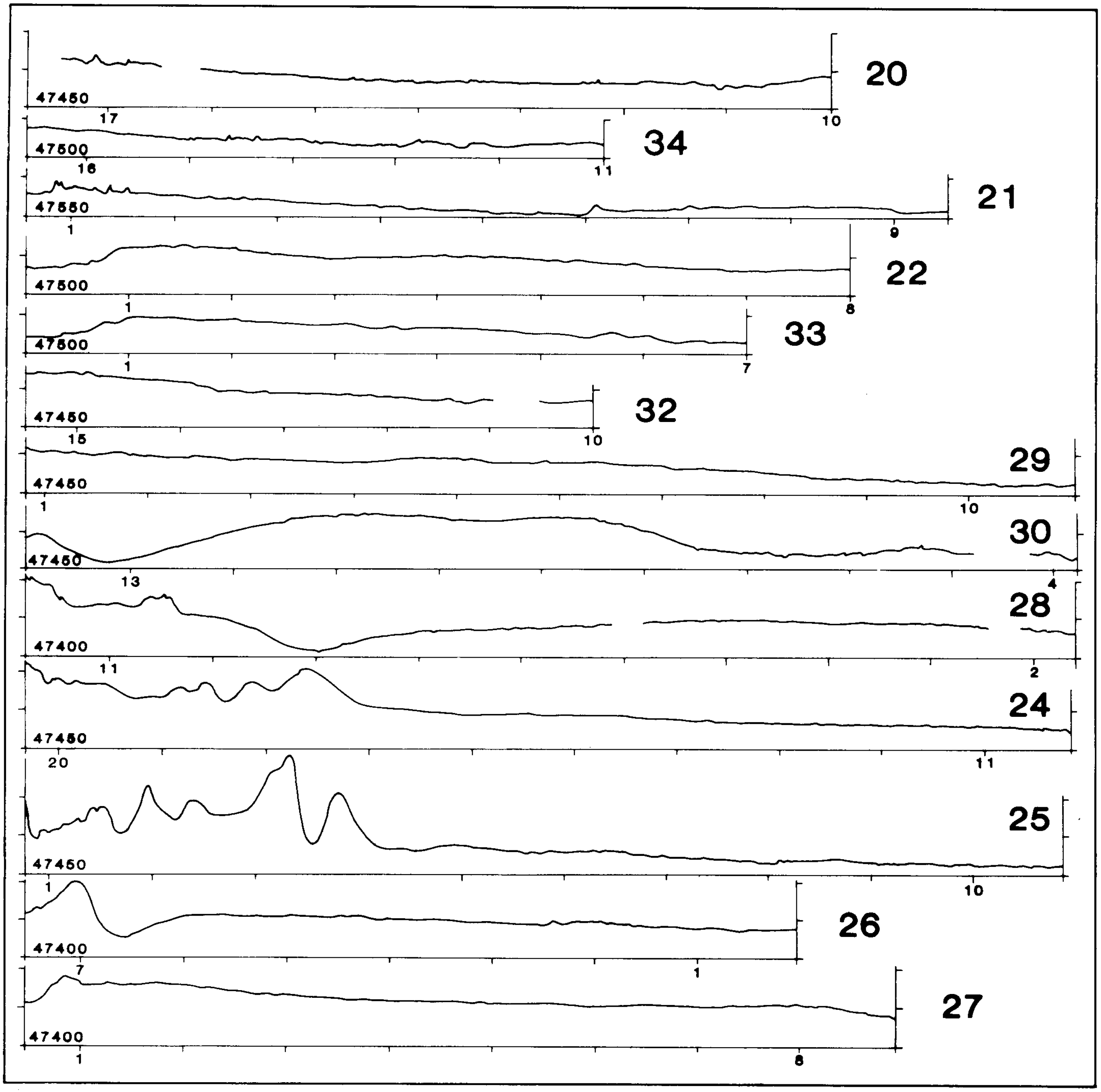

Figure 4. Magnetic profiles along survey lines. Vertical scale is 50nT per graduation. Horizontal axis is marked in fix number 2km apart.

around Penzance. The dipping reflector is interpreted as the Carrick Thrust, which forms the southern boundary of the Formation. More dipping reflectors may be seen further south, and two (U and V) have been traced from line to line, although there is no independent evidence to support the correlations. They could be the Dodman and Veryan Thrusts. The southern end of line 30 shows a dipping reflector (Z) with a rough, elevated sea-bed on the hanging-wall side. A similar, though smaller, shoal can be seen near fix 10 on line 29. Two samples of metamorphic rock have been collected in the area; one (sample no. 78 in degree square 49°N 6°W) led Lott (in Holder et al. 1983) to postulate a small area of the Lizard Complex 3km east of line 29, and the other (sample no. 59 in degree square 49°N 6°W) was collected 2km east of fix 3 of line 30. Although these samples could be loose pebbles, they suggest that the shoal consists of high-grade metamorphic rocks, and may be part of the Normannian Nappe. Further evidence for the existence of high-grade metamorphic rocks is provided by a refraction experiment of Bullard and Gaskell (1941), which they carried out 4.5km south of Lizard Point at 49°55'N 5°12'W, which is 100m south of the northern boundary of the New Red Sandstone. Three refractors were found. The seabed gave a refractor with a velocity of 2.74km/s, which could be weathered New Red Sandstone. The other two refractors were at depths of 46m and 320m with velocities of 3.66 and 6.02km/s respectively. Low grade metamorphic rocks have a seismic velocity between 5 and 6km/s, suggesting that the upper refractor is within the New Red Sandstone, and the other is the top of the basement consisting of high-grade metamorphic rocks.

Start Point and Eddystone inlier

Nappe tectonics may also explain the structure of the eastern part of Plymouth Bay. High-grade metamorphic rocks are exposed close to Start Point, and at Eddystone and other inliers on the sea-bed, where they are surrounded by New Red Sandstone. To elucidate the structure in the area, and the relationship between the high-grade metamorphic rocks and the low-grade metamorphic basement, Hill and King (1955) carried out seven refraction experiments along a north-south line from 7.5km north of Eddystone to 74km south of it. They identified three refractors: one with a velocity of between 3.1 and 3.6km/s, a second with velocity between 4.1 and 4.5km/s, and a third (found in only three experiments) with a velocity between 5.2 and 5.5km/s. An exploration well (87/141) was subsequently drilled close to the southern-most experiment, and shows that the top refractor is within the Chalk, and the middle refractor is within the New Red Sandstone. Interpretations of reflection seismic data (Smith 1985) suggest that the Plymouth Bay Basin reaches a depth of up to 7km under the experiments. As this depth is far below the lowest refractor, it shows that the lowest refractor is within the New Red Sandstone. Previous interpretations of these experiments (Hill and King 1955; Allan 1961; Brooks et al. 1983) assumed that the lowest refractor was the top of the basement. The interpretations also postulated a thrust or horst to explain the high-grade metamorphic rocks. Although there are positive gravity and magnetic anomalies in the vicinity, they are not as large as would be expected if there were a large horst or thrust nappe and there is no close correlation between the anomalies and the inliers of high-grade metamorphic rock. A seismic reflection line between Eddystone and Start (line 3 of the South-western Approaches Survey of the Institute of Geological Sciences, project 76/8) gave a weak reflector at about 0.9 seconds two-way time, suggesting that the basement dips steeply away from the inliers. We propose that the inliers are part of a low angle thrust nappe which is preserved as klippen at the tops of inselbergs, which were later submerged under the New Red Sandstone. The nappe may be the Normannian Nappe. Allan proposed a horst of magnetic rocks in the middle of the Plymouth Bay Basin to explain a large magnetic anomaly. Subsequent seismic surveys have not found this horst (Smith 1985), and Day (1986) proposed that lavaflows within, or at the base of, the New Red Sandstone may be responsible for the anomaly.

Conclusions

We conclude that the offshore geophysical evidence is consistent with the thrust nappes, postulated from onshore mapping, continuing offshore. The formation boundaries proposed by us should be tested by sampling the rock-head.

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The structural evolution of the Davidstow Anticline, and its relationship to the Southern Culm Overfold, north Cornwall

L.N. WARR

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The formation of the Davidstow Anticline is regarded as synchronous with the development of the Tintagel High Strain Zone, which evolved during early heterogenous D2 shear strain directed towards the NN W. This movement wedged (underthrust) beneath the Culm trough sediments, initiating backthrusting and the formation of the Southern Culm Overfold during early Stephanian times. F1 folds south of the Rusey Fault Zone are attributed to an earlier phase of backthrusting occurring between post-lowest Namurian and pre-late Westphalian times (315-300±SMa). These F1 fold axes were subsequently rotated during D2 high shear strain towards the principal stretching direction, initiating 'folds oblique to the regional trend'. Continued wedging of the Culm flysch basin initiated late F2 folding in the wedge. The low angle north-dipping faults of the Tintagel and Boscastle area are considered to be the same generation of low angle extensional faults as affect the southern Culm Synclinorium; reactivation of D1 backthrusts is probable. Ruck folds in the fault zones of the Tintagel area are attributed to the sticking *of* basal fault surfaces during extensional movements.

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Introduction

The Davidstow Anticline is a regional scale, gentle fold structure in Lower Carboniferous and Devonian rocks lying south of the Culm Synclinorium and north-west of the Bodmin Moor granite (Fig. 1). Interpretations of its origin have ranged from up-doming by the granite (Wilson 1951), late regional fold episodes (Sanderson and Dearman 1973) to an antiformal stack of D2 thrusts above a blind lateral/oblique ramp (Andrews et al. 1988).

Lying north of the Davidstow Anticline, the Southern Culm Overfold represents the transition from upright to flat-lying south-facing folds that occurs from Wanson Mouth to Rusey Cliff. It has long been recognised that facing on the S1 cleavage between Wanson Mouth and Padstow is towards the south (Freshney et al. 1972; Sanderson and Dearman 1973). Early tectonic modelling involved a single deformation event which evolved as a regional scale south-facing overfold (Sanderson 1979; Rattey and Sanderson 1982). Subsequently the Southern Culm Overfold was interpreted as representing the suprastructure of a nappe pile overriding a highly strained infrastructure (Tintagel High Strain Zone; Sanderson 1979). The high strain zone and the occurrence of 'folds oblique to the regional trend' (Sanderson 1973) in the Lower Carboniferous and Upper Devonian rocks south of the Rusey Fault Zone were considered the result of southward D I shear. The importance of northward transport has been shown in more recent studies (Selwood et al. 1985; Andrews et al. 1988). The revision of the stratigraphy and adjacent inland mapping by the University of Exeter (Selwood et al. 1985) led to the suggestion of southerly derived nappe sequences which underthrust the southern margin of the Culm Synclinorium. More specific analysis of shear indicators and rock fabrics (Andrews et al 1988) in the Tintagel High Strain Zone indicates the majority of strain to be the result of NNW shear, synchronous with greenschist fades metamorphism.

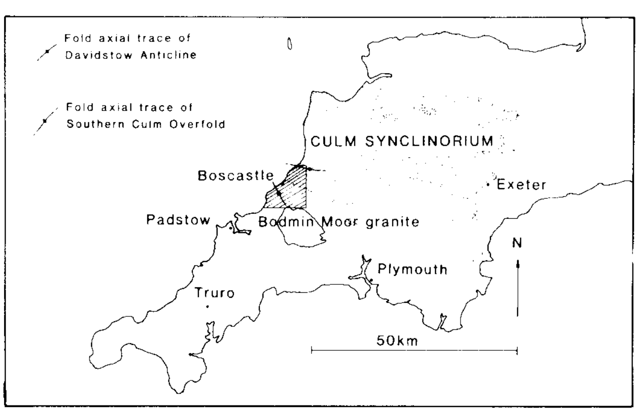

Figure 1. Location of the area of study: the Boscastle region.

This paper presents a new deformation chronology for the Boscastle area, and suggests a mechanism involving early wedging (underthrusting) of the Culm flysch basin, to explain the deformational histories of the Davidstow Anticline and Southern Culm Overfold. It provides a new model for the occurrence of D1 south-facing deformation, within a northward propagating system (Dodson and Rex 1971; Selwood and Thomas 1986b), involving the early backthrusting of the contents of sedimentary basins, initiated by a wedging process.

Stratigraphy

Three stratigraphic successions can be recognised in the area (Figs 2 and 3). The Southern Culm Succession: thick Namurian flysch (Crackington Formation), represented in a conformable Upper Devonian to Lower Westphalian sequence; the Boscastle Succession: a sequence of shallow water marine elastics and limestones of Upper Devonian to earliest Namurian age (Selwood et al. 1985), lying south of the Rusey Fault Zone, and the Tintagel Succession: a sequence of Upper Devonian to Lower Carboniferous slate and volcanics, interpreted as marine shelf and basinal fades (Selwood and Thomas 1986a).

Each succession is separated by gently northward-dipping faults. The Rusey Fault separating the Southern Culm and Boscastle Successions marks the boundary between two structural regimes; a feature emphasised by the magnetic anomaly across it (Mckeown et al. 1973).

Structure

The Southern margin of the Culm Synclinorium (Figs. 4 and 5a) is dominated by F1 south-facing chevron style folds forming the Southern Culm Overfold which developed during D1 southward simple shear (Sanderson 1979; Lloyd and Whalley 1986). Facing directions are generally perpendicular to the southern margin of the Synclinorium (Fig. 4, stereo. 1) which is marked by the Rusey Fault Zone. South of this, the regional structure is dominated by the Davidstow Anticline which is an

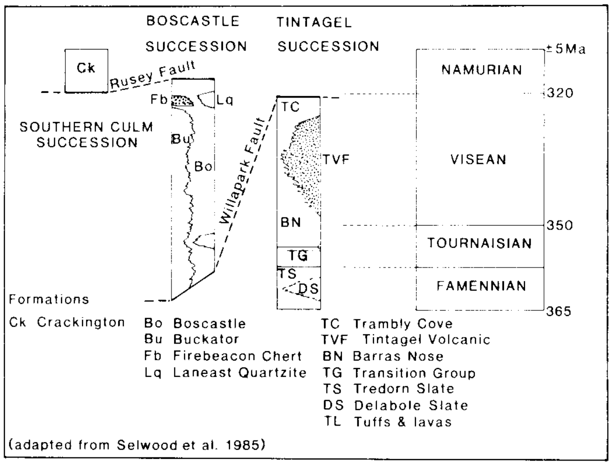

Figure 2. Stratigraphic successions of the Boscastle area.

open fold structure deforming S1 (Fig. 4, stereo. 3). Its fold axis plunges 10/330 (NNW) in the trend of the regional stretching lineation (Fig. 4, stereo. 2). Since this lineation is consistent on both limbs of the structure, it is regarded as synchronous with the formation of the regional fold. Mineral lineations of the same trend are also present in the aureole of the granite, as weak alignments of andalusite and cordierite porphyroblasts in schists. These may represent the overgrowth of a pre-existing lineation, although not observed in the equivalent rock type outside the aureole. An alternative interpretation is that the contact metamorphism was partly synchronous with the formation of the stretching lineation.

Studies of minor structures exposed in the Tintagel High Strain Zone indicate that high ductile strains occurred during an early D2 stretching event (Andrews et al. 1988), which was synchronous with greenschist facies metamorphism. Shear indicators show a NNW sense of shear, with varying amounts of strain recorded during the evolution of these structures. Estimates from boudins in the Barras Nose Formation indicate 40% stretching of the bedding (Ferguson and Lloyd 1982), whereas shear fibre growth (Andrews et al. 1988) suggests that stretching may have locally reached 300%.

F1 fold axes show a rotation towards the stretching lineation trend around the nose of the Davidstow Anticline. They have been rotated from an original E-W strike in the south, towards NNW-SSE through the Tintagel area, and return to an E-W strike just south of the Rusey Fault. It is this pattern of high strain modifying the F1 fold axes around the nose of the anticline, that has given rise to the large degree of sheathing of F1 fold axes (Sanderson 1973) in the Tintagel and Boscastle area. The D1 strain was largely rotational and initiated much folding, whereas the early D2 strain was irrotational and largely coaxial to D1. F1 structures were thus tightened and extended rather than refolded during D2. Although from a regional viewpoint the majority of the strain occurred in these rocks during early D2, the observed sheathing of folds is the result of both D1 and D2 strain components. The amount of curvature of F1 fold axes before their modification by early D2 strain is uncertain. Complications in determining the original orientation of early D2 and D1 structures in the highly anisotropic Boscastle Formation is caused by intense late F2 refolding (the zig-zag folds of Dearman and Freshney 1966). Late F2 fold axes are commonly curvilinear (< 30°), verge to the north, and represent a continuation of D2 shear towards the

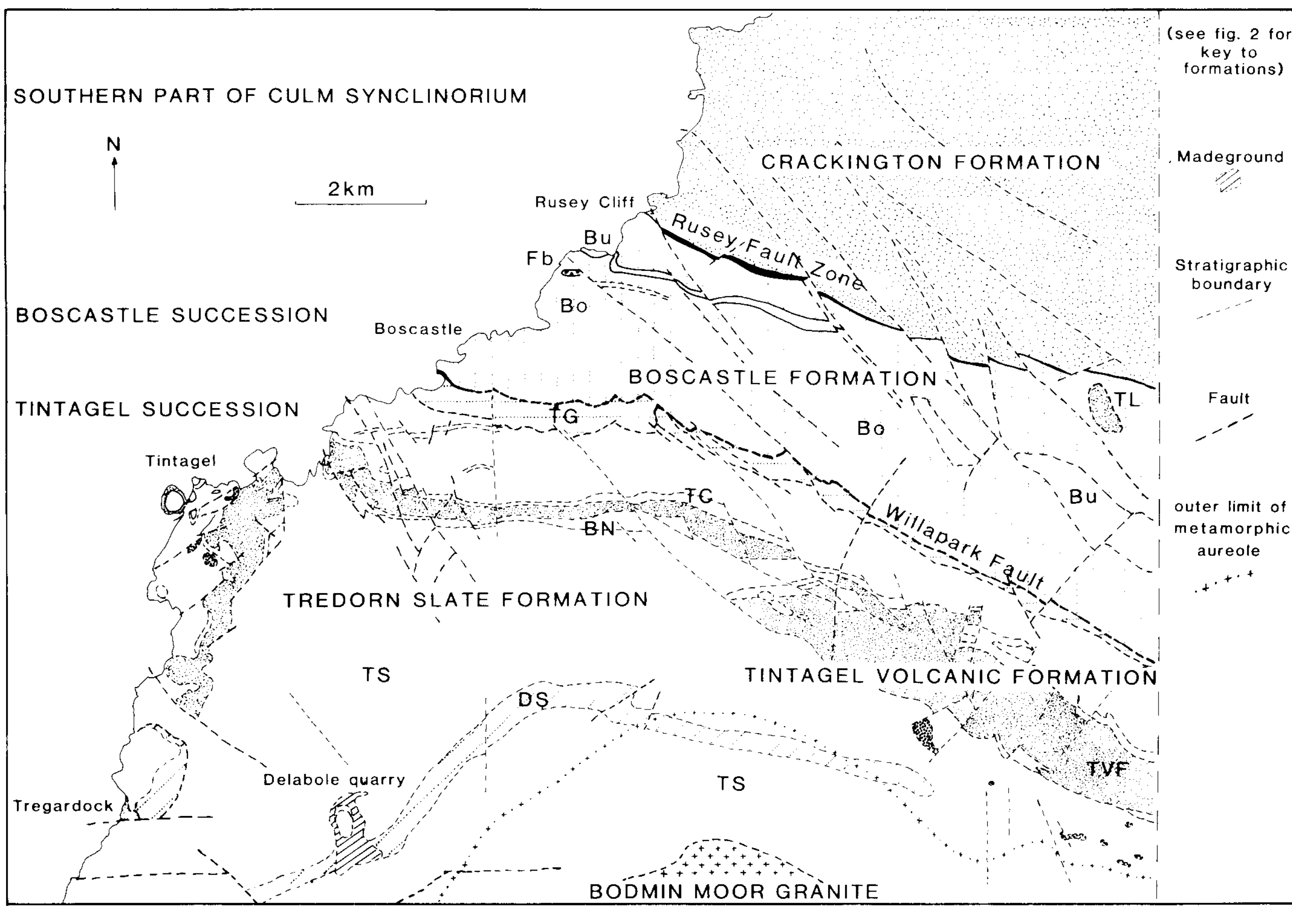

Figure 3. Geological map of the Boscastle area (use Fig. 2 for key).

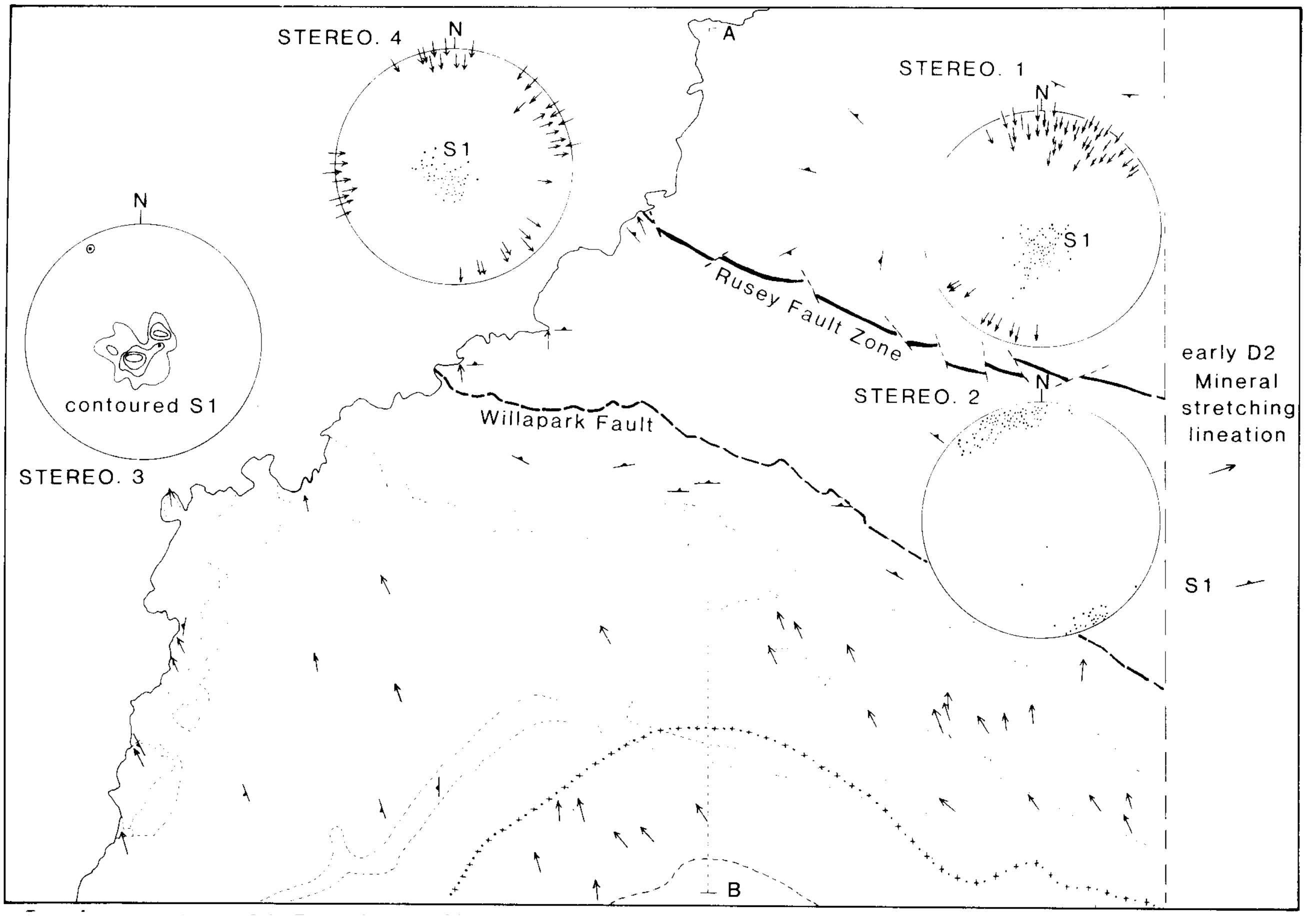

Figure 4. Structural map of the Boscastle area, with stereographs of selected structural data. Stereo. 1: Southern Culm Overfold, arrows represent direction and dip of facing on S1, dots are poles to S1. Stereo. 2: dots represent D2 mineral stretching directions across the Davidstow Anticline. Stereo. 3: Contoured plot of poles to S1 across the Davidstow Anticline. Stereo. 4: S1 facing and poles to S1 in the Boscastle Formation.

NNW. Allowing for late F2 folding, facing on S1 is commonly towards a southerly or north-easterly direction (Fig. 4, stereo. 4). This complex variation of facing is interpreted as sheath folds with noses sheared out in a general NW-SE direction.

Studies on minor structures show that a transition from D2 ductile strain to brittle thrusting occurred within the Tintagel High Strain Zone (Andrews et al. 1988; Warr 1988). Most authors have ascribed to the original view of Wilson (1951), that the gently northward dipping faults reported throughout the area represent northward directed thrusts (Selwood and Thomas 1986a; Andrews et al. 1988), subsequently tilted towards north and north-west about the Davidstow Anticline. However, many of these faults show extensional geometries (Freshney et al. 1972; Andrews et al. 1988; Warr 1988), and some cut D2 thrusts (Warr 1988). Locally developed ruck folds in the fault zones are transected by fault surfaces, indicative of the sticking of the basal fault surfaces during extensional movements. These faults are more likely to be D3 structures of the same generation as the normal faults affecting the southern part of the Culm Synclinorium (Freshney 1972; Lloyd and Whalley 1986). It is probable that reactivation of D1 (e.g. Willapark and Rusey Faults), and D2 thrusts occurred during D3 movements.

Wedging of the Culm flysch basin

Density data (Freshney et al. 1972) show a density contrast of around 4.4% between the rocks of the Culm Synclinorium and those of the Boscastle and Tintagel successions. Such a density contrast and the attitude of the boundary between were favourable (Zang et al. 1984) for underthrusting (Fig. 5b and c) rather than overthrusting of the southern successions during Variscan shortening. It appears that wedging movements of the Tintagel High Strain Zone `locked up' during late D2 times producing localised strains (late F2), and the displacement transferred to a lower decollement surface passing beneath the Culm Synclinorium.

Deformational chronology and regional implications

A new deformational chronology is proposed for the area (Fig. 6). Although F1 folds face southwards throughout the area, the F1 folds north and south of the Rusey Fault Zone are attributed to different backthrusting events. The first occurred between post-earliest Namurian and pre-late Westphalian (315300±SMa) and involved the Boscastle and Tintagel successions. This is seen as synchronous with Culm flysch sedimentation to the north, with deposition occurring in a foreland basin setting. The second, north of Rusey, occurred during post-late Westphalian times (300-295±5Ma), and gave rise to the Southern Culm Overfold. The latter event is regarded as synchronous with D2 movements of the Tintagel High Strain Zone.

The Davidstow Anticline evolved around lower Stephanian times (300-295±5Ma), during early D2 heterogenous shear strain towards the NNW. This fold structure is also regarded as synchronous with the Tintagel High Strain Zone, the majority of strain occurred during early D2, synchronous with greenschist facies metamorphism. Strain modification of F1 fold axes occurred around the nose of the antiformal structure and rotation of originally E-W axes of south facing folds towards the D2 principal stretching direction gave rise to ‘folds oblique to the regional trend’. It is this early D2 shear towards the NNW which wedged beneath the southern margin of the

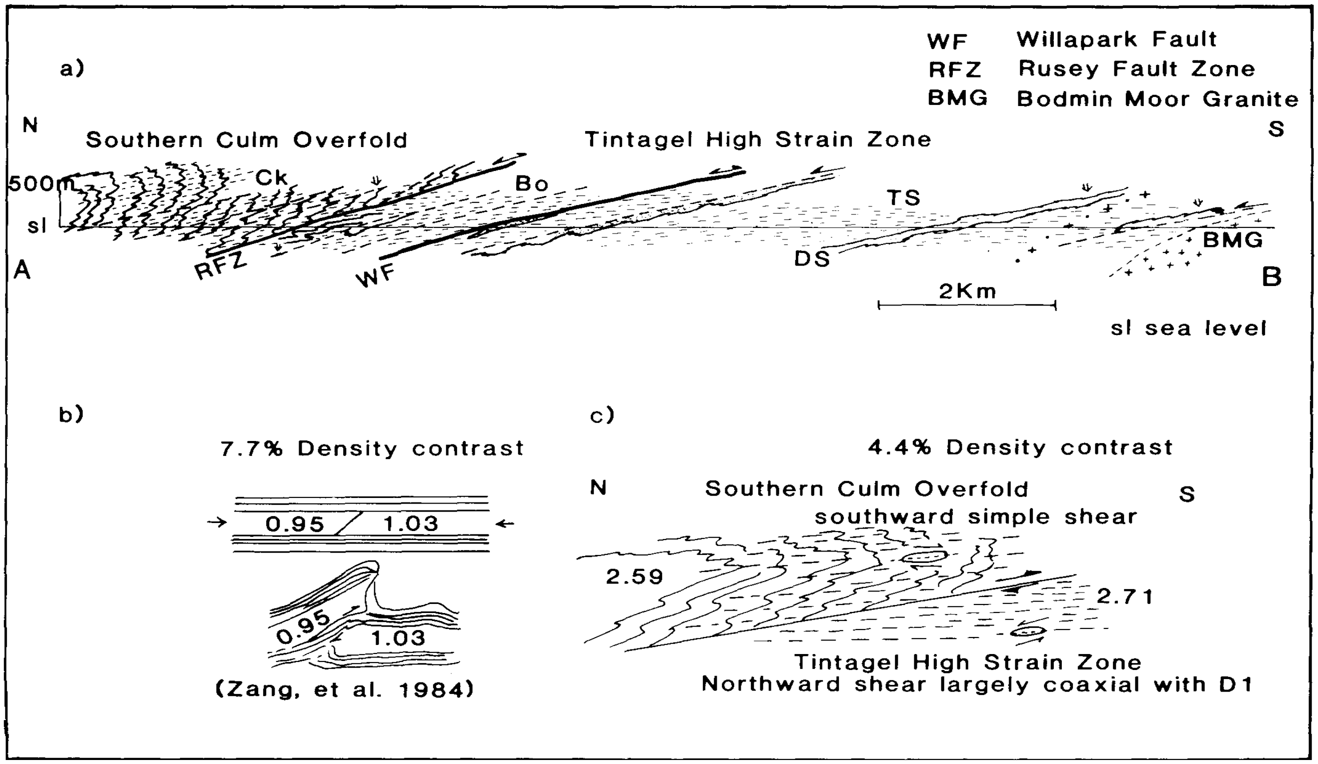

Figure 5. a) Structural section A-B across the Boscastle area (see Fig. 4). b) Experimental modelling (Zang *et al.* 1984), showing underthrusting of denser clays beneath less dense (density in gm cm^{-3}) Schematic cross section showing underthrusting of the Tintagel High Strain Zone beneath the Southern Culm Overfold.

Culm flysch basin, intiating backthrusting and formation of the Southern Culm Overfold. The obliqueness of opposed transport directions across the Rusey Fault Zone is seen as characteristic of NNW wedging of an E-W trending sedimentary basin. Transport within the southern Culm basin was perpendicular to the basin margin (SSW) and not related to the direction of the wedging (NNW). Continued wedging initiated late F2 folding within the Davidstow Anticline area, with strains becoming more localised during a 'locking up' of the wedging movement. The low angle north dipping faults across the area are considered as a separate (D3) phase of faulting. Their extensional geometries are original and ruck folds within the fault zones developed by sticking of the basal fault surfaces during extensional movements.

The NNW regional transport of the Variscan foreland belt of south-west England migrated northwards, deforming a series

Stratigraphic chronology	Southern Culm Overfold		Tintagel High Strain Zone	
Post-lowest Namurian - pre- late Westphalian 315-300±5Ma		Deposition occurring in Culm Flysch Basin	D1	South facing folding
Post-late Westphalian 300-295±5Ma	D1	South facing folding	early D2 late D2	Ductile shear towards NNW with transition to brittle thrusting
Post-late Westphalian	D3	North dipping extensional faults	D3	North dipping extensional faults

Figure 6. A new deformation chronology for the Boscastle area.

of E-W trending sedimentary basins. The Culm flysch basin was a symmetrical basin with a density contrast > 4% across its southern margin. These boundary conditions were favourable for the wedging of denser Boscastle and Tintagel successions beneath the less dense Culm sediments. Wedging of sedimentary basins provides a mechanism for the occurrence of early south-facing folding in north Cornwall within a northward propagating system, with the backthrusting of the contents of sedimentary basins controlled by basin geometry and in this case aided by a density contrast across its southern margin. The Dl south-facing deformation is therefore considered to be strongly diachronous across north Cornwall.

There remains a problem in providing the necessary uplift to source Famennian to earliest-Namurian paralic and deltaic sediments of central south-west England and north Cornwall (Boscastle Succession in this area). Facies modelling (Selwood and Thomas 1986b) led to the suggestion of a southerly source of sediment, with deposition occurring syntectonically in advance of the northerly progress of the Carrick Nappe. These rocks were subsequently transported tens of kilometres northwards as the furthest travelled nappes. The early structural history of these rocks involves southerly transport, it is therefore structurally more favourable to maintain these successions within the region of D1 south-facing structures between the Culm Synclinorium and the Padstow Confrontation Zone. The question as to the source of these sediments is left open.

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