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10th October, 1968.

A SEISMIC REFRACTION LINE ACROSS THE SOLENT

SIR,—We would like to present the results of a reversed seismic refraction line shot between Thorns Beach (SZ39309610), on the mainland of Hampshire and Elmsworth Brickworks (SZ46209228), near Newtown on the Isle of Wight, a distance of about 5 km.

Reversal was obtained by firing, in either direction, a series of shots across the Solent, the geophone spread being laid on land. The technique adopted was similar to that described by Griffiths *et al.*, (1961).

A total of twenty shots was fired at sea, eleven on the line shot towards Thorns Beach and nine on the line shot towards Elmsworth Brickworks. Charges varied in weight from 0.5 kg to 2 kg. Water depths beneath each shot were recorded. The shot positions were fixed by theodolite bearings observed from two survey stations situated on land at each end of an accurately measured base line. Error in reading the bearings is estimated to be of the order of 2 minutes of arc. Thus at a distance of 3km the error in shot position is of the order of 6.5 m. This is considered to be one of the principal sources of error in this survey.

The time-distance graph obtained for the reversed line is shown in Figure 1. To simplify presentation the arrival data plotted is for the geophone nearest to the shot. A correction has been applied to these arrival times for variation of water depth.

No direct arrivals were observed, but the time for the shot nearest to either end of the line can be used to give a limiting maximum velocity for the top layer. In both cases this is calculated to be less than 1,700 m/sec (5,600 ft/sec). A short reversed line fired at Thorns Beach gave a near surface velocity of $1{,}660 \pm 6$ m/sec ($5{,}450 \pm 20$ ft/sec). This velocity is used for the surface layer (layer 1) in the interpretation.

The apparent velocities and their intercepts together with standard errors are summarized in Table 1. Figure 2 presents our interpretation of the depths to the refractors. This indicates that the three main refractors rise slightly towards the mainland.

The lowermost refractor (layer 3/layer 4 interface) we consider to be the Tertiary-Cretaceous unconformity, which Wooldridge & Linton (1955) have estimated to be about 500 m deep in this area.

Layer 4 with velocity of 3,500 m/sec must consequently be the Chalk. Laboratory determinations by Laughton & Stride (1957), for a stratigraphic profile within the Chalk at Flamborough Head, indicate a velocity range from 3,000 m/sec to 5,000 m/sec. More recently, commercial seismic investigations in the North Sea (Cook, 1965) reveal a compressional wave velocity for the Chalk of approximately 3,650 m/sec. These velocities are appreciably higher than velocities for the Chalk obtained by Bullard *et al.* (1940) in eastern England (1,930–2,520 m/sec), and Day *et al.* (1956) in the English Channel and the Western Approaches (2,290–2,440 m/sec). Stride (1959) suggested that a velocity of 3,000 m/sec observed in refraction surveys over the Dogger Bank may represent the Chalk, but could include Upper Palaeozoic and/or other Mesozoic rocks.

The velocities for the Tertiary sequence within the Solent area compare with the class I velocities (1,700–2,500 m/sec) obtained from seismic refraction studies in the English Channel by Hill & King (1953), and Day *et al.* (1956), who identified this velocity interval as Mesozoic and/or Tertiary strata.

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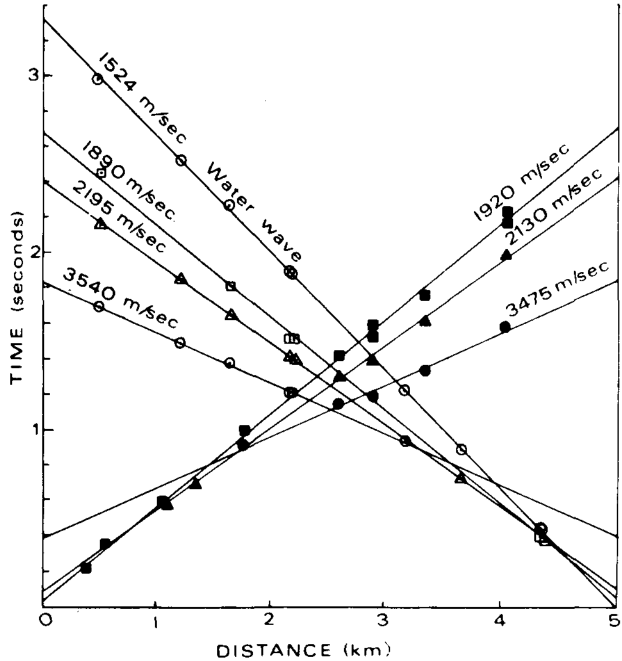

FIG.1.–Time-distance data. (Distances from Thorns Beach).

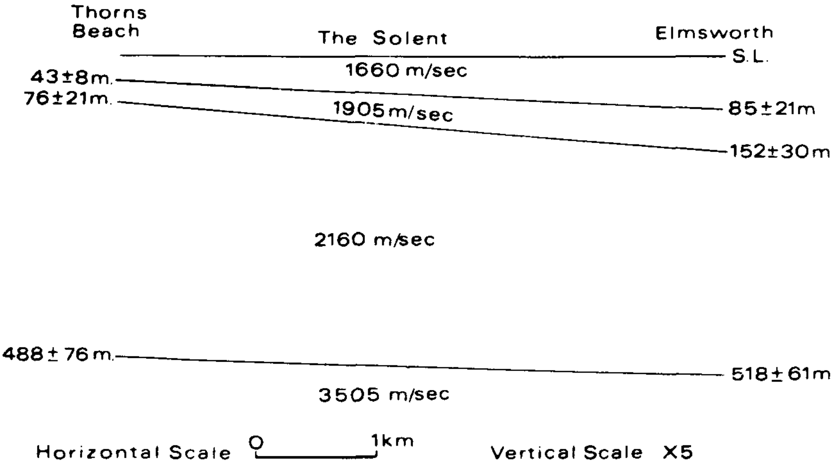

FIG.2.–Seismic interpretation.

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TABLE I.–SUMMARY OF VELOCITIES AND INTERCEPTS

	ARRIVALS AT THORNS BEACH		ARRIVALS AT ELMSWORTH BRICKWORKS	
	Apparent velocity m/sec (ft/sec)	Intercept Time msec	Apparent velocity m/sec (ft/sec)	Intercept Time msec
LAYER 1	1,660 ± 6 (5,450 ± 20)	-	1,660 ± 6 (5,450 ± 20)	-
LAYER 2	1,920 ± 60 (6,300 ± 200)	30 ± 6	1,890 ± 60 (6,200 ± 200)	50 ± 12
LAYER 3	2,130 ± 60 (7,000 ± 200)	55 ± 20	2,195 ± 60 (7,200 ± 200)	100 ± 15
LAYER 4	3,475 ± 150 (11,400 ± 500)	380 ± 50	3,540 ± 60 (11,600 ± 200)	410 ± 25

Compressional wave velocities were determined in the laboratory for a selection of samples taken from various horizons within the Tertiary sequence of the Isle of Wight. Apart from the high velocities observed for the freshwater limestones, the bulk of the Eocene succession shows uniformly low values, with the Barton Beds having marginally lower velocities than the underlying Bracklesham Beds. The limestones in the upper part of the sequence are too thin to act as well defined refractors over the range involved here as such a seismic signal attenuates rapidly (Bullard *et al.*, 1940).

Recognition of the layer 3/layer 4 interface as the Tertiary-Cretaceous unconformity allows us to attempt to correlate layers 3, 2 and 1 with existing geological divisions within the Tertiary sequence of the Hampshire Basin (Hodson & Shelford, 1964). Some control for this correlation is provided by the presence of Bembridge Limestone outcropping on the foreshore near the Elmsworth end of the seismic line. The seismic layering cannot therefore refer to any strata younger than the Bembridge Limestone. The method used here, however, does not allow us to resolve the presence of any shallow recent sediments along the central portion of our refraction line within the Solent itself.

The bulk of the Tertiary sequence in the Solent area is represented by layer 3 with a thickness of approximately 390 m and an associated compressional wave velocity of 2,160 m/sec. Addition of the thickness of Tertiary strata, obtained from measured sections in the Isle of Wight and boreholes on the mainland gives an approximate thickness of 358 m for Reading Beds, London Clay, Bagshot and Bracklesham Beds. Tentatively, therefore, we suggest that the layer 3/layer 2 interface marks the junction of the Bracklesham Beds with the overlying Barton Beds.

In our seismic interpretation layer 2 clearly thins towards the mainland. It is 67 m thick at Elmsworth and 33 m thick at Thorns Beach. Comparison with geological observations indicates an interesting similarity in the thinning of the Lower and Middle Barton Beds (Barton Clay) from the Isle of Wight to the type section at Barton-on-Sea.

At Alum Bay these beds have a thickness of 75 m which is reduced to 38 m at Barton-on-Sea. The succeeding Upper Barton Beds (Barton Sands and Headon Hill Sands, in the Isle of Wight) offer a good lithological contrast from the underlying clays. At present, it seems reasonable, therefore, to correlate our layer 2 with the Barton clays, with the layer 1/layer 2 interface marking the junction between the clays and the predominantly sandy lithology of the Upper Barton Beds. Layer 1 would consist of the Upper Barton Beds together with the varied lithologies of the Lower Headon Beds and the succeeding Oligocene strata, possibly upwards as far as the Osborne Beds.

These estimates of thickness may be subject to error due to unknown lateral variations both in lithology and in individual bed thickness. However, the estimates do indicate approximately the expected cumulative thickness within the area. More specific indentification of layers 1, 2 and 3 should be possible when further information is obtained from velocities observed from outcrop shooting within the Hampshire Basin.

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21st October, 1968.

A GRAVITY INTERPRETATION OF THE LIRUEI RING COMPLEX, NIGERIA

SIR,–I should like to consider some implications of Miss Ajakaiye's most welcome paper (*Geol. Mag.*, **105**, 256–263). The finding of a pronounced negative anomaly was to be expected in the Liruei complex, which consists almost entirely of granitic rocks with only insignificant amounts of basic rocks exposed at the surface. The almost completely acidic nature of the Nigerian Younger Granite province has long been recognised from surface mapping. The geophysical evidence from Liruei now shows that these granitic ring-complexes are unlikely to be associated with large basic intrusions at depth.

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