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SIMPLE GAMMA-RAY RESPONSE OF THE UPPER JURASSIC FROM THE DORSET COAST — A PRELIMINARY INVESTIGATION USING THE SCINTILLOMETER PROFILE TECHNIQUE

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Surface gamma-ray logs or scintillometer profiles are not widely used but are a potentially valuable approach to stratigraphic correlation in regional field surveys, given suitable continuous outcrop (Chamberlain, 1984): Myers (1987) gives a detailed review of surface gamma-ray spectrometry. The gamma-ray detector provides a rapid method of measuring the concentration of the three main naturally occurring radio-elements Th, U and ^{40}K (Myers, 1989) to be found in rocks. Where a total count of the radio-activity is obtained, this is known as a Simple Gamma-Ray Log **(GR).** An analysis may also be made allowing for the differentiation between the radio-elements to give the relative proportion of each, this is the Spectral Gamma-Ray Log **(SGR),** and is possible because the radio-elements concerned have distinct energy spectra.

This investigation was undertaken to assess the value and application of GR logs in the lithological interpretation of the coastal Corallian succession and, secondly, towards any pertinent correlations that might be made across the west Wessex Basin, as a result of comparing our own field-generated GR profiles with those provided by the British Geological Survey (BGS). This paper provides the first description of GR signatures for the Corallian succession at Osmington Mills and Bran Point, and also the first published attempt at using this technique for correlation purposes within the Wessex Basin.

Using a Gamma-Ray Integrating Spectrometer, a field study of GR emissions was conducted on part of the Upper Jurassic (Corallian) succession on the Dorset Coast at Osmington Mills and Bran Point.

Recent remapping by BGS in the Shaftesbury/Wincanton area, and the drilling of three cored boreholes has established a detailed stratigraphy for the Corallian Group of inland Dorset (Bristow, 1989, 1990; Freshney, 1990). In this study, two of the boreholes, East Stour [ST 8013 2297] and Cannings Court [ST 7187 6734] were examined. A correlation of the GR logs from East Stour and Cannings Court boreholes, with surface-generated GR profiles compiled on the coast is attempted (Figure 1).

The stratal nomenclature used in this work for the coastal sequence is taken from Wright (1986). The cliff section studied between Osmington Mills and Bran Point (see Wilson, 1968a,b; Talbot, 1973a,b; Wright, 1986; Sun, 1989) comprises the Bencliff Grit Member of the Redcliff Formation: the Upton Member, Shortlake Member and Nodular Rubble of the Osmington Oolite Formation, and the Trigonia clavellata Formation. The nomenclature used for the two BGS boreholes is taken from Bristow (1989).

The Gamma-Ray Integrating Spectrometer used was a Scintrex Scintillation Counter (SSC). The unit comes in two parts: a hand-held probe (placed on the rock surface) and a control box (on a strap, hung around the neck), which houses the electronics and battery source. The two are connected with a cable. The circuitry includes gamma-ray energy discrimination enabling the determination of Th, U and ^{40}K anomalies for detailed quantitative studies (SGR) if required. For our purposes, a total count (GR) was all that was needed to make a comparison with the BGS logs. There is a feedback loop which stabilizes the gamma spectrum in energy, using a reference gamma-ray source and continuous re-calibration of the tool. This is essential as the response of the detector changes with temperature.

The units on the coast were logged and sampled (for micropalaeontological work). With the tape measure still in position, the sections were studied using the SSC, and the readings recorded alongside the lithological logs.

Fresh flat sections, vertical in this study, are needed to make accurate readings. Due to varying lithology, it was decided to take readings as close together as possible, to provide greater resolution. The SSC probe is 10 cm in width and so, with a 10 cm sampling frequency, the counter was placed end on end allowing total coverage of any given section. Sampling duration (or the time constant) was between 3 and 6 seconds, allowing the unit to re-calibrate and time to take averaged readings. Readings were averaged from a swinging pointer on a dial meter. Whilst appearing somewhat arbitrary, it is the relative values between readings which provide the distinctive profile and not the absolute values. The unit of measure used in both the BGS and coastal profiles was counts per second. Generally, the principal contribution to the radioactivity detected by the SSC will come from within 30 cm of the detector both horizontally and vertically (Rider, 1986).

The exposed Corallian sequence at Osmington Mills/Bran Point comprises shales, argillaceous sands and silts, heterolithic fine-grained sediments, oolitic limestones, bio-oomicrites, nodular limestones, nodular oolitic limestones and preserved organic carbon. As expected, this complex lithology elicited a varying signature response (Figure 1). By comparing the gamma-ray logs and the lithology, trends in the signature became apparent.

At the base of the Bencliff Grit Member, there are argillaceous fine sands/silts, these become sandier and slightly coarser-grained toward the top resulting in a lower gamma-ray count (Figure 1). There are also 'kicks' at unit boundaries, resulting from erosion or omission surfaces. The Upton Member is composed of a series of interbedded limestones and shales: the GR log responded well to this by producing a well-spaced, serrated signature, particularly towards the top, which consists of regularly interbedded limestones and shales with high frequency (Figure 1). The basal Shortlake Member is composed of oolitic limestone which produces a low response. The upper part of this member is composed of interbedded clays and micritic limestones, hence the higher values and a highly serrated signature.

Limited scope exists for correlation between the coast, Cannings Court and East Stour sections. The only unit lithologically equivalent between these areas is the Trigonia clavellata Formation: a peak within the lower part of this formation can he recognised from all three logs. In sand and shale sequences correlations become extremely complex (Rider, 1986). Combined with the presence of interbedded limestones and facies variations between the areas studied, direct correlation becomes subjective. Responses elicited below the Trigonia clavellata Formation after the digitization of the Osmington Mills/Bran Point section produce certain trends that may be considered equivalent (though do not appear to be directly correlatable) but it is felt that data from other borehole sections and de-classified company logs closer to the studied coastal section would initially produce more reliable comparisons. Whittaker *et al* (1985) illustrated a gamma-ray log from the BGS Winterbourne Kingston Borehole and provide a useful account of varying signature responses from the Upper Jurassic of Britain. Unfortunately however, the log produced

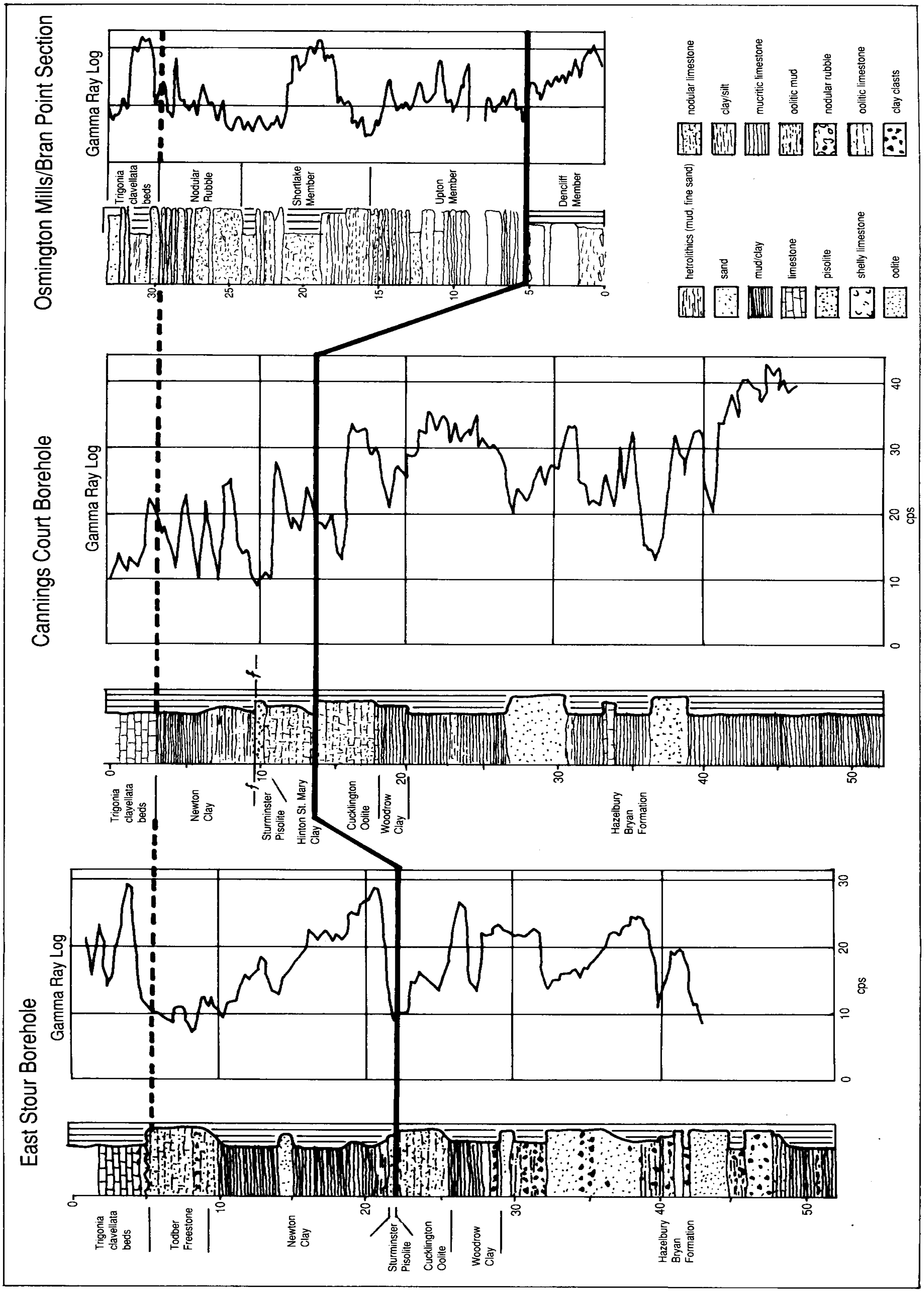

Figure 1: A comparison of the East Stour/Cannings Court boreholes (courtesy, BGS) and the Osmington Mills/Bran Point log.

the log produced does not have high enough resolution to permit direct comparisons with our surface-generated logs.

Gamma-ray logs are useful and have advantages for correlation especially when this concerns shale sequences, however, the lithologies under review in this area are not composed entirely of shales, and there is an obvious variability in the depositional environments which have shown themselves to be laterally impersistent over the basin. As a result, the gamma-ray signatures are seen to be individualistic.

We have attempted to apply GR field logging in our studies as a logical extension to normal data-gathering facilities, and have used GR profiles as an aid to our research, and not as an end in themselves. They have been, and are to be, used in conjunction with logged sections as well as macro/ microbiostratigraphic control. Further investigations on the Th, ^{40}K and U contents will provide new data not available from borehole logs. We believe the GR technique will prove to be a useful addition to research. With on-going investigations into the microfaunal elements to be found in both inland and coastal sections, it may be possible in the future to determine a viable integrated event-stratigraphy for the area.

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REFERENCES

ARKELL, W. J. 1936. The Corallian Beds of Dorset. Pt. 1, the coast. *Proceedings of the Dorset Archaeological and Natural History Society,* **57**, 59-93.

BRISTOW, C. R. 1989. *Geology of the East Stour-Shaftsbury district (Dorset).* British Geological Survey Technical Report No. WA/89/58.

BRISTOW, C. R. 1990. *Geology of the West Stour-Cucklington district.* British Geological Survey Technical Report No. WA/90/48.

CHAMBERLAIN, A. K. 1984. Surface gamma-ray logs: a correlation tool for frontier areas. *American Association of Petroleum Geology Bulletin,* **68 (8)**, 1040-1043.

FRESHNEY, E. C. 1990. *Geology of sheet ST70NW and NE (Hazelbury Bryan-Mappowder district, Dorset).* Technical Report of the British Geological Survey No. WA/90/51.

MYERS, K. L. 1987. Onshore-outcrop gamma-ray spectrometry as a tool in sedimentological studies. Unpublished PhD Thesis, University of London.

MYERS, K. J. 1989. The origin of the Lower Jurassic Cleaveland Ironstone Formation of north-east England: evidence from portable gamma-ray spectrometry. In: *Panerozoic Ironstones.* Eds: T. P. Young and N. E. G. Taylor, Geological Society Special Publication, **46**, 221-228.

RIDER, M. H. 1986. *The Geological Interpretation of Well Logs.* Blackie and Son Ltd. p 175.

SUN, S. Q. 1989. A new interpretation of the Corallian (Upper Jurassic) cycles of the Dorset coast, southern England. *Geological Journal,* **24**, 139-158.

TALBOT, M. R. 1973a. The deposition and diagenesis of the Corallian beds of southern England. Unpublished PhD Thesis, University of Bristol.

TALBOT, M. R. 1973b. Sedimentary cycles in the Corallian beds (Oxfordian) of southern England. *Palaeogeography Palaeoclimatology Palaeoecology*. **14**, 293-317.

WHITTAKER, A., HOLLIDAY, D. A. and PENN, I. E. 1985. *Geophysical Logs in British Stratigraphy.* Geological Society Special Report No. 18.

WILSON, R. C. L. 1968a. Upper Oxfordian palaeogeography of southern England. *Palaeogeography Palaeoclimatology Palaeoecology,* **4**, 5-28.

WILSON, R. C. L. 1968b. Carbonate facies variation within the Osmington Oolite Series in southern England. *Palaeogeography Palaeoclimatology Palaeoecology*. **4**, 89-123.

WRIGHT, J. K. 1986. A new look at the stratigraphy, sedimentology and ammonite fauna of the Corallian Group (Oxfordian) of south Dorset. *Proceedings of the Geologists' Association,* **97(1)**, 1-21.