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3 July 2014

REPORT ON PLANNING APPLICATION Reference SDNP/13/05896/CM)

I have been asked in a letter to me from Mrs L Harding dated 26th June of the South Downs National Park Authority to comment on the application by Celtique Energy Weald Ltd. to drill a petroleum exploration well at Nine Acre Copse, Fernhurst.

I have been specifically asked to address the issues below. My comments are in italic font coloured blue.

Subject: Provision of petroleum geology advice to the South Downs National Park Authority

In December 2013, the South Downs National Park Authority (the Authority) received a planning application (reference SDNP/13/05896/CM) for the development of a temporary exploratory oil and gas well 'Fernhurst-1' at Nine Acre Copse, Fernhurst. The applicant (Celtique Energie Weald Ltd) has also specified that this is not a 'fracking' application. I have carried out a full ES Review, however the Authority would welcome further technical advice with regards to the geology of the Weald Basin and how it relates to this planning application.

Work brief:

We would like you to carry out a critical review of the geological information submitted by the applicant. This consists of:

1. The original planning application submission documentation (environmental statement included); and
2. The further information received in May 2014.

A key difference between the two, is that the further information submission amends the application by removing the horizontal drilling element, the reason for this is not clear.

I have asked Celtique's CEO, Mr Geoff Davies, for further clarification on this amendment. He replied that such queries should come direct from the SDNPA. Celtique's website states that they are not pursuing with the application for a horizontal well to save time and money. It is possible that the issue of trespass by underground drilling may have been a further factor in reaching this decision. Until this matter is resolved it might cause further delay in the application being processed and a decision reached. Recent pronouncements by Michael Fallon, the Minister for Energy & Climate Change, suggest that the issue of trespass may be resolved speedily to allow horizontal drilling below a depth of 300m to not require the permission of the landowner.

As part of the critical review, we would like to understand:

- a) The consistency, accuracy and level of completeness of the geological information submitted. Is the information submitted with the application consistent with other sources of geological data/research for the Weald Basin?

The geological information of the application is consistent, accurate and sufficiently complete. In particular it is consistent with the definitive published report on the Weald by:

Andrews IJ 2014. The Jurassic Shales of the Weald Basin: geology and oil & gas resource estimates. British Geological a Survey for the Department of Energy & Climate Change. London 79pp.

Swan, G & Munns J. 2003. The Hydrocarbon Prospectivity of Britain's Onshore Basins. Department of Trade & industry. London. 81pp.

The Fernhurst well must regarded as high risk. The reservoir characteristics of the Kimmeridge limestones are unknown. Furthermore the BGS study suggests that only a small thickness of the Kimmeridge Clay source rock may have been heated sufficiently to generate oil.

- b) To understand the target formations within PEDL 231 and how they compare to those outside the PEDL boundary, but within the Weald Basin. Can the same geology be found outside PEDL 231?

*The general geology of the Weald is very well known after nearly 200 years of research. The surface geology has been mapped both by the British Geological Survey, by academic and amateur geologists (**Figure 1.**).*

*The subsurface geology of the Weald is less well known, obviously, though many wells have been drilled across the basin since the Netherfield wells in 1875. The Weald is a basin of sedimentary rocks (limestones, sandstones & mud rocks) deposited layer on layer over many millions of years. Surface mapping and subsurface boreholes show that the main rock units are laterally continuous across the Weald (**Figure 2**) though there are some minor changes in rock type across the basin.*

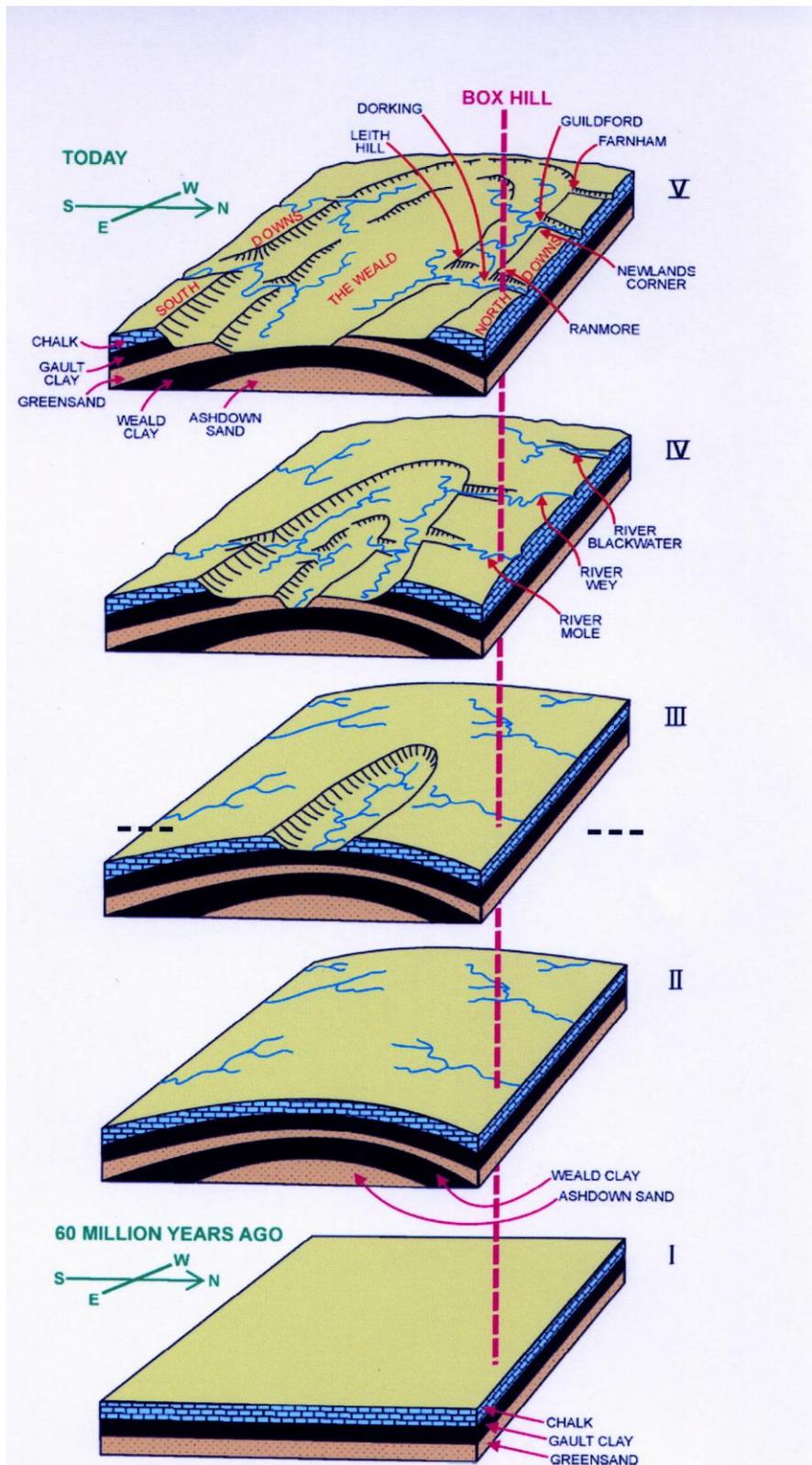


FIGURE 1. Diagrams to illustrate the surface geology & evolution of the landscape of the Weald. From Selley, R.C. 2006. *The Box Hill & Mole Valley Book of Geology*. Published by the Friends of Box Hill. Dorking. 35PP.

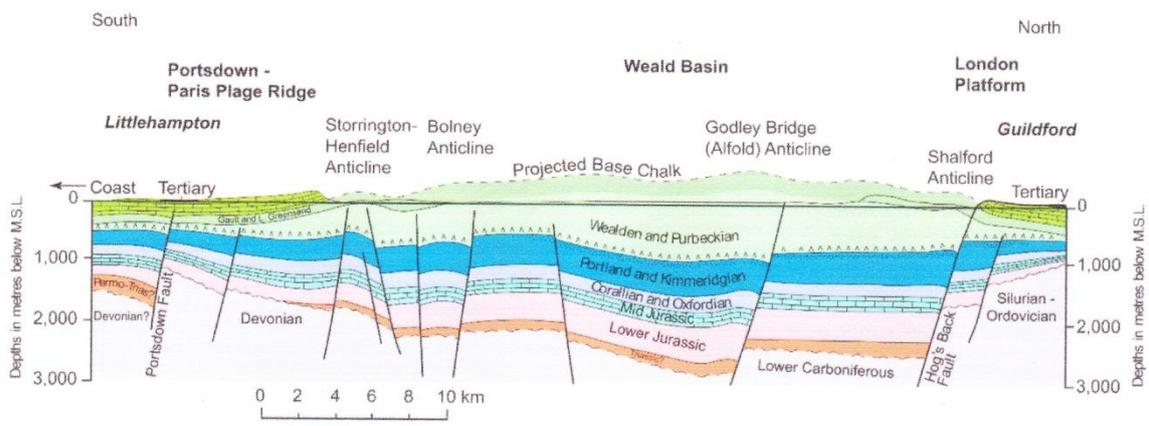


Figure 2. South to North cross-section of the Weald basin showing the continuity of the various rock strata. From Butler M. & Pullan C.P. 1990. Tertiary structures and hydrocarbon entrapment in the Weald basin of southern England. In: Hardman, RFP & Brooks J (Ads.) Sp. Pub. Geol Soc Lond. 55. 371-391.

Figure 3 shows the producing oil & gas fields of the Weald that provide information of known source rocks and reservoirs, and can be used to predict their distribution. Some variations in source rock and reservoir quality have been observed.

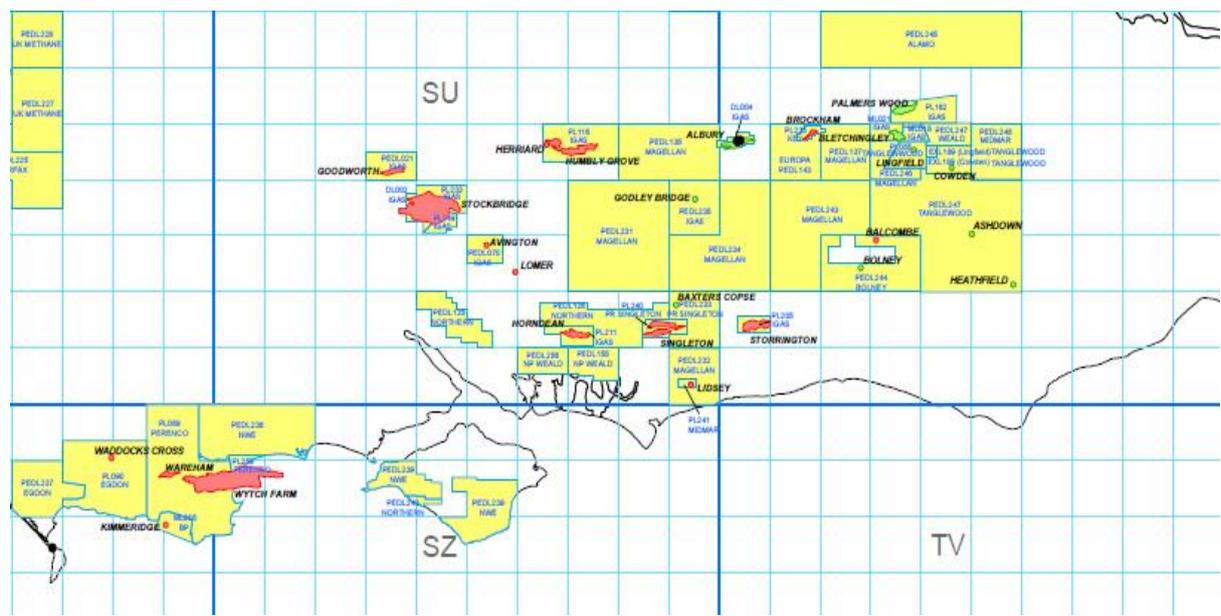


Figure 3. Map showing the location of Wealden oil & gas fields that provide evidence of reservoirs and their continuity © Department of Trade & Industry.

- c) Some of the basics behind petroleum geology and terminology (e.g. Is the Weald Basin a 'prospect' and if not, what is the difference between a 'prospect' and a 'target horizon'?)

Figure 4 is a stratigraphic column that shows the sequence of rocks to be encountered across the Weald. This figure also shows the rock strata which are petroleum reservoirs for the various oil & gas fields of the basin. In the petroleum industry the term **'prospect'** is applied to a location where it is possible that petroleum may be trapped and that merits testing by drilling. The term **'prospective'** is applied to an area where evidence suggests that petroleum may be trapped.

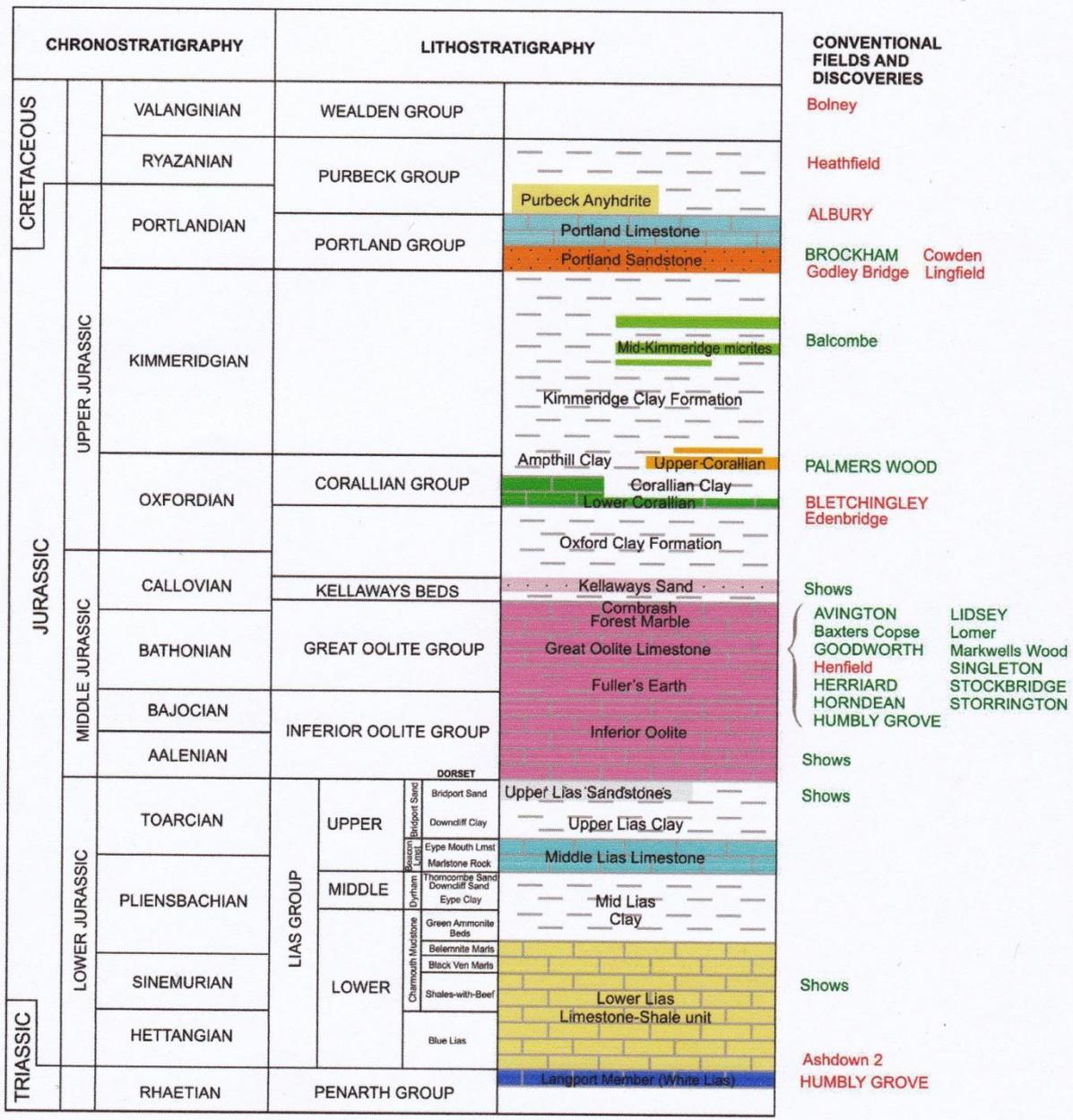


FIGURE 4 Summary of the sequence of rock of the Weald basin showing the main petroleum reservoirs. From: Andrews. 2014. © Department of Industry & Climate Change.

Thus the Weald basin is known to be **prospective** because it contains many producing oil and gas fields. A **prospect** has been identified beneath Nine Acre Copse that merits drilling.

A **target** horizon is a layer of rock, generally sedimentary (sandstone or limestone), that may contain petroleum, i.e. has the potential to be a petroleum reservoir, i.e. has porosity (pore spaces to hold petroleum) and permeability- the pores are interconnected, enabling petroleum and water to flow through the rock. Thus there are two **targets** for the Nine Acre Copse **prospect**: the Kimmeridge Limestones (Upper Jurassic) and the Great Oolite (Middle Jurassic).

The Great Oolite is a major petroleum reservoir across the Weald basin producing oil in many fields such as Singleton, Storrington and Lydney. The Kimmeridge Limestone target is not yet a proven reservoir in the Wessex Basin. This was the target for Cuadrilla's well at Balcombe.

- d) To understand the porosity of the primary target; Kimmeridge Limestone formation and the secondary target; Great Oolite formation and the likelihood of whether the oil would be free flowing or trapped and require fracking.

The **Kimmeridge** Clay is a thick formation that is largely composed of mud that contains within it thin layers of fine-grained limestone. The Kimmeridge Clay has a high content of organic matter. This has generated petroleum in some areas, notably the North Sea, where it is the main source rock for North Sea petroleum. Within the Weald basin the thin limestone beds are particularly well –developed forming the rock unit that is termed the Kimmeridge Limestone. It must be understood that this is not a bed of solid limestone many metres thick but a sequence of thinly inter-bedded limestones and clays. The limestones have negligible porosity and permeability, but they are brittle and naturally fractured due to earth movements. Petroleum can migrate from the organic rich clay beds into the intervening naturally fractured limestones. Colloquially Americans call this the 'Oreo cooky' model (An oreo cooky is a biscuit composed of alternate layers of crisp biscuit and viscous sugary confection) **Figure 5**. This situation produces petroleum in the Franciscan cherts of California and the Bakken shale of Illinois. When the shale gas industry began in 1821 production was solely from natural fractures. The artificial fracturing of conventional reservoirs (sandstones and limestones) began in the late 19th century. For many decades explosives were used, more recently the less exciting and more environmentally friendly hydraulic fracturing was developed in the 1940's, first for conventional reservoirs and then for shale in the late 20th century.



FIGURE 5. Upper: Photo of a vertically arranged pile of Oreo™ Cookies showing interbedded brittle biscuit and unctuous cream.



FIGURE 5. Lower. Outcrop of Kimmeridge Clay showing alternation of soft grey shale (source rock), and brittle fractured limestone (Reservoir –hopefully).

The **Great Oolite** is a limestone with good porosity and permeability. It is a type of rock that is a major petroleum reservoir around the world and in Arabia in particular. In some cases the carbonate grains are completely un-cemented, but generally there is some mineral cement that infills pores and thus diminishes both porosity and permeability. In such cases the rock is hydraulically fractured and flushed through with acid to leach out some of the carbonate and thus increase flow rate. The Great Oolite is a major producer of petroleum across the Weald basin in the Storrington, Singleton, Humbly Grove, Stockbridge, Baxter's Copse, Lidsey and Goodworth fields (Refer back to Figure 4).

- END -

CONFLICT OF INTEREST STATEMENT

I am not currently, nor have been, nor expect to be involved with Celtique Energy and/or its partners as a consultant or shareholder. I have, in the past, consulted for several companies exploring for petroleum in the Weald and across the whole UK. I have no consulting arrangements in the Weald at the present time.

Richard C Selley

3 July 2014