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Reply to Discussion on 'A thermal maturity map, based on vitrinite reflectance of British coals', Journal of the Geological Society, London, 176, 1136-1142.

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We welcome the comments of Smith and Rippon (2021) about our map of vitrinite reflectance data derived from Carboniferous coal in Britain. The essence of their contribution is that our map is based upon a limited database (103 samples). We are well aware that data is available for other localities, at a range of depths within mines, and in some cases with details of statistical accuracy. Smith and Rippon conclude that the data available is too extensive to make it possible to produce a summary map. That is possibly why, despite the heritage of coal studies in Britain, such a map has not been published. However, the scale at which we have resolved variations in the reflectance values, simplified further in Figure 1, allows realization of the tremendous educational potential in the data. Our purpose was to produce a map, and we have employed a data base appropriate to do so, rather than assemble a national data base, which is the responsibility of others.

The map covers the whole of Britain. The higher values relate to the North Atlantic Igneous Province, high heat flow granites, and the Variscan Orogeny (Figure 1). The test of whether our data base has been too limited is to assess the effect of additional data on a north-south transect spanning the length of the map. The transect distinguishes the key features of the Midland Valley of Scotland, the high heat flow region of northern England, the cooler basins of central England, and the hotter regime in the vicinity of the Variscan Front. Additions to our data base to include the recommended structural and stratigraphic complexities do not change this pattern, or advance the educational value that it provides.

Smith and Rippon (2021) suggest that our referencing of reflectance data from oil and gas literature is not appropriate. Nowhere do we use this data to support our map of coal data. We only refer to these studies, in our introduction, to show how reflectance data can be used, which is consistent with the educational nature of our compilation.

In addition to the geological context, variations in reflectance data have a wider educational potential which show how geology links to diverse aspects of society. Here we suggest a range of topics that might be evaluated at either school or university level with different nuance. Each of these points is a result of variations in the thermal maturity (vitrinite reflectance) of coal across Britain:

(i) In the First World War, much of the Royal Navy was based in northern Scotland, but warships were fuelled with coal transported from South Wales, the most distant large British coal field. (the coal in South Wales had the required volatility)

(ii) Many coal miners suffered from the occupational lung disease pneumoconiosis, which is known to vary with coal rank (Landen et al. 2011). The incidence of the disease varied across the South Wales coalfield (Michael 2008), but was uniform across Scotland (Black 1953). (Rank varies across South Wales, but not across Scotland)

(iii) Steam locomotives built in different parts of Britain required different designs, to burn the 'local' coal. Britain's numerous heritage steam railways need coal with optimum qualities, and hence from particular places, to burn reliably (Mitchell & Brignall 2019). (Welsh Steam Coal is optimal)

(iv) Controversial plans for new coal mining in Britain emphasize its value in making carbon steel (West Cumbria Mining Ltd. 2018), which uses coal with a particular volatility, and therefore is distributed in certain regions. (Identified in Cumbria)

The map also serves to show the extent of British coal deposits, including former mining regions in localities such as Anglesey, West Shropshire and the Island of Bute, which are largely forgotten. Coal resources may be largely of historic interest, but their environmental legacy is substantial, and therefore of relevance today. For example, the map of coal deposits across Britain helps to understand the distribution of ‘orange rivers’ (Robinson 2018, Brown 2020, Warrender 2020), and links aqueous geochemistry to current ecology.

We look forward to seeing a more detailed map of thermal maturity published by other authors. In the meantime, the student of British coal deposits would do well to read the work of Williams (1789), which is full of information and scientific conjecture about our coal and other resources, and which was published before such luminaries of British geology as Lyell and Murchison were born.

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Figure caption

Fig. 1. Mean vitrinite reflectance values (Ro %) for coalfields of Great Britain, particularly distinguishing values <1.0 % (typical sedimentary basins) and values >1.0 % (anomalous heating, reasons shown). Localized heating due to small igneous intrusions omitted. Exposed British coalfields (grey) shown.