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Mr R Bennett
c/o West Cumbrian MRWS Partnership
Copeland Borough Council
The Copeland Centre
Catherine Street
WHITEHAVEN
Cumbria CA28 7SJ
[by email only]

Dear Mr Bennett

**Comments on MRWS Document 285: geological document review of
consultation submission by FWS Consultants Ltd**

I wish to comment on the above document from Dr Jeremy Dearlove of FWS Consultants Ltd, dated 18 June 2012.

The letter contains one positive development; that by omitting to include the 'BUSC' category of rocks, such as the Borrowdale Volcanic Group (which was the target host rock at Longlands Farm), **Dr Dearlove now appears to concede that there is no further prospect of re-investigating the coastal zone of West Cumbria.**

However, he persists in asserting that there remain "*at least*" two specific rock volumes that in his view warrant further study, so that proceeding to MRWS Stage 4 is justified. In my view we already know enough about these two rock volumes to say that they do not hold any promise whatsoever. No other potential rock volumes are mentioned, therefore they must be discounted.

I now discuss his letter under three headings, respectively: 1. Mercia Mudstone Group, 2. Granitic Rocks (the two rock volumes in question), and 3. Methodology.

1. Mercia Mudstone Group (MMG)

My analysis of the MMG comprised 11 pages of text and one diagram, to which can be added another page or so of text and two more diagrams, if one includes the hydrocarbon prospectivity of northern Allerdale in the analysis. I concluded with a summary list of ten reasons why the MMG is unsuitable as a repository host rock (my consultation response, section 4.7.9). I repeat these below, in bold italics, each one followed by comments on how and whether Dr Dearlove has satisfactorily answered these objections.

1. The MMG was (rightly) not previously considered as a host rock by the BGS during its national search in the late 1980s.

Dr Dearlove states:

“Figure 2.1.1 (b) in Smythe's submission identifies the area including the MMG as "areas of potentially suitable sedimentary rocks" following Dr Chapman's 1986 review.” (my underlining).

This statement is wrong and misleading; although there was an oval patch of sedimentary rocks marked by Chapman and his colleagues, at a place where the MMG is present, the patch refers specifically to older Permian rocks, whereas all the MMG in West Cumbria was explicitly excluded. I thought I had clarified this in my consultation, but for the avoidance of doubt I provide a few more details in Appendix A below. In addition, a specific site on the MMG in the Solway plain, Anthorn Airfield, was considered during the national site search of 1988-89, and rejected on geological grounds. It is shown in my consultation response, fig. 4.7.1.

2. This region is the subject of current hydrocarbon exploration licences and should be excluded.

Not discussed in the context of possible intrusion.

3. The regional hydraulic gradient is high, contrary to international guidelines.

Not discussed in detail, but Dr Dearlove claims that the Solway plain should be considered as being remote from the Cumbrian mountains, so that the hydraulic gradient which drives groundwater flow is low.

4. A repository would have to be sited at an undesirably shallow depth of between 200 and 500 m.

Not discussed.

5. The one candidate area with these depths available, near Silloth, is bisected by normal faults with throws of up to 100 m, which may act as water conduits.

Dr Dearlove cites a BGS paper from 2009, in which it is stated that faults in the MMG of the Cheshire basin do not act as pathways for fluid migration. But he misses the point that because of the essentially unknowable fluid-flow properties of faults, the only rational course is to avoid any rock volume that is faulted. I provide more details of this topic in Appendix B below.

6. The geology is well understood, thanks to oil industry seismic and the Silloth-1A well.

Dr Dearlove agrees with this conclusion, while asserting that only the BGS is competent to analyse the suitability of the MMG.

7. The geochemical environment of these haematite-bearing red beds is oxidising.

No comment.

8. The groundwater is fresh, and exploited within this zone as an aquifer.

No comment.

9. The hydraulic conductivity is 10^4 to 10^6 times higher than that considered desirable by reference both to international guidelines and to current international practice.

Dr Dearlove merely refers to the MMG as being of “low permeability”, but refuses to go into any deeper-level analysis.

10. It is an ineffective seal for hydrocarbons if less than at least 600 m thick; this is a priori hydrogeological evidence that if used as a repository host rock it will be ineffective as a barrier.

Not commented upon.

2. Granitic rocks

My analysis of the Eskdale granite, within the wider context of the overall ‘mother’ granite body, the Lake District batholith, ran to over 7 pages of text and 16 diagrams. Dr Dearlove makes no substantive comment on any of this evidence. He resorts instead to vague, blanket denials of the problems of heavy fracturing within the granites and the extreme topography, with phrases such as “*a detailed assessment ... is currently not available*”. He makes no mention of the fact that the Lake District granites were excluded from the late 1980s BGS national site search.

On the question of the extreme topography driving water flow, he speculates on a simplistic version of a perfect unfractured granite with possibly elevated porosity but low permeability, so that the hydraulic gradient may be high but groundwater nevertheless does not flow. I maintain, from published BGS maps and reports, that the Eskdale and Ennerdale granites are both highly fractured. Therefore they will have a significant permeability. I showed examples of the mapped major faults cutting the Eskdale granite in my consultation response figures 4.8.4 and 4.8.5. In addition, the Lake District Boundary Fault, one of the UK’s main fault-lines, bounds the western edge of the Eskdale granite.

Dr Dearlove appears to have forgotten about the complex interleaved structure of these two granites, as viewed in a vertical plane (see my consultation figure 4.8.9, taken from the BGS). There is an interleaving of ‘country’ (pre-existing) rock with the granite intrusion, as well as ‘rafts’ of country rock suspended within the granite body. Lastly, in view of the fact that both granites pre-date the continental collision in which Europe and North America were scrunched together, with the Lake District caught locally in the middle, it is well-nigh impossible to imagine that these granite bodies somehow survived unscathed. The fact is that they did not. The fractures that the BGS have mapped are probably just a small proportion of those that exist.

I am further surprised with his claim that the Lake District batholith meets “*the current international guidelines for a potentially suitable Geological Disposal Facility*”. This claim is so surprising that Dr Dearlove really must provide the detailed evidence to substantiate it. Section 3 of my consultation response reviewed the international site search criteria and practice, from 1997 to the current date.

3. Methodology

The MRWS Partnership appears to be in a quandary about the geology of the Partnership area. I have been criticising the process since before the publication of the BGS screening report in October 2010, and by way of answer to my submissions, the Partnership has several times employed Dr Dearlove to try to counter my arguments. All that debate was incorporated into my own consultation submission. It is therefore surprising that, instead of trying to resolve the issues by inviting a genuinely independent expert, the Partnership has now called in Dr Dearlove again, to ‘arbitrate’ on a debate on which he has evidently taken the opposing side – not just to that of myself, but also to that of Professor Haszeldine, Mr. McDonald and Mr. Knipe, who all largely share my views.

In my view there is no real debate left or doubt remaining; we know more than enough already to rule out the entire Partnership area from further consideration. The Partnership has also invited the Lead Inspector and his Assessor to speak to them. They are without doubt both expert and independent, but whether or not they had had sufficient opportunity to review all the latest evidence in detail, at the date of the meeting on 29 March 2012, is moot. Nevertheless, the Partnership evidently received very little support from them on the question of whether or not to move to Stage 4.

Dr Dearlove’s letter comprises a mere three pages of substantive text, in which he tries to summarise the following:

- **Smythe:** c. 70 pages substantive text, plus 70 diagrams and 94 references.
- **Haszeldine :** 14 pages of text with 16 diagrams therein, including new unpublished work on heating effects of HLW in a Sellafield-type location.
- **McDonald and Knipe:** Summary review, in oral form, minuted by MRWS, of the Inquiry Inspector's and his Assessor's views of the likelihood of a suitable site being found in West Cumbria; their presentation was based on their meticulous scrutiny of thousands of pages of technical submissions from both Nirex and the Objectors, dating from 1995-96, but updated to current geological knowledge and legal framework.

Dr Dearlove's so-called 'document review' is not what it purports to be; it is merely a *threadbare denial* of detailed evidence, with no attempt to refute any of the arguments put forward to show that the two rock formations in question are unsuitable. In at least two places he appears to misquote clear evidence (see Appendix A for one example, and the remarks attributed to Mr Knipe below for another).

Referring specifically to the MMG, the McDonald & Knipe presentation minutes state (section 5.5):

"Mercia Mudstones were identified for Nirex as potentially favourable geologically (equivalent of White Paper Stage 4) but no MMG Site was brought forward into the final lists (equivalent of Stage 5) ... we concur with rejection as MMG there not deep or thick enough, and has conductive horizons". [my underlining; also note that MMG was identified as stated at various locations in England and Wales for Nirex, but excluding West Cumbria; see Appendix A below].

Dr Dearlove has misunderstood this clear conclusion, and attributes to Mr Knipe comments that he apparently did not make, and are in fact contradicted by the minutes. Dr Dearlove states:

*"I also agree with Mr Knipe's comments that, whilst not currently ruled out, the prospect of finding sufficient volume of suitable rock in the MMG is not promising, it **CANNOT AT THIS STAGE BE ENTIRELY RULED OUT.**"*

The above statement is a perversion of Messrs McDonald and Knipe's conclusion, quoted above. Furthermore, Messrs McDonald and Knipe were minuted as follows:

"A number of suggestions were made ... Look only for environments that show obvious promise in their geology and hydrogeology, and restrict further investigations to those that continually demonstrate potential to be well within regulatory targets." [my underlining].

So the MMG in West Cumbria has been clearly ruled out ever since 1986, independently by various expert earth scientists. No appeal to adhere to the 'stages' in a so-called 'process', by following the MRWS white paper, can overturn this scientific conclusion.

The main thrust of his arguments, such as they are, regarding both the MMG and the Lake District granites is that, yes, some more data have been made available since the 1980s, but no, we cannot rule out these rock volumes until a systematic desk study has been done by the BGS. In other words, all geological evidence submitted to the consultation process should be ignored, unless it comes from the BGS. The BGS has, of course, not submitted any evidence, because it is awaiting the invitation to undertake a desk study and fieldwork in Stage 4. Such wilful and deliberate ignorance is irrational.

Nevertheless, Dr Dearlove has previously claimed to be privy to informal brief discussions with the BGS, at which the BGS apparently let it be known that it now considers the MMG to have potential as a GDF host rock. So are we to believe that the BGS is leaking out its 'true' opinion of the MMG via the hearsay of

Dr Dearlove, while simultaneously not contributing to the consultation? If Dr Dearlove has indeed heard these opinions correctly, I would have expected a contribution from the BGS by now, with the evidence to back it up.

All I have done is to reproduce the conclusion that the Cumbrian MMG, a rock volume used for drinking water, and having unacceptably high fluid flow rates for a nuclear waste repository, was excluded by the BGS in 1986, and that the increase in geological knowledge of the area (and of the MMG in general) since then only serves to confirm this exclusion. Similarly, I have used all the published evidence to show how complex is the Eskdale granite. Incidentally, the same complexity applies to the neighbouring Ennerdale granite, which is just 2 million years younger, but which I did not explicitly discuss in my consultation response. The complexity, the topography, and the previous exclusion by the BGS of these two granite bodies cannot now be cast aside with the unfounded claim that ‘more work needs to be done’.

The attempt to deny these facts, by the device of avoiding detailed discussion, using the political ploy of postponing serious geological analysis to Stage 4 of the MRWS white paper process, to say nothing of the attribution to the BGS of views it does not hold, is both irrational and essentially dishonest. That is why I compare the current MRWS process to the published examples of ‘agnotology’, which is defined variously as:

- the deliberate obfuscation or suppression of scientific data and hypotheses;
- the introduction of doubt, for example by bringing in misleading data to a scientific debate to muddy the waters;
- the cultural production of ignorance.

This field of study arose about 20 years ago out of consideration of the tobacco industry’s attempts to smear, deny, or obfuscate the fact that lung cancer is caused almost entirely by active or passive smoking. Later examples, in which agnotology is proving to be a fruitful field of analysis include:

- The links between childhood leukaemias and nuclear power plants,
- The link between mesothelioma and asbestos exposure, and
- The confusion being sown in the lay public’s mind by the tiny minority of ‘scientists’ who are still trying to deny that climate change is caused by modern human activity.

It is interesting that a whole page of Dr Dearlove’s letter is devoted to legal disclaimers. But rather than speculate on whether or not Dr Dearlove could ever be held to account for his opinions in a legal framework, the Partnership would clearly be wise to consider the consequences of persisting with a search within West Cumbria, **when the chance of finding suitable rocks is effectively non-existent**. I am not talking so much about the likelihood of a legal challenge to the process at some point, but of the moral duty of local Cumbrian councillors to the **thirty thousand generations** that may follow us over the next million years.

I trust that you will distribute this letter to the MRWS Partners so that they will be able to take account of my comments at the next Partnership deliberations at which geology will be discussed, and that you will be able to place this letter quickly on the MRWS website.

Yours sincerely

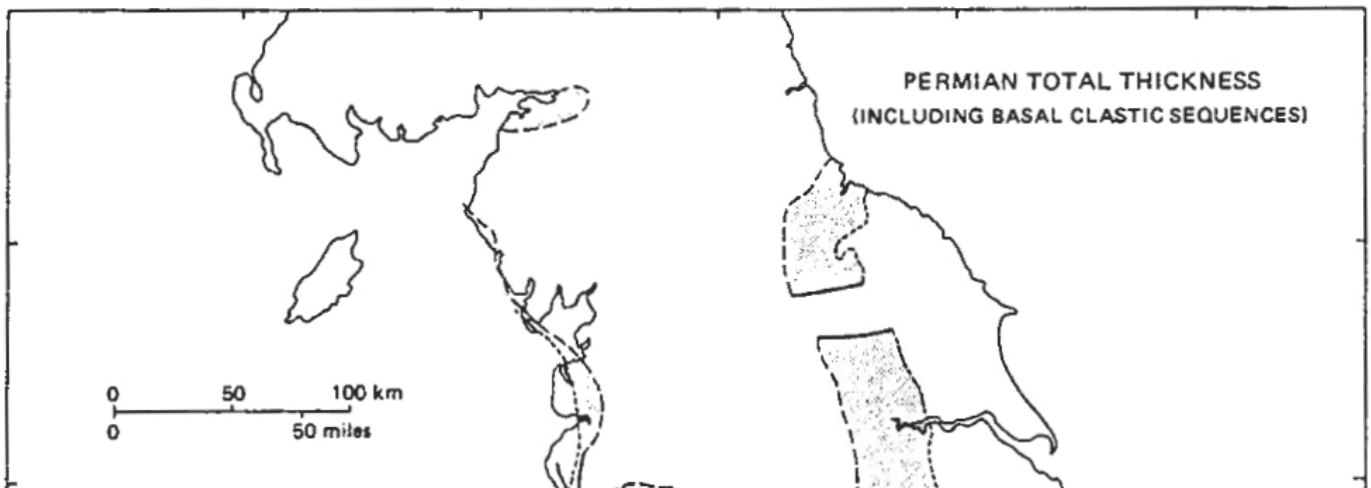


David SMYTHE
[Emeritus Professor of Geophysics, University of Glasgow]

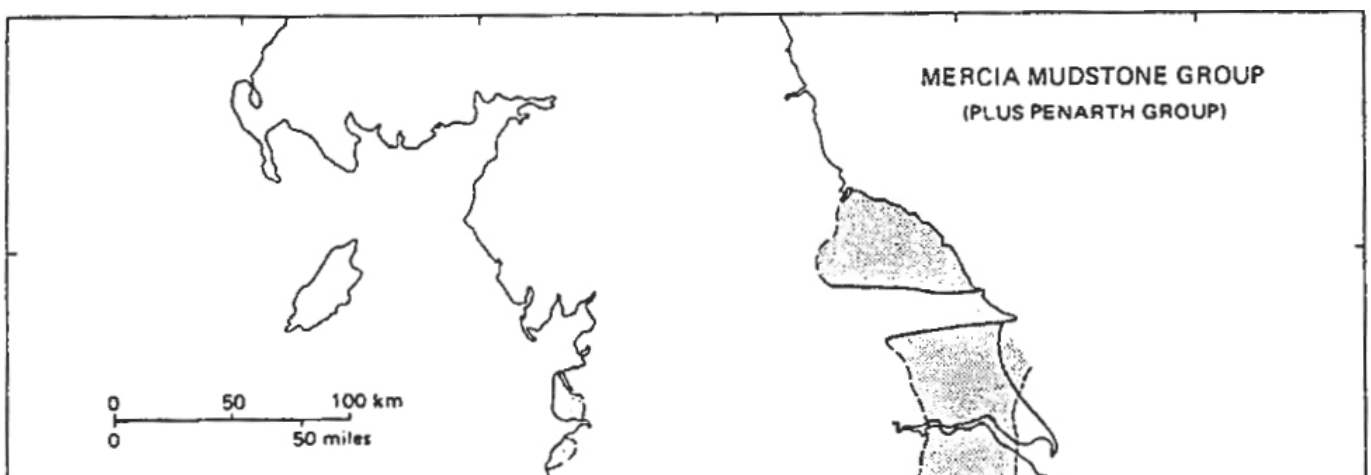
Appendix A. Exclusion by the BGS of the Mercia Mudstone Group

This appendix shows detail from Chapman, N. A., McEwen, T.J. and Beale, H. 1986. *Geological environments for deep disposal of intermediate level wastes in the United Kingdom*. IAEA-SM-289/37. Two of the three authors of the 1986 paper, which has become something of an international classic in the field of nuclear waste disposal, were employed by the BGS (Chapman and McEwen), and Beale was employed by Nirex.

I have already clarified in my submission that the oval patch west of Carlisle, identified by Chapman and his colleagues in 1986 and reproduced in my Fig. 2.1.1 refers to older Permian sediments and not to the MMG (see my submission, section 4.7.1, first paragraph). Furthermore, if Dr Dearlove had read the Chapman and colleagues' paper (available via my website) he would have seen that in their figure 2, showing potentially suitable Permian rocks, the relevant patch is marked, as was later reproduced by Nirex, but is absent from their figure 3, which specifically shows areas of potentially suitable MMG. The upper parts of each figure are reproduced below. So the BGS has never claimed that Cumbrian MMG is potentially suitable.



Detail from Chapman et al. 1986, fig. 2; “areas containing potentially suitable Permian rocks”.



Detail from Chapman et al. 1986, fig. 3; “areas containing potentially suitable Mercia Mudstone Group rocks”.

Appendix B. Faulting

Dr Dearlove comments:

“The BGS have published a report indicating that large faults in the MMG strata of the Cheshire Basin “where present, (the faults) are impermeable and do not form pathways for fluid migration” (Evans and Hough, 2009).”

But the same authors had previously stated, concerning the same rocks *“Faults may in nature, therefore, be both barriers to the flow of fluid (sealing) or permeable and act as conduits for fluid flow”*. (Evans et al. 2005). This latter statement concurs closely with the quotation I took from Lunn et al. 2008:

“Faults can be barriers to flow, conduits, or combinations of the two, and their hydraulic properties vary considerably over both space and time”.

These last authors (of whom lead author Professor Lunn is a member of CoRWM) went on to conclude that the required micro properties of faults (that Dr Dearlove thinks can be measured in due course) are *fundamentally unmeasurable* other than in a probabilistic way. While the huge international fault database proposed by Professor Lunn and her colleagues might eventually be realised, it will only be of use to the hydrocarbon industry, because the probabilistic modelling of faults is, by definition, insufficiently precise for characterising a potential GDF. If an oil exploration company gets its predictions of fault sealing or flowing wrong, no damage is done, other than to the company shareholders; but we cannot be so complacent about a facility, whose behaviour is supposed to be predictable for up to a million years into the future.

All international guidelines and practice advise that geology must be simple, and this includes avoiding faults.