Thick Coal Seams Challenge Uniformitarianism

Very thick and extensive coal seams in the Powder River Basin of north-eastern Wyoming and south-eastern Montana, USA (see Figure 1), have perplexed geologists for years.[1] The coal beds are found within the basin fill sediments and are dated as Late Palaeocene and Early Eocene. The Wyodak and Big George coal seams in Wyoming are up to 35 m and 61 m thick, respectively. The Lake DeSmet coal bed has a maximum thickness of 75 m, the thickest in the United States and second thickest in the world. The Big George seam extends about 100 km north-south, parallel to the basin axis, and about 25 km east-west. The total amount of coal in the Powder River Basin is estimated to be about 1,200 trillion kg.[2] These beds of coal have a low ash and sulphur content,[3] making them very economical to mine. One of the many mysteries is the huge reserves of nearly pure coal in this basin while there is hardly any coal in other similar basins of Wyoming.

Seeland estimates that the Wyodak coal seam represents peat compressed seven times.[4] With this proportion, the Wyodak coal seam represents 252 m and the Lake DeSmet coal seam 525 m of peat accumulation! Based on a mean peat accumulation rate of 1.72 m/1000 yr, the Wyodak coal seam would take 145,000 years and the Lake DeSmet coal seam 305,000 years to accumulate.

A recent article in the *Journal of Geology* states that thick coal beds challenge the **Law of Uniformitarianism:**

> *'Since peat is expected to compact appreciably during burial, there appears to be no modern analogue for the processes which formed thick coal beds, and this seems to challenge the Law of Uniformitarianism.'*[5]

Although pointing out that modern peat deposits are a maximum of only 20 m thick, the authors believe they have found the solution to the violation of the 'law'. The proposed solution is a divide and conquer mechanism. By pointing out thin inorganic and organic partings, the authors claim that a thick coal bed is made up of many thinner beds stacked one upon the other. For instance, the Big George coal seam has six mudstone partings that range in thickness from 3 to 17 cm, dividing the coal up into beds ranging from 0.8 to 20 m. Therefore, the thinner coal seams are more within reach of modern peat bed analogues.

However, this divide and conquer mechanism does not seem to be a solution to the problem. The 20 m of pure coal in the Big George seam still represents about 140 m of peat, which is still *seven times* the thickness of the thickest modern peat. The fact that the divided coal seams are stacked on top of each other still means that the **total** thickness of coal in one area needs explaining. Besides, most modern peat beds do not show evidence of stacked mires divided by partings.[6]

A further examination of the stratigraphy of the Power River Basin from the uniformitarian point of view demonstrates why extensive, thick coal beds are such a conundrum. First, long-term stability of the basin is required:

> *'The origin of the thick, low- to moderate-ash coal beds (averaging 6.3 percent) .. . of the basin is controversial, however, because these coal beds require long-term stability for formation, not a typical attribute of continent-*

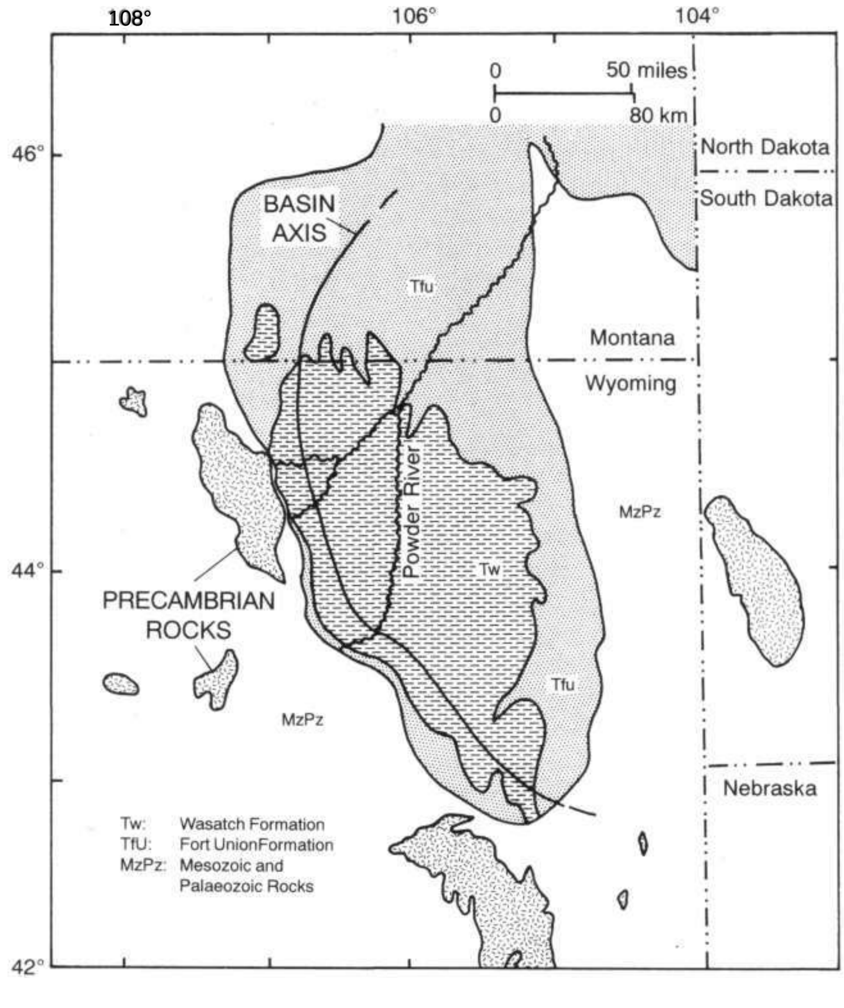

Figure 1. *Map showing the location of the Powder River Basin in north-eastern Wyoming and the generalised geology of the basin.*

al fluvial depositional systems.'[7]

Second, as stated by Seeiand above, the depositional environment has been deduced to be fluvial, based on sandstone crossbeds and the grain-size and grain-shape distribution.[8] Not only that, the thick coal beds are located parallel to and adjacent to the main 'palaeoriver' draining the basin. How flooding of debris into the peat beds is to be avoided is admittedly a problem.

Third, gradual subsidence of the peat beds must be at just the right rate for growth on the surface to continue unabated. The rate of subsidence must also be balanced by the build up of sediments in the adjacent river channels. Accumulation of peat layers hundreds of metres thick, subsiding gradually, in a fluvial environment for hundreds of thousands of years without collecting flood debris from a meandering river is an amazing coincidence.

Fourth, the purity of the coal eliminates practically all the many proposed theories, such as a low-lying swamp, transported vegetation into place, and a basin-wide lacustrine environment.[9]

Fifth, the most viable theory, the raised swamp environment, suffers from too many special conditions. A raised swamp, which supposedly protects the peat from flooding, must be watered either through ground water seeping upward by capillary action, which is limited, or by rain water. If you have too much rain, there is flooding, either from the adjacent river or from flows from off the surrounding mountains. Special conditions already mentioned above would also apply. High biomass production with low rates of decay are also required. Based on pollen analysis, swamp cypress was a prime constituent of the vegetation. This tree generally grows in low-lying flooded swamps and not in raised mires.

Despite the divide and conquer proposal, it still seems that the 'law' of Uniformitarianism is violated by thick coal seams in the Powder River Basin. A Flood catastrophic mechanism, although difficult to explain in detail, is more likely. The Flood at least could have provided the ripped-up vegetation, much of which would have floated for a while during the Flood. In the right circumstances, it could have deposited the vegetation rapidly and then covered the plant material with thick sediments that would have aided in rapid coal formation.

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'Simple'? Whole Bacterial Genome Sequenced

A team of 40 scientists in the United States recently achieved a landmark with the sequencing of the whole of the genome of the bacterium *Haemophilus influenzae* Rd.[1] This is the first free-living bacterium to be fully sequenced. The team also proved the usefulness of the technique of random sequencing for sequencing bacterial genomes in particular and possibly eukaryotes as well.

Haemophilus influenzae was chosen for sequencing because no physical gene map existed and, with a genome size of about 1.8 million bases, it was considered *'typical among bacteria'.*

The project involved an enormous amount of work and considerable computer analysis of the data generated by each of the laboratories involved. The DNA was physically chopped into random pieces, and pieces of a maximum of between 1,600 and 2,000 bases in length were selected for sequencing. Sufficient segments were sequenced to get the equivalent of six full genomes. The sequences were entered into a database and computer programmes used to match up the random segment sequences to derive the sequences for larger segments ('contigs') of the full genome. One part of this data analysis used 30 hours on a