"The Earth Moves" an extract from Bill Bryson's 'A Short History of nearly Everything'.

In one of his last professional acts before his death, in 1955, Albert Einstein wrote a short but glowing foreword to a book by a geologist named Charles Hapgood entitled *Earths Shifting Crust: A Key to Some Basic Problems of Earth Science.* Hapgood's book was a steady demolition of the idea that the continents were in motion. In a tone that all but invited the reader to join him in a tolerant chuckle, Hapgood observed that a few gullible souls had noticed 'an apparent correspondence in shape between certain continents'. It would appear, he went on, that South America might be fitted together with Africa, and so on … It is even claimed that rock formations on the opposite sides of the Atlantic match.'

Mr Hapgood briskly dismissed any such notions, noting that the geologists K. E. Caster and J. C. Mendes had done extensive fieldwork on both sides of the Atlantic and had established beyond question that no such similarities existed. Goodness knows what outcrops Messrs Caster and Mendes had looked at, because in fact many of the rock formations on both sides of the Atlantic *are* the same – not just similar but the same.

This was not an idea that flew with Mr Hapgood, or many other geologists of his day. The theory Hapgood alluded to was one first pronounced in 1908 by an amateur American geologist named Frank Bursley Taylor. Taylor came from a wealthy family and had both the means and the freedom from academic constraints to pursue unconventional lines of enquiry. He was one of those struck by the similarity in shape between the facing coastlines of Africa and South America, and from this observation he developed the idea that the continents once slid around. He suggested – presciently, as it turned out – that the crunching together of continents could have thrust up the world's mountain chains. He failed, however, to produce much in the way of evidence, and the theory was considered too crackpot to merit serious attention.

In Germany, however, Taylor's idea was picked up, and effectively appropriated, by a theorist named Alfred Wegener, a meteorologist at the University of Marburg. Wegener investigated the many plant and fossil anomalies that did not fit comfortably into the standard model of Earth history and realised that very little of it made sense if conventionally interpreted. Animal fossils repeatedly turned up on opposite sides of oceans that were clearly too wide to swim. How, he wondered, did marsupials travel from South America to Australia? How did identical snails turn up in Scandinavia and New England? And how, come to that, did one account for coal seams and other semi-tropical remnants in frigid spots like Spitsbergen , over 600 kilometres north of Norway, if they had not somehow migrated there from warmer climes?

Wegener developed the theory that the world's continents had once existed as a single land mass he called Pangaea, where flora and fauna had been able to mingle, before splitting apart and floating off to their present positions. He set the idea out in a book called *Die Entstehung der Kontinente und Ozeane*, or The Origin of Continents and Oceans, which was published in German in 1912 and –despite the outbreak of the First World War in the meantime – in English three years later.

Because of the war, Wegener's theory didn't attract much notice at first, but by 1920, when he produced a revised and expanded edition, it quickly became the subject of discussion. Everyone agreed that continents moved – but up and down, not sideways. The process of vertical movement, known as isostasy, was a foundation of geological belief for generations, though no-one had any really good theories as to how or why it happened. One idea which remained in textbooks well into my own school days, was the 'baked apple' theory pronounced by the Austrian Eduard Suess just before the turn of the century. This suggested that as the molten Earth had cooled, it had become wrinkled in the manner of a baked apple, creating ocean basins and mountain ranges. Never mind that James Hutton had shown long before that any such static arrangement would eventually result in a featureless spheroid as erosion levelled the bumps and filled in the divots. There was also the problem, demonstrated by Rutherford and Soddy early in the century, that earthly elements hold huge reserves of heat – much too much to allow for any cooling or shrinking Suess suggested. And anyway, if Suess's theory were correct, then mountains should be evenly distributed across the face of the Earth, which patently they were not, and of more or less thee same ages; yet by the early 1900's it was already evident that some ranges, like the Urals and Appalachians, were hundreds of millions of years older than others, like the Alps and Rockies. Clearly the time was ripe for a new theory. Unfortunately, Alfred Wegener was not he man geologists wished to provide it.

For a start, his radical notions questioned the foundations of their discipline, seldom an effective way to generate warmth in an audience. Such a challenge would have been painful enough coming from a geologist, but Wegener had no background in geology. He was a meteorologist, for goodness; sake. A weatherman – a German weatherman. These were not remedial deficiencies.

And so geologists took every pain they could to dismiss his evidence and belittle his suggestions. To get around the problem of fossil distributions, they posited ancient 'land bridges' wherever they were needed. When an ancient horse named *Hipparion* was found to have lived in France and Florida at the same time, a land bridge was drawn across the Atlantic. When it was realised that ancient tapirs had existed simultaneously in South America and Southeast Asia a land bridge was drawn there, too. Soon maps of prehistoric seas were almost solid with hypothesised land bridges – from North America to Europe, from Brazil to Africa, from Southeast Asia to Australia, from Australia to Antarctica. These connective tendrils had not only conveniently appeared whenever it was necessary to move a living organism from one land mass to another, but then had obligingly vanished without leaving a trace of their former existence. None of this, of course, was supported by so much as a grain of evidence – nothing so wrong could be – yet it was geological orthodoxy for the next half century.

Even land bridges couldn't explain some things. One species of trilobites that was well known in Europe was also found to have lived in Newfoundland – but only on one side. No-one could persuasively explain how it had managed to cross 3,000 kilometres of hostile ocean but then failed to find its way around the corner of an island 300 kilometres wide. Even more awkwardly anomalous was another species of trilobite found in Europe and the Pacific Northwest of America but nowhere in between, which would have required not so much a land bridge as a flyover. Yet as late as 1964, when the *Encyclopaedia Britannica* discussed the rival theories, it was Wegener's that was held to be full of 'numerous theoretical difficulties'. To be sure, Wegener made mistakes. He asserted that Greenland is drifting west by about 1.6 kilometres a year, a clear nonsense (it's more like a centimetre.) Above all he could offer no convincing explanation for how land masses moved about. To believe in his theory you had to accept that massive continents somehow pushed through solid crust, like a farm plough through soil, without leaving any furrow in their wake. Nothing then known could plausibly explain what motored these massive movements.

It was Arthur Holmes, the English geologist who did so much to determine the age of the Earth, who came up with a suggestion. Holmes was the first scientist to understand that radioactive warming could produce convection currents within the Earth. In theory, these could be powerful enough to slide continents around on the surface. In the popular and influential textbook *Principles of Physical geology*, first published in 1944, Holmes laid out a continental drift theory that was, in its fundamentals, the theory that prevails today. It was still a radical proposition for the time and widely criticised, particularly in the United States, where resistance to drift lasted longer than elsewhere. One reviewer there fretted, without any sense of irony, that Holmes presented his arguments so clearly and compellingly that students might actually come to believe them. Elsewhere, however, the new theory drew steady if cautious support. In 1950, a vote at the meeting of the British Association for the Advancement of Science showed that about half those present now embraced the idea of continental drift. (Hapgood soon after cited this figure as proof of how tragically misled British geologists had become.) Curiously, Holmes himself sometimes wavered in his conviction. In 1953 he confessed: 'I have never succeeded in freeing myself from a nagging prejudice against continental drift; in my geological bones, so to speak, I feel the hypothesis is a fantastical one.'

Continental drift was not entirely without support in the United States. Reginald Daly of Harvard spoke for it, be he, you may recall, was the man who suggested that the Moon had been formed by a cosmic impact and his ideas tended to be considered interesting, even worthy, but a touch too exuberant for serious consideration. And so most American academics stuck to the belief that the continents had occupied their present positions for ever and that their surface features could be attributed to something other than lateral motion.

Interestingly, oil company geologists had known for years that if you wanted to find oil you had to allow for precisely the sort of surface movements that were implied by plate tectonics. But oil geologists didn't write academic papers; they just found oil.