The History of Continental Drift - Alfred Wegener

Alfred Wegener was a meteorologist and an astronomer. He was well respected in all the many fields to which he applied his undoubted talents - with the exception of his bizarre theory of "Continental Drift", which won him few friends and no respect. The following page describes the conception of his theory, and the uncomfortable time the theory and its perpetrator had in the early 20th Century.

- Birth of a Dream
- Problems with the Contracting Earth Theory
- 'The Origin of Continents and Oceans'
- Rejection of the Theory

Birth of a Dream

In 1911, Alfred Wegener was a lecturer of astronomy and meteorology at a German university. He was a widely-read and highly respected professional, and despite the legacy he left to geological science, astronomy and meteorology were the basis of his professional credentials throughout his life.

Browsing his university library that day (aged 31) he chanced upon a paper that expounded the theory of a land bridge between Brazil and Africa, which was a commonly held view of that time. The evidence her read there, that of fossils species that could not have crossed the ocean but were found on both sides of it, was a surprise to him, and caught his imagination. This chance find thus started his lifelong-obsession - which became the most significant advance of 20th Century geological thinking.

Like many others before him, Wegener had noted the match of the African and South America continents, and considered that they might once have been joined. However, like those others before him, he too had rejected the idea because of the huge distance the continents would have
needed to have travelled to produce the 5000 mile (8-9000 km) wide Atlantic Ocean.
For him, however, the fossil evidence he found (that had been written to prove the existence of long-gone land bridges) instead proved to him that the continents had once been joined but had since drifted apart.

Wegener was not a geologist, he was a meteorologist; but that flash of insight allowed him to formulate a comprehensive theory that - ultimately - totally altered the way geologists, geophysicists and palaeontologists viewed the Earth and evolution. Sadly, acceptance of his theory was not reached in his lifetime, and the theory (and its proponents) suffered a tortuous route and much argument, insult, derision and obscurity before gaining scientific recognition and acceptance.

The Restrictions of Specialising

As a non-geologist, Wegener’s trespass into the discipline was not welcomed. A supporter later explained, of his problems in gaining a hearing:

“To work on subjects which fall outside the traditionally defined bounds of a science naturally exposes one to being regarded with mistrust”.

Throughout his career he was an outsider in the field; and although it gave him the ability to see beyond the entrenched ideas of the science, it also opened him to mistrust and criticism. At that time, scientists kept well within the bounds of their own specialities.

Not only did biologists keep away from the earth sciences, but even geophysics, geology and geography had been totally separated, with no connection between these obviously-related disciplines or their specialists. Wegener’s work that reconnected them was derided throughout his lifetime, and he himself was ostracised by the narrow geological community.

His theory was rejected partially because in formulating it he had straying outside of the narrowly-defined field in which he was expected to work. However, once accepted, that same theory broadened and enriched many diverse fields, not only those of geophysics, geology, geography and evolution, but also oceanography, biology and zoology.
The Meteorologist in Greenland

When Wegener got involved with it, meteorology was an infant science, and he was a pioneer of rapidly developing techniques. Rather than being limited by his specialisation, Wegener used what he learned as a springboard, from which his mind ranged over all fields encompassed by geophysics - climatology, volcanology, magnetism, oceanography, hydrography and glaciology, to name but a few.

He also developed a passion at an early age to visit Greenland, so spent his teenage years building up his physical strength to become an indefatigable expeditionist, prepared for the harsh climate of that country that he visited many times - and where he died.

His first trip to Greenland was in 1906, as a Danish expedition's 'official meteorologist'. There, he was involved not only in their task of mapping the country, but also in atmospheric research, and in making lunar observations used to determine longitude. In one of his many reports, he noted the discrepancy between the longitudinal calculations of his party, and earlier ones that used measurements made in 1823 and 1870. This discrepancy was a key factor he later recalled and used in developing his theory.

A fellow professor, in describing the loyalty of Wegener's students to his enthusiasm and clarity in explaining anything, however complex, said, (amongst his heaped praises), that "Wegener possessed a sense for the significant that seldom erred". Frequently, his reflections would result in a proclamation, "I think..." that was proved only days later only after rigorous analysis.

However; he showed impatience with mathematical treatises that he could not understand and suggested that impenetrable arguments might simply be wrong - so if unable to follow the written word, one should not always blame oneself.

He was clearly a man of great intellect and foresight, but also popular and lucid, so earned the great respect and loyalty from his students and associates alike. This popularity and respect, however, was not always shared with the specialists of the other disciplines in which he dabbled.
Problems with the Contracting Earth Theory

At the time of Wegener's accidental reading of the fossil proof of sunken land bridges, the 'scientific consensus' was that of sunken land and continents, now covered in oceans. This land had once provided a migratory path for the former flora and fauna, now found as fossils in diverse continents. Land, of course, was a permanent and unmovable feature of the earth's surface. Although it might sink, land could neither move nor be created afresh.

The sunken land had, it was supposed, suffered from the effects of a 'cooling and contracting earth'. As the core of the earth cooled and contracted, its outer crust collapsed inwards. Mountains had thus arisen, and oceans formed in the depressions, covering the earlier land bridges.

Like many scientists of the time, Wegener noted serious flaws in this theory, even though it was held dear. There were 3 principle flaws, although not the only ones. These were:

- The pattern of mountain ranges that occur around the earth. They occur in narrow, curvilinear belts, and are often located along continental edges. Were the earth truly contracting, no such belts, or typical location, would be expected. Instead, mountains would occur randomly scattered all over the Earth's surface.
- The age of the mountains. Were the contraction theory true, all mountains ought to be of roughly the same age. However, it was already then known that mountains varied enormously in age, from both fossil evidence, and even radioactive dating techniques. The Caledonians of Scotland had already been recognised as being far far older than the European Alpine system.
- The gravity problems. Gravity studies had illustrated the lesser density of continental crust compared to oceanic rock. This caused insurmountable problems for the contraction theory, with its sinking land bridges - which ought 'bob up' again to the surface, if the theory was true.
"The Origin of Continents and Oceans"

Only months after first reading of the fossils in his library, Wegener formulated his extraordinary thesis. In January 6th 1912, he delivered an address to the Geological Association in Frankfurt, entitled "The Formation of the Major Features of the Earth’s Crust (Continents and Oceans)". However; his challenge to the theories of sunken land bridges, and proposal that continents had once been united but had since drifted apart to their present positions, was not well received, and was considered a ludicrous notion.

Three years later, Wegener used several lines of evidence from several different disciplines to produce his now-famous "The Origin of Continents and Oceans", which unashamedly trespassed into other sciences. Three more volumes followed, in 1920, 1922, and 1929. Each adding further elaboration; but his over-stepping of scientific boundaries, his rejection of long-held beliefs, and even his German nationality (around the time of the Great War and its aftermath, 1914 - 1918, all Germans were treated with at best suspicion by the rest of Europe), did not win Wegener many converts.

The theory reasons quite simply that if the fossil evidence proves the existence of a land link between now-separate continents, and the concept of land bridges is inconsistent with the concept of isostasy, then the only possible conclusion to be drawn is that the continents were once one, and had somehow separated.

Horizontal movement

A key part of the theory suggested that the oceanic crust of the Earth could be likened to pitch. This is solid, and shatters under the sudden pressure of a hammer-blow. However, under continued pressure and over time, it can flow in a plastic, or ductile, manner. If continents are sitting in a similar substance, and can move vertically -
as already suggested under Dutton's theory of isostasy, which had been accepted at that time - then equally, they could move horizontally over and through it.

**Continental 'fit'**

He further proposed that in attempting to make a continental 'fit', one ought not take notice of the shoreline, but of the edge of the continental shelves instead. This is where the shallow sea dips sharply downwards to the deep ocean floor, and is a far more 'real' edge of a continent. It ignores the fluctuations of sea level, and the majority of coastal erosion sediments. Using this demarcation, the geographical fit of African and South America was even better than had previously been seen. Furthermore, the geological rock strata matched perfectly.

**Climatic Evidence**

In the early 1920’s, Wegener added climatic evidence to his theory. He plotted the worldwide distribution of rock and fossil types that indicated the former locations of tropical climates, deserts and icecaps. The continents showed evidence of a variety of different climates, such as remains of temperate species of trees including beech, maple and oak below the ice of polar Spitsbergen. Rearranging, moving and reuniting the continents into a different configuration is the only possible explanation of the history of these climate changes.

**Pangea**

By 1922, Wegener had joined all of the present-day continents into one huge landmass. He used both fossil evidence, and eight different geological indicators, including

- the coal fields shared by Britain, Belgium and the Appalachian Mountains of the USA,
- the red sandstone band that passes through Norway, Britain, Greenland and Canada and
diamond fields of South Africa and Brazil.

This continent he called Pangea - from the Greek meaning "all land". Mountains, he claimed, were the result of continents colliding and crumpling, and he cited the example of India colliding into Asia to uplift the Himalayas. At this stage, he used his earlier measurements of the longitudinal change of Greenland to show that the land was still moving. His estimate was somewhat exaggerated, as he claimed a rate of 118 feet (36 metres) per year, while it was alter shown that the ocean is widening at only about 2 cm per year (so the land on either side only half that). Unfortunately, this mistake (due to imprecise measurements) did nothing to convince the already disbelieving sceptics, who disbelieved that continents could move at all, let alone at that speed.

The Lack of a Process

The biggest problem Wegener had, however, was not this error, but that of being unable to describe the process of movement, or why the continents would move in the first place. Although he made some suggestions, he was aware that they were weak (and were in fact wrong.) This inability to explain the "why" and the "how" of continental movement was a primary reason that his theory was rejected. The weaknesses of his suggested processes were torn apart, and their failure to hold up to simple maths, was used to discredit the whole theory in the international forum.

Rejection of the Theory

Following this response, Wegener’s friends talked of depressing times, and his reputation suffered. Despite his obvious brilliance, he never gained a professorship in a German university, but remained a lecturer. The reasons given for his failure to gain a chair for which he had applied were always the same - he was “interested in matters that lay outside its terms of reference”. The tyranny of specialisation thus hampered his career - although after his death he earned a reputation that will never be forgotten within the global geological community. However, he moved away from his native land to Austria, where a chair of
"meteorology and geophysics" was created especially for him, by the sympathetic - and far-seeing - administration of the University of Graz.

International attacks on each later version of his theory continued, but he appeared unconcerned during the symposia that railed against him. He was, however, sufficiently moved to say cite> "Scientists still do not appear to understand sufficiently that all earth sciences must contribute evidence toward unveiling the state of our planet in earlier times, and that the truth of the matter can only be reached by combining all this evidence..... It is only by combining the information furnished by all the earth sciences that we can hope to determine 'truth' here.... Further, we have to be prepared always for the possibility that each new discovery, no matter what science furnishes it, may modify the conclusions we draw."

return to top

Allies

He did, moreover, have some powerful allies. These were mainly those who had actually travelled, and seen with their own eyes the astonishing similarities in distant continents. Some claimed that when they saw such familiar rock strata and its fossil content, they had difficult believing they were not at home, despite the 1000s of miles of ocean that lay between. For this unbelievable coincidence, they wanted credible and scientific explanations.

One such devotee, the South African Alexander Du Toit, compiled a wealth of evidence that ought to have been persuasive. Unfortunately, he wrote in such a flamboyant style that what was a valuable contribution to the body of evidence was rejected for being written in "the colourful language of a pamphleteer".

Reasons for Rejection

Thus; although Wegener was far-sighted and (almost) right, his theory were rejected by the geological community of the day.

Many reasons have been put forward for this vehement rejection - not only rejection, but hostility and derision.

Such reasons are thought to include:

• Being ahead of his time,
• His contradiction of the prevailing view,
• His inability to explain how or why the continents moved;

And (perhaps most likely) because he was an 'outsider' - which he had to be, to successfully draw the conclusions he did from the evidence from the many different disciplines.

Despite the vilification he received from the geological community, he clung to his beliefs, while enjoying his chair of meteorology, other interests, and continued expeditions to Greenland. He died there in 1930 on a winter expedition, aged 50. His obituaries were laudatory and filled with lavish praise for his achievements as a meteorologist and explorer. Much was written about his expeditions to Greenland, his distinguished career as a scientist and teacher, his abilities as a lead and his academic brilliance. Hardly a mentioned was made of continental drift, which was by then generally considered to be a "bizarre fantasy - an aberration in an other exemplary life".