i3 Continental drift < jigsaw puzzle, pack ice analogy >

> Now, these parts of the earth [Europe, Africa, Asia] have been more extensively explored and a fourth part has been discovered by Amerigo Vespucci. ... Inasmuch as both Europe and Asia received their names from women, I see no reason why anyone should justly object to calling this part Amerige [Gk. *ge* means *land of*], i.e., the land of Amerigo, or America, after Amerigo [b. 1451, Florence, Italy—the main airport there is named after him], its discoverer, a man of great ability.
>
> —Martin Waldseemüller in the summary chapter of *Cosmographiae Introductio*, in which the first map of the world showing South America with an ocean to its west was published April, 1507, by the press of Saint-Die, France.[1]

For the absence of storms, during the first crossing of it, by Ferdinand Magellan using the Southeast Trade Winds, the Pacific was so named, as Let Pigafetta lived to chronicle: "Wednesday, November 28, 1520, we debouched from the strait [of Magellan, which is through the southern tip of South America] engulfing ourselves in the Pacific Sea." Australia and Tasmania were circumnavigated by Abel Tasman ca. 1642. New Zealand was circumnavigated by James Cook ca. 1770 and he circumnavigated, at high latitude, Antarctica ca. 1773 without seeing it for the ice encountered made any continent within, for him, "out of the reach of Navigation." —HR

Alfred Lothar Wegener (pronounced *Vey-gen-er*). A geophysicist at heart and, in keeping with that, an armchair geologist. And so he was vulnerable to the field geologist's grumble: 'He writes grandly about orogenesis, but did he ever see, was he ever on, a mountain?' Instrumental in the induction of his continental drift hypothesis had been his early training as a meteorologist.

As a young man, **Alfred Wegener** (1880-1930) found employment as a meteorologist on an expedition to Greenland in 1906. To know what best to study, he sought out Wladimir Peter Köppen (1846-1940) with the happy consequence also of meeting Köppen's, linguistically talented, pretty daughter Else (1892-1992) (they would marry in 1913).[2] During the winter, the sea is frozen about the edge of Greenland. Arriving early in the spring, Wegener could watch the break up of the pack ice into ice flows while the boat waited for that to happen so that it could dock. An apocryphal tale told by Lauge Koch (1892-1964), a fellow Greenland-expeditioner:[3]

> The hypotheses of continental drift, which he would later develop, would be an inference based on the analogy of the break up of pack ice into ice flows. From his prior study of isostasy, he [Wegener] knew that continents (sial) float in mantle rock (sima) like icebergs float in water. Like icebergs, floating continents could, in principle, also drift laterally.

In the opening chapter of *The Origin Continents and Oceans* (1924 translation), Wegener himself recalls:[4]

> The first notion of the displacement of continents came to me in 1910 when, on studying the map of the world, I was impressed by the congruency of both sides of the Atlantic coasts ... In the autumn of 1911, I became acquainted (through a collection of references, which came into my hands by accident) with the paleontological evidence of the former land connection between Brazil and Africa, of which I had not previously known. This induced me to undertake a hasty analysis of the results of research in this direction in the spheres of geology and paleontology, whereby such important confirmations were yielded that I was convinced of the fundamental correctness of my idea.

Closing the Atlantic ocean recreates a supercontinent. The first person to find a need for such was Antonio Snider-Pellegrini. He had discovered that the Carboniferous Coal Measures of Europe and North America are composed of mostly identical fossil plants. In 1858, he published his findings along with two maps (***Figure i3.1***) that make clear his conception of continental drift. His book *La Création et ses Mystères dévoilés*, despite its title (The Creation and its Mysteries unveiled), seems to have been immediately forgotten.[5]

Wegener was the first to bring uniformitarian perspective to findings for large-scale rearrangements of continental positions. Gravity measurements indicate that continents of "sial" composition float in denser rock of "sima" composition with the deep-ocean floor the sima's free upper surface. Fold mountains require lateral movement far greater than the crustal shortening a cooling and contracting Earth can give. Geology indicates former close connections of now widely separated continents. Against the fixity of continents Wegener published (in German) two journal articles in 1912 [6] and a book, *Die Entstehung der Kontinente und Ozeane*, 1915,[7] with fully revised editions appearing in 1920, 1922 (with iconic map ***Figure i3.2***), and 1929.[8] Paleoclimalogical evidence is given of true polar wanderings. Such motions in the past are invoked to have caused an Earth-enveloping, thin, primordial sial-shell to split into slabs. These by irreversible collisions that rotated them toward the vertical, left the sima in which they are buoyant, widely uncovered about amassed "primordial continental blocks" that were thick enough to be emergent in an originally Earth-enveloping "Panthalassa" (all-ocean, as envisaged by Eduard Suess in 1893, and calculated to have been 2.64 km deep by Albrecht Penck in 1921).[9] Wegener's "displacement theory" is that the present continents are drifting apart blocks of a primordial collection in existence during the Carboniferous. For it, John W. Evans in his introduction to J. G. A. Skerl's [4] English translation in 1924 of the 1922 (3rd German) edition of Wegener's book, coined the proper name "Pangæa." This was a take-off from Wegener's loan comment that the western margin of the North American sial block, pressing against the sima, was folded (Antler orogeny) while it was still part of "die Pangäa" (the pangæa) in existence during the Carboniferous. The proper name "Pangea" gained immediate currency although it was not used by Wegener, nor by John Biram[10] in his translation of the 1929 (4th German) edition. The putting together of "Pangea," as a jigsaw puzzle of the present continents, earnestly engaged Emile Argand (*La tectonique de l'Asie*, 1922),[11] Frank Bursley Taylor (*The lateral migration of land masses*, 1923),[12] and Rudolf Staub (*Der Bewegungsmechanismus der Erde*, 1928).[13] The objection to these efforts, noted presciently by Willem Anton Joseph Maria van Waterschoot van der Gracht (*Theory of continental drift; a symposium in the origin and movement of land masses both intercontinental and intracontinental*, 1928),[14] is that they left earlier Earth developments alone. ❑

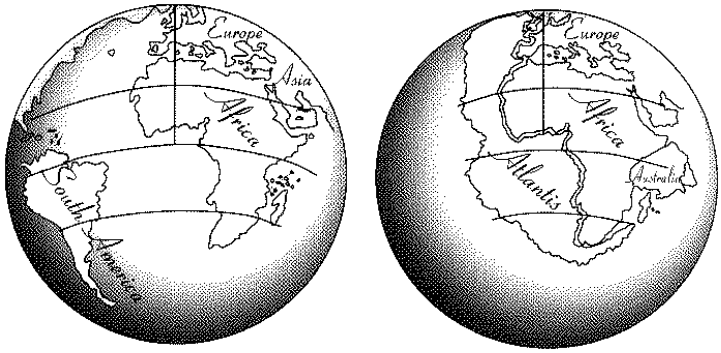

Figure i3.1 [5] *After* maps published in 1858 by A. Snider which show the present Americas (left) as drifted fragments of a single continent (right), that his study of matching fossil coal flora (correctly) indicated existed in the Late Carboniferous. The text (*see* Topic *i8*) that accompanies these maps is rightly lumped by Wegener with the "fantastic views" of Green,[15] Colberg,[16] Kreichgauer,[17] and H. Wettstein[18] in whose books are "many inanities."

Figure i3.2 "Doesn't the east coast of South America fit exactly against the west coast of Africa, as if they had once been joined? The fit is even better if you look at a map of the floor of the Atlantic and compare the edges of the drop-off into the ocean basin rather than the current coasts of the continents. This," Wegener in 1910 wrote in a letter to his fiancée Else Köppen, "is an idea I'll have to pursue."[19] So to reconstruct the single land that once was, he fitted the continents back together (as shown here, in 1922) at their true margins which are not their shorelines but are the outer edges of their continental shelves. This, following Wegener, was done by Alex L. du Toit in 1927 [20] and in 1937,[21] by Howard B. Baker in 1932,[22] and by Reinhart Maack in 1934.[23]