# Continental displacement: early lines of evidence that deserve attention

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Palaeontologists, particularly those with Gondwanan distribution, are entitled to be irritated by the frequent dismissal of A. Wegener's Continental Drift (more correctly Continental Displacement), as an inadequate hypothesis which only came to maturity in the 1960s with the advent of 'Plate Tectonics'. The excuse is made that Plate Tectonics provided a mechanism missing from Wegener's concept. But, as has been pointed out (e.g. Rastall 1929), Fold Mountains and Ice Ages were accepted as real phenomena before mechanisms were postulated. Furthermore, sea-floor spreading, crucial to Plate Tectonics was not a new idea. Osmund Fisher in 1881, in his 'Physics of the Earth's Crust' had argued for convection in the mantle. O. Ampferer in 1906 introduced a 'subfluction' theory of the origin of folds. J. Joly had in 1923 pointed out that crustal radioactivity might provide subcrustal heat, so promoting crustal movement. G.A.F. Molengraaff in 1916 referred to the Mid Atlantic Ridge in connection with Wegener's Continental Displacement. In doing so, he initiated the concept of sea-floor spreading. In 1928 he recognized a 'Rift Valley' in the Mid Atlantic Ridge. In the same year O. Pratje analysed echo-sounding observations of the Atlantic sea floor, and referred to Wegener, while Arthur Holmes published on a convection concept which included subduction of edges distal to a hot plume. K. Wadati in 1928 published an extensive study of deep earthquakes at the margin of a continent, clearly associated with subduction; he referred to Wegener. O. Pratje's observations of the ruggedness of the Atlantic sea-floor, accorded with gravitational measurements made from submarines in several oceans from 1923 by F.A. Vening-Meinesz, using a precision double-pendulum he had invented. In 1959 H. Korn and H. Martin published a description of folds in southwestern Africa, where two series of folds, mostly detached from the original stratum in each case, were separated by a layer of dolomite without folds. They concluded that folding was caused by movement under gravity on a gentle slope. This suggests that gravity might be involved in sea-floor spreading and continental displacement. That Plate Tectonics itself is subject to revision is suggested by the title of A. Ribeiro's 2002 book '*Soft Plate and Impact Plate Tectonics*' and the use of the terms 'schizosphere' and 'plastosphere.'

Palaeontology provided most of the evidence for Continental Displacement. Between 1815 and 1841 the Geological Periods were recognized and named. Comparisons could be made between the palaeofloras and palaeofaunas of different regions. In 1843 C. Lyell compared the Carboniferous plant fossils of Europe and North America. E. Forbes in 1846 and 1859 noted contiguous faunas of littoral molluscs between the continents, and S.V. Wood, in 1862, noted distinct Miocene marine mollusca on either side of a land bridge between Europe and Northern America. In 1870 T.H. Huxley compared Miocene mammals of the two continents, and concluded that there had been a substantial land connection. He noted as probable that his Austro-Columbia (South and Central America plus southern parts of North America) was separated from North America during the Miocene.

A fossil flora, named the *Glossopteris* flora for characteristic leaves, was described for peninsular India in 1828 by A.T. Brongniart. That *Glossopteris* lived in a temperate region was indicated by their apparent deciduous habit, with an abscission zone at the base of the leaf, which cut off the supply of sap before the leaf was shed. Wood found in the same deposits showed annual rings, this despite the proximity of the site to the equator, unlike the distance from the equator of the floras studied by Lyell, which appeared to be at least subtropical, although only slightly older. In 1875 an article by H.F. Blandford was accompanied by discussion of whether the layers below the *Glossopteris* flora were glacial. The *Glossopteris* flora had been reported in Australia in 1847 by F. McCoy, in South Africa in 1867 by R. Tate, and in South America in 1869 by W. Carruthers. In 1885 E. Suess conceived Gondwana, a region which had in common a *Glossopteris* flora. As the parts of Gondwana all had glacial strata below the common flora, A. Wegener, who was a researcher on polar weather and climate, in 1912 conceived the idea of grouping the parts of Gondwana together around the South Pole. It might have been predicted that the *Glossopteris* flora would also have existed on Antarctica. Such a flora was reported for Antarctica by A. Seward in 1914. Any alternative to Continental Displacement would require explanation of the distribution of the *Glossopteris* flora sites between a southern polar region across the equator to a northern tropical region.

A.L. du Toit in 1921 studied the late Carboniferous glaciation in southern Africa. Rocky material in the flowing ice causes striations in the strata over which it passes, and features such as 'chatter marks' indicate the direction of movement. 'Glacial pavements' in the south-east indicated flow from the east. Since glaciers only form on land, there must have been land to the east of Africa. In 1974 M.R. Cooper and R. Oosthuizen, reported erratics in Dwyka tillite from near Prince Albert in the southern Cape of South Africa that contained pieces of coral-like *Archaeocyathia* apparently from Antarctica.

W.T. Blanford in 1890 discussed the question of the permanence of ocean-basins on the basis of palaeobiogeography.

P. Gervais in 1864 described a Lower Permian aquatic reptile from South Africa, and named it *Mesosaurus tenuidens,* from its numerous, slender, very long teeth. An obviously similar genus, *Stereosternum,* was described from Brazil by E.D. Cope in 1886, and a species of *Mesosaurus* from Brazil by J.H. McGregor in 1908. The moderate size of the animals suggested very strongly that they were not animals of the open sea. This was also suggested by associated sediments that indicated fossilization in anaerobic carbonaceous mud, probable in an


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embayment. The discovery of insect fossils in the same Formation, the Whitehill Formation, a few metres above the *Mesosaurus,* accords with proximity to land (mostly unpublished, but including Geertsema & van den Heever 1996).

F. Ameghino in 1891 described a fossil marsupial from Argentina, which he named *Prothylacynus patagonicus,* and which he compared to the living Tasmanian predator *Thylacynus.* No comparable fossils were known from the well-studied Palaearctic and Nearctic of North America, Europe and Asia, and none were later discovered. A direct connection between Patagonia and the Australian region was indicated. *Microbiotherium* Ameghino 1887 provided a valid taxon for such a study.

H. von Ihering from 1889 studied living and fossil freshwater molluscs, notably in South America. In 1890 and 1891 he distinguished old widespread taxa, young taxa common to Australasia and western South America, and still younger taxa which included some found also in North America. In 1891 he noted different flat worms (Temnocephala) on the molluscs on the two sides of the Andes and conceived the idea of using symbionts and parasites as biogeographic guides to dispersal. In 1904 F. Zschokke was able to place a tapeworm, from a South American marsupial, sent to him by von Ihering, in a genus known from an Australian marsupial. Harrison in 1928 reviewed applications of the technique in evaluating Wegener's hypothesis.

Palaeomagnetic data from strata of separate continents of different ages, can establish apparent pole-wandering curves, which can be used to locate and orientate the continents at various points in time. However, it was only after Holmes had shown in 1947 that absolute radiochronology coincided well with stratigraphy, that such curves could reliably be constructed, mainly from dateable igneous intrusions. P-L. Mercapton in 1926 referred to Wegener in his palaeomagnetic studies in Greenland and Australia. Data for pole-wandering for Europe and North America were available well before they were used.

A.L. du Toit in 1921 gave a public lecture which was published, in which he summarized much evidence of the Gondwanan relationships of South Africa, and in 1937 published a book dedicated to Wegener's memory.

G. Nelson and P.Y. Ladiges (2001) has a valuable discussion of opposition to acceptance of Continental Displacement as explanation of palaeobiogeography and biogeography.

**REFERENCES** (*not seen in the original)


AMEGHINO, F. 1891. Nuevos restos de mamiferos fósiles descrubiertos par Cárlos Ameghino enel eoceno inferior de la Patagonia austral. – Especies nuevas, adiciones y correcciones. *Revista Argentina de Historia Natural* **1**: 289–328.

AMPFERER, O. 1906. Über das Bewegungsbild von Faltengebirgen. *Jahrbuch der kaiserlich-königlichen geologischen Reichsanstalt Wien* **106**: 539–622.

BLANFORD, H.F. 1875. On the age and correlations of the plant-bearing series of India, and the former existence of an Indo-Oceanic continent. *Quarterly Journal of the Geological Society of London* **31**: 519–542, Plate XXV.

BLANFORD, W.T. 1890. The Anniversary Address of the President. The question of the permanence of ocean-basins. *Quarterly Journal of the Geological Society Proceedings* **46**: 43–110.

*BRONGNIART, A-T. 1828. Histoires des végétaux fossiles ou recherches botaniques et géologiques sur les végétaux renfermés dans les diverses couches du globe Vol. 1. Paris, G. Dufour et Ed. D'Ocagne, 2 vols, 136 pp.

CARRUTHERS, W. 1869. Coal plants from Brazil. On the plant remains from the coal. *Geological Magazine London* **6**: 5–10.

COOPER, M.R. & OOSTHUIZEN, R. 1974. Archaeocyathia-bearing erratics from Dwyka Subgroup (Permo-Carboniferous) of South Africa, and their importance to continental drift. *Nature* **247**: 396–398.

COPE, E.D. 1886. A contribution to the vertebrate paleontology of Brazil. *Proceedings of the American Philosophical Society* **23**: 1–20, plate.

DU TOIT, A.L. 1921. Land connections between the other continents and South Africa in the Past. *South African Journal of Science* **18**: 120–140.

DU TOIT A.L. 1937. *Our Wandering Continents. An hypothesis of Continental Drifting.* Edinburgh, Oliver & Boyd. xiii + 366 pp, folding charts.

FISHER, O. 1881. *Physics of the Earth's Crust.* London, Macmillan. xiv + 298 pp.

FORBES, E. 1846. On the connexion between the distribution of the existing fauna and flora of the British Isles, and the geological changes which have affected their area, especially during the epoch of the Northern Drift. *Geological Memoirs* **1**: 336–432, Plates 6 & 7.

FORBES, E. & GODWIN-AUSTEN, R. 1859. *The Natural History of the European Seas.* London, John Van Voorst. viii + 306 pp, folding map.

GEERTSEMA, H. & VAN DEN HEEVER, J.A. 1996. A new beetle, *Afrocupes firmae* gen. et sp. nov. (Permocupedidae), from the Late Palaeozoic Whitehill Formation of South Africa. *South African Journal of Science* **92**: 497–499.

GERVAIS, P. 1864. Description du *Mesosaurus tenuidens,* reptile fossile de l'Afrique australe. *Memoires de l'Academie des science et lettres de Montpellier, Sciences* **1864**: 169–173.

HARRISON, L. 1928. Address of the President. The composition and origins of the Australian fauna, with special reference to the Wegener Hypothesis. *Report of the Australasian Association for the Advancement of Science* **18**: 332–396.

HOLMES, A. 1928. Radioactivity and Earth movements. *Transactions of the Geological Society of Glasgow* **18**: 559–606.

HOLMES, A. 1947. The construction of a geological time-scale. *Transactions of the Geological Society Glasgow* **21**: 117–152.

HUXLEY, T.H. 1870. The Anniversary Address of the President. *Quarterly Journal of the Geological Society London* **26**: *Proceedings* xxix–lxiv.

JOLY, J. 1923.The movements of the Earth's surface crust. *Philosophical Magazine* (6)**45**: 1167–1188.

JOLY, J. 1923. Movements of the Earth's crust II. *Philosophical Magazine* (6)**46**: 170–176.

KORN, H. & MARTIN, H. 1959. Gravity tectonics in the Naukluft Mountains of South-West Africa. *Bulletin of the Geological Society of America* **70**: 1047–1078, 8 pls.

LYELL, C. 1843. On the upright fossil-trees found at different levels in the coal strata of Cumberland, Nova Scotia. *Proceedings of the Geological Society of London* **4**: 176–178.

MACGREGOR, J.H. 1908. *Mesosaurus brasiliensis* nov. sp. **In**: White, I.C., *Final Report, Commissao de Estudos das Minas de Carvao de Pedra do Brazi, Rio de Janeiro,* pp. 301–336

MERCANTON, P-L. 1926. Aimantation de basaltes groenlandais. *C.R. de l'Academie des Sciences Paris* **182**: 859–860.

MERCANTON, P-L. 1926. Aimantation de roches volcaniques australiennes *C.R. de l'Academie des Sciences Paris* **182**: 1231–1232.

MOLENGRAAFF, G.A.F. 1916. The Coral reef problem and isostasy. Translated from the Dutch, somewhat revised and augmented. *Koninklijke Nederlandse Akademie van Wetenschappen: Proceedings* **19**: 610–627.

MOLENGRAAFF, G.A.F. 1926 (1928). Wegener's Continental Drift. **In**: Van Waterschoot van der Gracht, W.A.J.M. (Ed.), *Theory of Continental Drift,* pp. 90–96. Tulsa, American Association of Petroleum Geologists. xx + 240 pp.

NELSON, G. & LADIGES, P.Y. 2001. Gondwana, vicariance biogeography and the New York School revisited. *Australian Journal of Botany* **49**: 389–409.

PRATJE, O. 1928. Beitrag zur Bodengestaltung des Südatlantischen Ozeans. *Centralblatt für Mineralogie, Geologie und Paläontologie Stuttgart Abt.B* **3**: 129–152.

RASTALL, R.H. 1929. On Continental Drift and cognate subjects. *Geological Magazine* **66**: 447–456.

*SEWARD, A. 1914. Antarctic fossil plants; British Antarctic Terra Nova Expedition, 1910: natural history report. *British Museum Natural History Report, Geology* **1**: 1–149, 8 plates.

SUESS, E. 1885–1909. Das Antlitz der Erde. Prague, F. Tempsky, 3 Bände.

TATE, R. 1867. On some secondary fossils from South Africa. *Quarterly Journal of Geological Society of London* **23**: 139–175, Plates V–IX.

*VENING-MEINESZ, F.A. 1923. *Observations de pendule dans le Pays-Bas 1913–1921*. Delft, J. Waltman Jr., 146 pp., 4 plates.
VON IHERING, H. 1890. Die geographische Verbreitung der Flussmuscheln. *Das Ausland* 1890 **63**(48): 941–943.
VON IHERING, H. 1891. Ueber die alten Beziehungen zwischen Neuseeland und Südamerika. *Das Ausland* **64**(18): 344–351.
VON IHERING, H. 1891. On the ancient relations between New Zealand and South America. *Transactions of the New Zealand Institute* **24**: 431–445.
WADATI, K. 1928. On the activity of deep-focus earthquakes in the Japan Islands and neighbourhoods. *Geophysical Magazine* **1**: 162–202.
WEGENER, A. 1912. Die Entstehung der Kontinente. *Petermanns Mitteilungen* 1912: 185–195. Tafel 36: 253–256; 305–309.
WEGENER, A. 1912. Die Entstehung der Kontinente. *Geologische Rundschau* **3**: 276–292.
WOOD, S.V. Jr. 1862. On the form and distribution of the land-tracts during the Secondary and Tertiary periods, respectively; and on the effects on animal life which great changes in configuration have probably produced. *Philosophical Magazine* (4)**23**: 161–171; 269–282; 382–393.
ZSCHOKKE, F. 1904. Die Cestoden der südamerikanischen Beuteltiere. *Zoologischer Anzeiger* **27**: 290–293.