WERE THE CONTINENTS DRIFTING BEFORE CONTINENTAL DRIFT? DOMENICO LOVISATO AND THE ROLE OF WEGENER'S PRECURSORS IN THE THEORY OF CONTINENTAL DRIFT

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Abstract – For scientists, the continents have been drifting for over a hundred years, since Alfred Wegener presented his mobilist model of the Earth's crust known as the 'Theory of Continental Drift' (TCD). This theory represents a key moment in the history of geological research because the horizontal movements of the Earth's crust he proposed captured the geological debate of the period. This said, there were several previous studies which supported hypotheses of possible horizontal movements of the Earth's crust in past eras. These arose from the complementarity of the shape of the continents, some aspects of their physiography, and the distribution of many species of plant and animal fossils. These scholars included the Italian geologist Domenico Lovisato, who outlined the role of horizontal movements in the distancing of the continents from an ancient supercontinent in a vanished manuscript presented forty years before that of Wegener, in 1874, even providing a geological explanation for these extensional movements. Our paper analyses his biography, the panorama of geological research of the time, a historical analysis of the transition from the fixist theories to the TCD, and discusses the role of Lovisato as a precursor of Wegener's famous theory.

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Sommario – Per gli scienziati, i continenti sono alla deriva da oltre cento anni, cioè da quando Alfred Wegener ha presentato il suo modello mobilista della crosta terrestre noto come 'deriva dei continenti.' Questa teoria rappresenta un momento chiave nella storia della ricerca geologica perché i movimenti orizzontali della crosta terrestre da lui proposti catturarono il dibattito geologico del periodo. Detto ciò, c'erano già diversi studi precedenti che supportavano ipotesi di possibili movimenti orizzontali della crosta terrestre in epoche passate. Questi derivavano principalmente dalla complementarità della forma dei continenti, da alcuni loro aspetti fisiografici e dalla distribuzione di molte specie di fossili vegetali e animali. Tra questi studiosi c'era il geologo italiano Domenico Lovisato, che in un manoscritto scomparso presentato quarant'anni prima di quello di Wegener, nel 1874, delineò il ruolo dei movimenti orizzontali nell'allontanamento dei continenti da un antico supercontinente, fornendo anche una spiegazione geologica di questi movimenti di estensione. Il nostro contributo analizza la sua biografia, il panorama della ricerca geologica dell'epoca, un'analisi storica del passaggio dalle teorie fissiste alla 'deriva dei continenti,' e discute il ruolo di Lovisato come precursore della famosa teoria di Wegener.

Introduction

The Theory of Continental Drift (TCD) is the hypothesis that the Earth's continents have 'drifted' across the ocean bed, moving relative to each other during the Earth's history.[1] 1912, as a backdrop to the TCD saw Alfred Wegener propose that the continents had once been united in a single supercontinent that he called Pangea, before splitting apart.

His theory was finally accepted by the scientific community when it was integrated into the Theory of Plate Tectonics (TPT). However, the idea that continents might have moved was much older than the Wegenerian mobilist theory, or at least many scholars had noticed the complementarity of the coastlines of the continents bordering the edges of the Atlantic Ocean. These included Abraham Ortelius in 1596, but later Alexander von Humboldt

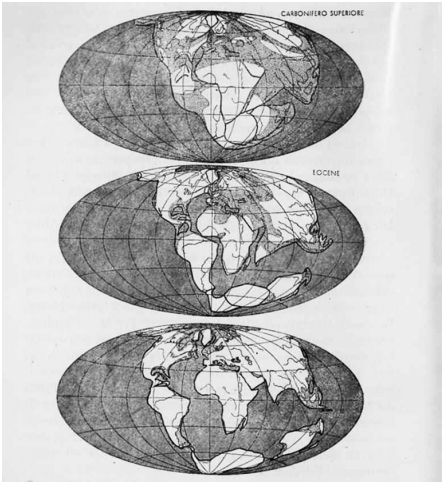

Fig. 1 – Reconstruction of continental drift. From Wegener, 1942, p. 40.

[1] Wegener, 2012.

in 1801,[2] and Antonio Snider-Pellegrini who in 1858[3] published writings and sketches describing the complementarity of Africa and South America.

Eduard Suess had proposed the existence of a supercontinent called Gondwana, and then the Tethys Ocean in 1893 assuming the past presence of a land-bridge between the continents which subsequently submerged in the form of a geosyncline.[4] In the same period, the Irish engineer, John Perry proposed that the Earth's interior was fluid,[5] while disagreeing with Lord Kelvin on the age of the Earth. This was confirmed by the exploration of the deep sea bed conducted by the 1872-1876 Challenger expedition which showed that, contrary to expectation, land sediments deposited by rivers into the oceans are deposited relatively close to shore on what is known as the continental shelf.[6] Alfred Russel Wallace added that the oceans were a permanent feature of the Earth's surface and did not change places with the continents.[7]

Among their predecessors, Domenico Lovisato (1842-1916) presented a manuscript in which he outlined a theory to explain the likeness of the coasts of Africa and South America within a mobilist framework.[8]

In 1874, in Sondrio (Italy), on the occasion of a commemoration of Leopoldo Pilla, an academic geologist at the University of Pisa and an Italian irredentist, Lovisato gave a lecture in which he put forward a mobilist hypothesis of continental drift almost forty years before Alfred Wegener formally proposed his TCD.[9]

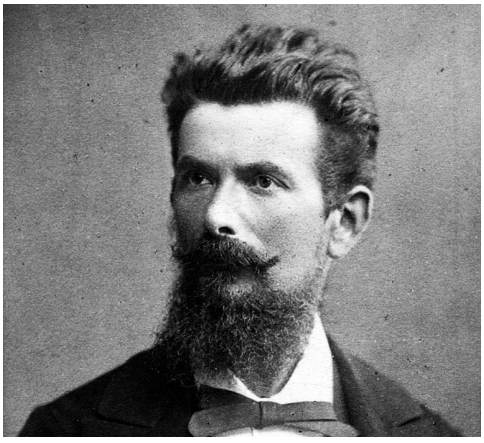

Fig. 2 – Portrait of Domenico Lovisato (Mazzoli, 2020, p. 26).

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2 Humboldt, 1816, pp. 122-123.

3 Snider-Pellegrini, 1858.

4 Suess, 1904.

5 Perry, 1895.

6 Wölfl, Snaith, Amirebrahimi et al., 2019.

7 Wallace, 1889.

8 Furlani, 2008.

9 Lovisato, 2015-2016.

Lovisato pointed out the extraordinary similarity between the coastlines of South America and Africa, suggesting that the continents might once have been connected, and that they separated because of great horizontal movements. Some parts of the manuscript, unobtainable for almost a hundred years, were copied by Fossa-Mancini in a brief biographical note on Lovisato, as reported by Segala.[10] In any case, many of the historians who have dealt with the TCD, such as Hallam,[11] have never cited Lovisato and his hypothesis.

The mobilist concept was independently and more fully developed by Alfred Wegener in 1912.[12] Wegener's hypothesis was very well received, but also came in for significant criticism, mainly for its lack of any well-motivated mechanism, this only arriving later, when Arthur Holmes proposed mantle convection as a possible driving force.[13] The idea of continental drift has since been integrated into TPT, which explains that the continents move by drifting on the plates that go to make up the Earth's lithosphere.[14] As stated by Pablo Pellegrini,[15] Wegener is considered to have been far ahead of scientists of his time because his theory turned out to be right, but it lacked sufficient evidence. The story tells of a scientific community which, since 1912, had had the theory right in front of their noses but had refused to accept it for half a century, until they were provided with the final evidence it required. But, in recent work by Pellegrini, the debate has been shown to have been far more nuanced and dominated by various schools of thought.[16] Following Le Grand,[17] the transition between pre-TCD theories to TPT was not marked by significant intellectual battles and revolutionary leaps *sensu* Kuhn,[18] since TCD was part of the debate between contractionists and permanentists. Greene adds that TCD was probably the best theory developed in Earth Sciences up to that time. Lovisato, perhaps unknowingly, was part of this debate.

Unfortunately, the manuscript continues to be untraceable, so we do not have additional paragraphs that we can report, but we will instead attempt to discuss the precursory role of Lovisato's mobilist ideas within

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10 Segala, 1990.

11 Hallam, 1973.

12 Wegener, 1912.

13 Holmes, 1931.

14 Oreskes, 1999.

15 Pellegrini, 2019.

16 Ibid.

17 Le Grand, 1988.

18 Kuhn, 2012.

the framework of the history of scientific research that preceded TCD. In doing so, we will keep in mind the inherent limitations of the fact that Lovisato's hypothesis was never published in a recognized scientific journal or in a book.

The life and scientific background of Domenico Lovisato

We know Lovisato for his extensive literature, both scientific and patriotic, with over one hundred papers,[19] particularly covering the geology of Sardinia, journals and notes from his scientific fieldtrips in Patagonia and Tierra del Fuego, and his writings on irredentism.

Domenico Lovisato was born on 12th August 1842 in Isola d'Istria (now Izola, in Slovenia). At the time this was a small town in the former Austrian-Hungarian Empire. The third of five children, his grandfather was a blacksmith while his father was a shoemaker who died when Domenico was just seven years old, leaving the family extremely poor. However, with the help of a priest relative and a family friend, he was able to complete both his primary and secondary education, enrolling in the University of Padua in 1862 to study mathematics.[20] Like many at the time he was a fierce Italian irredentist, devoted to the cause of the independence of Trento and Trieste as part of the Kingdom of Italy, and was arrested eight times for his pains. In 1864 he was tried for high treason but acquitted for lack of evidence. Then in 1865 he was banned from all schools of the Habsburg Empire, but this was reduced to a suspension and a period of internal exile. Despite these limitations, he fought as a volunteer in Trentino, and was noticed by Giuseppe Garibaldi when the Third Italian War of Independence broke out against Austria in 1866. After the war, he graduated from Padua in January 1867, where he remained at the University as a teaching assistant in Algebra and Geometry. He then qualified to teach Mathematics and Physics in high school and was sent far from his adopted home city, to the lyceum in Sondrio in the very north of Lombardy, close to Italy's border with Switzerland. Here, as a pastime, he devoted himself to Earth Sciences, forming a working relationship with the geologist Torquato Taramelli and with the mining engineer and mountaineer Felice Giordano. During these years he began work, at his own expense, on the geological map of Valtellina (Sondrio, Lombardy, Italy). It would seem this map was never finished

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[19] Fossa-Mancini, 1924a.

[20] Assorgia, Callia, 1999.

as, at the end of 1874, he was transferred to Sassari (Sardinia, Italy). A voluminous manuscript, which was written in 1876 but not published, reported all the survey data.[21]

At the end of 1874 he moved on to teach at schools in Sassari, in 1875 in Girgenti (now Agrigento), and in 1876 in Catanzaro, in Calabria (Italy).[22] In Calabria he undertook significant research into Geology and Palaeontology and published several papers.[23] On the basis of this work, in 1878 he was appointed professor of Mineralogy at the University of Sassari.[24]

His friend Felice Giordano recommended Lovisato for an expedition to Patagonia and Tierra del Fuego in Argentina sponsored by the Italian Geographical Society and funded by the Argentine government. The expedition, led by Giacomo Bove, left in December 1881, returning September 1882. The first of six of Lovisato's diaries was published by Assorgia, describing the expedition and reporting observations other than Geology, including Palaeontology, Botany, and Ethnography.[25] The government of Argentina invited him to continue his work in Argentina, but he declined the offer and returned to Italy.[26]

In 1884 Lovisato was appointed professor of Mineralogy and Geology at the University of Cagliari, in Sardinia, where he remained for the next thirty years. During that period, he taught, conducted research, and published over 100 papers, mainly involving the Geology of Sardinia. He died in Cagliari on 23rd February 1916.[27]

The Lovisato manuscript

Unfortunately, only few quotes from the manuscript itself remain, as all physical traces of it were lost after being read by the geologist Enrico Fossa-Mancini within the documents preserved by Domenico Lovisato's daughter.[28] In this section we describe just the quotes as they were reported by Fossa-Mancini himself. The manuscript was read during the commemoration of the geologist Leopoldo Pilla who died at the battle of Curta-

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21 Fossa-Mancini, 1924a.

22 Fabbi, Console, Pantaloni, 2017.

23 Lovisato, 2015-2016.

24 Ibid.

25 Ibid.

26 Ibid.

27 Ibid.

28 Fossa-Mancini, 1924b.

tone near Mantova during the First Italian War of Independence broke out against Austria in 1848. From these few fragments, it is still possible to outline Lovisato's thoughts regarding the concordance of continents and their subsequent movement:

If we take a geographical map we can see the evidence, that the eastern part of America corresponds throughout its length to the western part of the ancient continent […] if the American continent had not lost some fragments, which became the Cape Verde Islands, the Azores, the Antilles, […] and it is precisely by taking into account the islands and small peninsulas that have formed, that we are able to obtain the correspondence of the headlands on one shore with the gulfs located on the opposite side; thus Spain and France correspond to the basin located in the South of the United States, (lying) between Florida and Nova Scotia.[29]

And

In my opinion the two continents were joined […] at the end of Tertiary; […] the separation happened with the catastrophe before the icy period due to the broadening of the crevasse that already separated America from Africa […], a separation required by the equilibrium of our planet.[30]

As well as

The largest, longest and most important crevasse ran from North to South, it must have been visible and already wide enough at the dawn of the post-Pliocene period, but not impeding the communication of peoples from one side to the other; and it could have been foreseen from then that a separation was inevitable, that the greater mass would be pushed back to the West for a considerable distance to re-establish an equilibrium.[31]

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[29] "Prendiamo in mano la carta geografica e vedremo all'evidenza, che la parte orientale dell'America corrisponde perfettamente, in tutta la sua lunghezza, alla parte occidentale del continente antico; l'enorme rigonfiamento del Brasile corrisponde al golfo di Guinea e l'altro, più enorme ancora, dell'Africa dal Capo Verde fino al Sud di Liberia s'innesterebbe a meraviglia nel Mar delle Antille e del Golfo del Messico, […] se il continente americano non avesse perduto dei frammenti, che diventarono le Isole di Capo Verde, le Azzorre, le Antille, […] ed è appunto tenendo conto delle Isole e piccole penisole che si sono formate, che potremo avere la corrispondenza dei capi da un lato coi golfi situati dal lato opposto; così la Spagna e la Francia corrispondono al bacino situato al Sud degli Stati Uniti, tra la Florida e la Nuova Scozia," Fossa-Mancini, 1924b, pp. 126-127.

[30] "Secondo me i due continenti erano riuniti […] alla fine dell'epoca terziaria; […] col cataclisma prima del periodo gelido s'è operata la separazione per l'allargamento del crepaccio che separava già l'America dall'Africa […], separazione reclamata dall'equilibrio del nostro pianeta," ivi, p. 128.

[31] "Il più grande, il più lungo e il più importante crepaccio si trovava dal Nord al Sud, dovea essere visibile e già abbastanza largo all'aurora del periodo post-Pliocenico, non impedendo

And finally

The separation must have been violent in order to move large portions of the land a varying distance, (land) that once was once joined in a single mass, (and) which now consists in more than one […] in isolated masses, (which) according to their size, into continents and islands.[32]

Lovisato pointed out the extraordinary similarity between the coastlines of eastern South America and west Africa and suggested that the continents might once have been connected. Evidence of these similarities are provided by geographical maps in which the coastlines of the continents facing the Atlantic Ocean are very well-defined. In Lovisato's opinion the continents were joined together until the end of Tertiary, or about two million years ago. The separation would have happened with a catastrophe before the Quaternary glaciations and such a separation would have been required by a rebalancing of the planet. In his opinion the separation of the continents, once united in Pangea, had to be violent to cover the large distances between the continents. Unfortunately, no other fragments of the manuscript have been found.

It would also seem that the theory proposed by Lovisato is one completely disconnected from biblical facts, so there are no references to sacred texts, such as the Great Flood. On the other hand, Lovisato drew parallels with the myth of Atlantis. The American paleontologist Paul Tasch suggested that Lovisato formulated a three-way relationship between America, Atlantis, and Continental Drift.[33] In any case, this was not the first time that the idea that Atlantis might coincide with America had been expressed, and other authors had previously advanced the hypothesis, such as Abraham Ortelius, centuries before.[34]

So it was […] that it seems to me that that great continent that we now call America had to form […] this great island Atlantis, which was not separated from the continent other than by the crevasse we have indicated and which was believed to

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però la comunicazione dei popoli da una parte all'altra; e si poteva presentire fin da allora che una separazione era immancabile, che la massa maggiore sarebbe respinta ad Ovest per una distanza forte per ristabilire l'equilibrio," ivi, p. 126.

[32] "La separazione ha dovuto essere violenta perché a diverse distanze fossero respinte porzioni dell'arido che prima non formavano che una sola massa, e che d'ora innanzi ne formeranno parecchie […] in masse isolate, secondo la loro estensione, sia in continenti sia in isole," ibid.

[33] Tasch, 1954.

[34] Ibid.

have been submerged by the last cataclysm, (and) is precisely the current continent of America.[35]

As noted by Fossa-Mancini, Lovisato also reported some cultural similarities between America and the two continents, between the Spaniards and the ancient civilizations of the Mesoamerican and South American continents.[36]

The science of Geology between the second half of the 18th century and the Wegener epoch

Here we provide a short review of geological studies in the mid-19th century to better define the role of Lovisato within the mobilist paradigms and TCD. The history of geology of the 19th century was widely discussed by Greene,[37] who has traced and reviewed the history of European and American geology in that period. The two dominant topics of discussion in geological world from the 1870s through to the 1930s were fundamental to our dissertation: first of all, the age of the Earth, which, in 1874, was, at most, 96 million years,[38] and secondly, the state of knowledge of the ocean floor which at that time was still very meagre. Between 1872 and 1876, the Challenger expedition set out to measure ocean depths. The latter were measurements at specific points rather than bathymetric profiles.

The geology of the mid-19th Century dealt with Lyell's ideas of Uniformitarianism. This is the assumption that the same natural laws and processes that operate uniformly in space and time and those we observe nowadays have always operated in the past and apply everywhere in the Universe. These are slow processes and very similar to the ones we can currently see occurring. This theory stands in opposition to Catastrophism, in which the Earth's landforms and geological structures have formed and evolved as a result of a series of catastrophic events.

Another important question for our argument is to consider the global context of geological studies and the differences that existed with the Italian 'school' of that time. Back then, the Anglo-Saxon, but also French

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35 "Fu così […] che mi sembra abbia dovuto formarsi quel grande continente che oggigiorno chiamiamo America […] questa grande isola Atlantide, che non era separata dal continente che per il crepaccio che abbiamo indicato che si credea sommersa dall'ultimo cataclisma, è precisamente il continente attuale dell'America," Fossa-Mancini, 1924b, p. 126.

36 Ibid.

37 Greene, 1982.

38 Philips, 1860.

and German geological research were significantly more dynamic than their Italian equivalent. The need for geological data for their practical use pushed governments to support geological research.[39] During the 19th century the governments of several English-speaking countries funded geological surveys to produce geological maps covering vast areas. With government funding, more scientists could study geology with better technology and improved methods, leading to the expansion of the field. On the other hand, in 1860s Italy, but, to tell the truth probably also right through the second half of the 18th century, Italian Earth scientists were not particularly relevant within the international debate compared to the role played by researchers from other European countries.[40] Even though Italian geological research was ongoing within the country, this research slowed down in the middle of the 19th century and this led to a reduction in the institutional visibility of the country's geological community, which lost its centrality and authority at wider scale.[41]

In the early 19th century, Uniformitarianism was well accepted by Earth scientists. Charles Lyell challenged Catastrophism with his publication, in 1830,[42] of the first volume of his book entitled *Principles of Geology*, which discussed the geological evidence to prove Hutton's ideas of Gradualism to be correct.[43] He argued that most geological change had been very gradual during human history.[44] At the same time, following a two-week mapping expedition after his spring course on Geology, a student named Charles Darwin speculated about the Earth expanding to explain uplift, following on from the basis of the idea that oceanic areas sank as land was uplifted, and proposed the idea that coral atolls grew from fringing coral reefs round sinking volcanic islands.[45]

In the 19th century, the Earth Science community seriously addressed the thorny question of the age of the Earth in terms of millions of years. In 1862, the physicist Lord Kelvin, published calculations that fixed the age of Earth at between 20 to 400 million years, derived from thermodynamic calculations.[46] His result was based on the assumption that the diffusion of

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39 Jardine, Secord, Spary, 1996.

40 Vaccari, 2013.

41 Ibid.

42 Lyell, 1830.

43 Albrittron, 1980.

44 Gohau, 1990.

45 Darwin, 1846.

46 Dalrymple, 1994.

heat takes place by simple conduction, ignoring the convection phenomena, thus underestimating the real age of the Earth, as reported by John Perry in 1894.[47] Perry's explanation was not accepted until the second half of the 20th century. Kelvin's error was initially attributed to his ignorance of the radioactivity of the Earth, which was discovered in 1896 by Henri Becquerel and Pierre and Marie Curie. The age of the Earth was pushed back even further in the 20th century with the discovery of radioactive decay. In 1911 Arthur Holmes dated a sample from Ceylon at 1.6 billion years old using lead isotopes, showing that the Age of the Earth was a few billion years old, and that radiometric dating was credible.[48] Holmes published *The Age of the Earth, an Introduction to Geological Ideas* in 1927 in which he presented a range of 1.6 to 3 billion years.[49] Subsequent dating in the 1940s has pushed back the age of the Earth even further, to around 4.55 billion years and this is now generally accepted.

The other thorny question was that of seafloor mapping. The world's oceans cover 71% of the Earth, or about 362 million square kilometers,[50] but only a small fraction has been mapped by direct observation. In the second half of the 19th century, bathymetric measures were collected using lead weights at selected sites. As observed by John Noble Wilford,[51] the assumptions of 19th century geological sciences were based only on a knowledge of dry land. Until a few years ago, Geology was a science based on terrestrial observations that did not address the problem of the seabed for what it could reveal of the true nature of the Earth.

The initial measuring devices were sounding poles and lines with weights attached to them. The first large-scale scientific application using lead weights started with the HMS Challenger oceanographic expedition around the globe in the 1870s. Such 'plumb-line' measurements were the standard practice until the beginning of the 20th century.[52] The foundation for replacing plumb-lines with acoustic techniques had been laid at the end of the 15th century, when Leonardo da Vinci discovered that the noise of ships could be heard under water from afar, thereby discovering that sound also travels underwater.[53] The trigger for further development

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47 Perry, 1895.

48 Dalrymple, 1994.

49 Holmes, 1927.

50 Costello, Chaudhary, 2017.

51 Wilford, 1982.

52 Wölfl, 2019.

53 Urick, 1983.

of underwater acoustic techniques at the beginning of the 20th century was the need to detect underwater objects, exemplified by the search for the Titanic, that sank in 1912, as well as the developments in submarine warfare during World War One.[54] This moment marks the start of the era of echo sounding. The development of single beam echo sounders (SBESs) constituted a significant improvement in terms of accuracy and efficiency over earlier equipment. SBESs are configured with piezoelectric crystal – or ceramic – based transducers that can generate and receive acoustic signals. The depth of the seafloor is determined by measuring the each-way travel time of a sound wave that is sent toward the seafloor and is reflected back. This technique, combined with accurate measurements of acoustic wave travel times, laid the foundation for this success story.[55] In 1977, the *World Ocean Floor Panorama* was published, a spectacular atlas of the seabed of all the world's oceans based on the geological and geophysical data collected at that time.[56]

The discussion of mobilist theories that preceded the TCD

In this section we describe previous observations on the similarities between the coastlines on opposite sides of the Atlantic.

From the on-line Collins Dictionary, a precursor, or forerunner of something is a similar thing that happened or existed before it, often something which led to the existence or development of that thing, or was a sign of what was about to happen. In scientific reasoning, the concept of the precursor assumes a particular value, in the sense that the observations and the data as a whole contribute to the fact that at a certain moment in time a new theory is proposed, but the precursors can be indicated as such only once the theory has been accepted. Historians collect and interpret all those ideas that had previously approached the conceptual bases of the new paradigms in some fashion or other. Despite the TPT being widely accepted by the late 1960s, other mobilist theories were clearly proposed by some scholars from the 19th century onwards. Therefore, any mobilist idea that predates TCD and TPT should be evaluated in its predecessor role, but the limitation is precisely that the process is *a posteriori*, with the risk of being overly presentist.

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[54] Lurton, 2002.

[55] Mayer, 2006.

[56] Heezen, Tharp, 1977.

The first reference to the similarity between the Atlantic coasts of South America and Africa was made in 1596 by the Flemish cartographer Abraham Ortelius.[57] A century later the French naturalist Georges-Louis Leclerc, compte de Buffon, also observed the similarity.[58] Toward the end of the 18th century, Alexander von Humboldt, a German naturalist, suggested that the lands bordering the Atlantic Ocean had once been joined.[59] As regards his predecessors, Abraham Ortelius, in his work *Thesaurus Geographicus*, suggested that the American Continent was "torn away from Europe and Africa […] by earthquakes and floods."[60] Ortelius wrote that "The vestiges of the rupture reveal themselves if someone brings forward a map of the world and carefully considers the coasts of the three [continents]."[61]

Charles Lyell stated that "Continents, therefore, although permanent for whole geological epochs, shift their positions entirely in the course of ages,"[62] adding that James Dwight Dana was the first to throw doubt on this, as reported in the *Manual of Geology*, although he had proposed the so-called Permanence theory, widely accepted in the United States in the 1920s.[63] Alfred Russel Wallace remarked:

> It was formerly a very general belief, even among geologists, that the great features of the Earth's surface, no less than the smaller ones, were subject to continual mutations, and that during the course of known geological time the continents and great oceans had, again and again, changed places with each other.[64]

Formerly, certain scholars observed the similarity in shape of the coastline of South America with that of West Africa, such as Francis Bacon in 1620 in his *Novum Organum*.[65] The fact that this was the first work to point out the fit of the opposing coasts of Africa and South America is now firmly entrenched in the scientific literature, as suggested by Davies.[66] However, the shape of the two continents is very briefly mentioned in Aphorism

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57 Ortelius, 1596.
58 Leclerc, 1778.
59 Humboldt, 1816.
60 Ortelius, 1596
61 Ibid.
62 Lyell, 1830.
63 Dana, 1863.
64 Wallace, 1889.
65 Bacon, 1902.
66 Davies, 1965.

XXVII of *Novum Organum*, in which Bacon is concerned with analogies and resemblances in nature.[67] He did not compare the opposing coastlines of the two continents, but rather their corresponding coasts. He did not offer any discussion of the subject, but only suggested similarities in shape, and many geologists and historians of Science persist in wrongly attributing to Bacon the germ of the idea of TCD.[68]

In 1688, Francois Placet suggested that the continents were united until the Great Flood, after which America would have separated from Africa due to the sinking of the mythical Atlantis of which Plato had spoken. However, Carozzi stated that neither Francis Bacon nor Francois Placet can be considered forerunners of the TCD, and the same goes for von Humboldt, the German naturalist and geographer for whom South America and Africa were once united and might have separated due to a massive sea current that carved out a valley occupied today by the Atlantic Ocean.[69] On the other hand, writing in 1858, Antonio Snider-Pellegrini argued for a juxtaposition of the two continents with a subsequent drifting. In the chapter 29 of *La creation et ses mysteries devoiles: ouvrage ou l'on expose clairement la nature de tous les entres, les elements don't ils sont composes et leurs rapports avec les astres*, he described and illustrated the fitting together of the continents bordering the Atlantic to explain the occurrence of identical fossil plants in the coal deposits of both Europe and North America.[70] Abbot Snider-Pellegrini supposed that the present continents had arisen on the same side of the Earth and formed a single mass, and that a series of catastrophes until the Biblical Flood had dismembered them and driven them apart. The author also observed the similarity between the fossil faunas on both sides of the Atlantic Ocean.[71] Domenico Lovisato, however, only 16 years later, described his mobilist ideas without reference to the Holy Bible.[72]

In 1882, the English geologist Osmund Fisher, postulated a non-homogeneous composition of the Earth, and suggested that the continents broke up at the time of the Moon's separation from Earth, and then readjusted their positions to a new shape of the Earth with separated continents.[73] This association of continental drift with the origin of the Moon domi-

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67 Bacon, 1902.

68 Davies, 1965.

69 Carozzi, 1970.

70 Snider-Pellegrini, 1858.

71 Ibid.

72 Fossa-Mancini, 1924b.

73 Fischer, 1882.

nated many of the ideas later, and well into the 20th century. The American geologist Frank Bursley Taylor, in 1910, proposed a mobilist, non-catastrophist theory based on the distribution of the mountain chains on the Earth surface.[74] These chains can be found mainly at continental margins, and thus he speculated that they formed following the corrugation of the continental margin due to their drift. In Taylor's opinion, drifting might be due to very large tidal forces when Moon separated from the Earth, following the ideas of Fisher, and taking place, about 70 to 100 million years ago.

The Italian Roberto Mantovani, a violinist and scientist, was part of an orchestra that reached the volcanic Réunion Island in 1878. During his stay on the island, Mantovani had occasion to observe the huge volcanic fractures on the Indian ocean shore near the town of Saint-Denis. He argued that, on a global scale, all the continents might have undergone the same disjunction processes as he had observed on the flanks of the volcano. and that today, these global fractures are occupied by the oceans. After several years of observations, Mantovani published his hypothesis in 1889 in the Bulletin of the *Societé des Sciences et des Arts of Saint-Denis*. These were a precursor to the theory of planetary expansion.[75] Mantovani was not a mere precursor of the TCD and his ideas on Earth expansion were more general compared to those of Wegener who did not consider the possibility of variation of the Earth's radius.[76]

In 1912 the German meteorologist and geophysicist Alfred Wegener presented his theory at a conference in Germany.[77] The acceptance of the theory divided the scientific community into a group of very enthusiastic researchers and another, extremely reluctant, bordering on the offensive. For example, the Frenchman Émile Argand,[78] the South African Alexander Du-Toit,[79] and the British Arthur Holmes [80] were all very enthusiastic, while the Russian Vladimir Beloussov,[81] but especially the American geologist Thomas Chrowder Chamberlin considered the TCD as a heresy.[82]

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[74] Taylor, 1910.

[75] Mantovani, 1889.

[76] Scalera, 2003.

[77] Greene, 2015.

[78] Argand, 1924.

[79] Du-Toit, 1937.

[80] Holmes, 1965.

[81] Beloussov, 1962.

[82] Chicago, University of Chicago Library, Hanna Holborn Gray Special Collections Research Center, *Chamberlin, Thomas Chrowder. Papers*, Box 27, Folder 30, "Land connections and relations in North Atlantic area and beyond," 1923.

The mobilist ideas of Domenico Lovisato bear the date of 1874 when, during a commemoration of a geologist who had died 26 years earlier in a battle for the independence of Italy from Austria, the Istrian geologist read some pages in public, prepared shortly before and much reworked compared to the drafts.[83] Lovisato wasn't a geologist, he was a mathematician. He had not studied Natural Sciences, but Mathematics. Fossa-Mancini wrote that we should not be surprised if at the beginning of a new career he launched into controversial hypotheses, given his personal literary, historical and ethnological culture.[84] His manuscript was never published, perhaps because of its lack of a scientific framework for such a theory at the time,[85] but perhaps also because some friends might have questioned the theory and suggested to Lovisato that he avoid talking about it in the future.[86]

Fossa-Mancini suggested that Lovisato was probably wrong in wanting to search a single solution for two distinct problems, namely both the current disposition and the cultural affinity between the continents.[87] He also suggested that Lovisato's theory must have made such a disastrous impression as to induce him to abandon these studies and perhaps to lose all faith in his original conception, as there were no further similar positions taken in subsequent papers. Moreover, this manuscript was one of Lovisato's first public addresses, perhaps even the very first. He was presenting his hypothesis at a funeral commemoration, to a group composed mainly of geologists and irredentists. Therefore, the meeting was not a real geological conference, but probably a testing ground with friends and fellow scientists. Fossa-Mancini suggested that his friends advised him not to continue down this thorny track.[88] In any case, as highlighted by Greene,[89] Anglo-American scientists have obscured the important contribution of European geologists, perhaps at the same time reducing the remote possibility of knowledge of writings such as those of Lovisato.

On a careful reading of the original books, more than one scholar suggests that Bacon and Placet were the real precursors of TCD, mainly because they limited themselves to noting the similarity of the coasts on both

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83 Fossa-Mancini, 1924b.

84 Ibid.

85 Furlani, 2008.

86 Giannitrapani, 1957.

87 Fossa-Mancini, 1924b.

88 Ibid.

89 Greene, 1982.

sides of the Atlantic, without providing any kind of geological explanation. Only Snider-Pellegrini, in 1858 provided an age, the Universal Flood, which in his chronology of the world took place on 25th November of the year 1656 from the date of the creation of the world, the latter having started 6,984 years earlier than when he was writing, according to the prevailing religious orthodoxy at the time, proposed by bishop James Ussher more than 300 years previously. In any case, Snider-Pellegrini,[90] gave these movements only a small space in his book when he talks about the origins of the American continent, even if the problem of the origin of America is reported in the subtitles on the cover.

Did Lovisato know of Snider-Pellegrini's work? He was almost certainly not aware of the French abbot's volume, published only 16 years earlier in Paris. Nonnoi described Lovisato as a field geologist and not indifferent to theoretical questions relating to the formation and evolution of the Earth. It cannot be excluded that it was precisely the theoretical and speculative aspects that started him on a career for which he had not followed a specific academic curriculum.[91] We can also add that an academic course in Geology did not exist at that time, but geologists usually specialized after graduation. Nonnoi argued that, even if at first glance, his hypothesis might have been an evocative one, but, a glance at the text shows the conjecture was bound to encounter considerable resistance, although this might be related to Lovisato's inexperience and relative youth, given that in 1874 he was still a young high school teacher. Moreover, we should remember that Snider-Pellegrini dedicated only a few pages to the problem, so that theory did not pass muster either.[92] According to Nonnoi, as a first approximation it would seem that some of the distinctive theoretical nuclei of the TCD theory do not emerge, except in a vaguely embryonic form, at least from the edited passages of the manuscript. In particular, there are no traces of the postulate according to which the Earth's crust is formed of materials of medium specific weight (SIAL), floating on a layer of higher specific weight (SIMA), as postulated by Taylor in 1910 and then taken up *a posteriori* by Wegener in the TCD.[93] These observations also would have been impossible at the time of Lovisato, due to the very poor knowledge of the sea-floor and gravimetric data. It's worth remembering that the geological exploration at the time of Lovisato was still exclusively research on *terra firma*,

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[90] Snider-Pellegrini, 1858.

[91] Nonnoi, 2014.

[92] Ibid.

[93] Ibid.

and there was a complete lack of any measured data relating the sea-floor which covers more than three quarters of the Earth's surface. Wegener, in his *Origin of Continents and Oceans* published a hypsometric curve, in which there are two prevalence height above and below sea level, from which derive the debates on the isostasy of Airy and Pratt and the conclusion that there could be parts of the Earth's crust with different specific weights.[94]

Conclusions

In our opinion, starting from an examination of 1) the few snatches of manuscript available, 2) the major geological assumptions proposed in the second half of the 19th century and 3) the characteristics of the paradigm shifts, there are some characteristics that allow us to consider Lovisato a precursor. Lovisato's theory, in fact, is the first to provide a more precise date, the beginning of the Quaternary, for the separation of the continents, and he provides a valuable geological explanation, the latter not supported by data and field observations. These data were not available at the time, as we saw earlier. Even the question of the similarity between the two parts of the Atlantic Ocean, which today may even seem trivial, was less so at the time, in the sense that illiteracy rates were very high and few people, even including geologists, had access to geographical maps. Moreover, geologists are very sensitive to what is reported in maps and to their own observations, so it is likely that some characteristics, such as the similarity between the coasts of South America and Africa, did not go unnoticed to careful eyes.

Wegener almost certainly did not know the manuscript and had no contact with Lovisato and his research. The spreading of ideas and data in the 19th century was not as rapid as it is today. Moreover, Lovisato wrote his manuscript in Italian, so his ideas would hardly have left the immediate national context. In the end, the fact remains that Lovisato never published his idea of moving continents, so his observations can hardly be considered part of an actual philosophical discussion within geological historiography.

Archive sources

Chicago, University of Chicago Library, Hanna Holborn Gray Special Collections Research Center, *Chamberlin, Thomas Chrowder. Papers*, Box 27, Folder 30.

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[94] Wegener, 2012.

References

Adams Frank D., 1938. *The Birth and Development of the Geological Sciences*, Baltimore, The Williams & Wilkins Company.

Albritton Claude C. Jr., 1980. *The Abyss of Time: Changing Conceptions of the Earth's Antiquity after the Sixteenth Century*, San Francisco, Freeman, Cooper & Company.

Argand Emil, 1924. *La tectonique de l'Asie. Conférence faite à Bruxelles, le 10 août 1922, devant le Congrès géologique international (XIII^e session)*, Liege, Imp. Vaillant-Carmanne.

Assorgia Antonio, Callia Raffaele, 1999. "Lo scienziato irredentista Domenico Lovisato," in Iid. (a cura di), *Lo sviluppo delle ricerche geologiche e minerarie nella Sardegna dell'Ottocento*, Cagliari, C.U.E.C., pp. 233-263.

Bacon Francis, 1902 [1620]. *Novum Organum*, New York, Collier & Son.

Beloussov Vladimir V., 1962. *Basic Problems in Geotectonics*, New York, McGrawn-Hill.

Carozzi Albert V., 1970. "New Historical Data on the Origin of the Theory of Continental Drift," *Geological Society of America Bulletin*, 81/1, pp. 283-286.

Costello Mark J., Chaudhary Chhaya, 2017. "Marine Biodiversity, Biogeography, Deep-Sea Gradients, and Conservation," *Current Biology*, 27/11, pp. R511-R527.

Cox Allan V., 1973. *Plate Tectonics and Geomagnetic Reversal*, San Francisco, Freeman.

Dalrymple Brent G., 1994. *The Age of the Earth*, Stanford, Stanford University Press, 1994.

Dana James D., 1863. *Manual of Geology. Treating of the Principles of the Science with Special Reference to American Geological History, for the Use of Colleges, Academies, and Schools of Science*, Philadelphia, Theodore Bliss and Co.

Darwin, Charles, 1846. *Journal of Researches into the Natural History and Geology of the countries visited during the voyage of H.M.S. Beagle round the world under the command of Capt. Fitz Roy, R.N.*, 1, New York, Harper and Brothers. Publishers.

Davies Gordon L., 1965. "Francis Bacon and Continental Drift," *Geological Magazine*, 102/4, p. 347.

Du-Toit Alexander L., 1937. *Our Wandering Continents. An Hypothesis of Continental Drifting*, Edinburgh, Oliver and Boyd.

Eakins, B.W., Sharman, G.F., 2010. *Volumes of the World's Oceans from ETOPO1*, Boulder, CO, NOAA National Geophysical Data Center.

Heezen Bruce C., Tharp Marie, 1977. *World Ocean Floor Panorama*, National Geographic.

Fabbi Simone, Console Fabiana, Pantaloni Marco, 2017. "1876-1881: Domenico Lovisato and the Geology of Calabria (Southern Italy)," *Italian Journal of Geosciences*, 136/3, pp. 471-484.

Fisher Osmond, 1882. "On the Physical Cause of the Ocean Basins," *Nature*, 25, pp. 243-244.

Fossa-Mancini Enrico, 1924. "L'opera scientifica di Domenico Lovisato," *Bollettino della Società Geologica Italiana*, 43/2, pp. 139-150.

Fossa-Mancini Enrico, 1924b. "La recente teoria della deriva dei continenti in un vecchio manoscritto di Domenico Lovisato," *Urania*, 8/6, pp. 123-129.

Furlani Stefano, Dall'Olio Nicola, 2007. "The Role of Domenico Lovisato in the Context of the Historical and Epystemological Evolution of the Continental Drift Theo-

ry," in Federazione Italiana di Scienze della Terra, *Geoitalia 2007. Sesto Forum Italiano di Scienze della Terra, Rimini, 12-14 settembre 2007*, s.l., FIST, 2007, p. 371.

Giannitrapani Luigi, 1957. "Il precursore italiano della teoria di Wegener. L'Universo," 37/1, pp. 227-232.

Gohau Gabriel, 1990. *A History of Geology*, New Brunswick, Rutgers University Press.

Greene Mott, 1982. *Geology in the nineteenth Century. Changing Views of a Changing World*, Ithaca, London, Cornell University Press.

Greene Mott, 2015. *Alfred Wegener. Science, Exploration, and the Theory of Continental Drift*, Baltimore, Johns Hopkins University Press.

Hallam Anthony, 1973. *A Revolution in the Earth Sciences. From Continental Drift to Plate tectonics*, Oxford, Claredon Press.

Holmes Arthur, 1927. "Some Problems of Physical Geology and the Earth's Thermal History," *Geological Magazine*, 64/6, pp. 263-278.

Holmes Arthur, 1931. "Radioactivity and Earth movements," *Transactions of the Geological Society of Glasgow*, 10, pp. 559-606.

Holmes Arthur, 1965. *Principles of Physical Geology*, Edinburgh, Nelson.

Humboldt Alexander von, 1816. *Voyage aux regions équinoxiales du noveau continent, fait en 1799, 1800, 1801, 1802, 1803, et 1804*, Paris, Librarie grecque-latine-allemande.

Imeroni Amerigo, 1927. *Domenico Lovisato, la vita e le opere*, Cagliari, Tip. Ledda.

Jardine Nicholas, Secord, James A., Spary Emma C. (eds.), 1996. *Cultures of Natural History*, Cambridge, Cambridge University Press.

Kuhn Thomas S., 2012 [1962]. *The Structure of Scientific Revolutions*, Chicago and London, The University of Chicago Press.

Leclerc Georges-Louis, comte de Buffon, 1778. *Histoire naturelle, générale et particulière, contenant les epoques de la nature*, t. 12, Paris, de l'Imprimerie Royale.

Lovisato Domenico, 2015-2016. *In Patagonia e nella Terra del Fuoco, trascrizione dei Diari di Domenico Lovisato di proprietà dei Civici musei di Storia e Arte di Trieste, sull'esplorazione antartica del 1881-1882*, a cura di Antonio Assorgia, 2ª edizione riveduta e corretta, s.l., Associazione per il parco geominerario, storico ed ambientale della Sardegna.

Lyell Charles, 1830. *Principles of geology, being an attempt to explain the former changes of the Earth's surface, by reference to causes now in operation*, vol. 1, London, John Murray.

Lovisato Domenico, 1883. "Una escursione geologica nella Patagonia e nella Terra del Fuoco," *Bollettino Società Geografica Italiani*, s. 2, 8., pp. 333-347; 420-443.

Le Grand Homer E., 1988. *Drifting Continents and Shifting Theories*, Cambridge, Cambridge University Press.

Lo Monaco Mario, 1983. "Un geologo istriano precursore della teoria della deriva dei continenti," *Rivista dalmatica*, 54/2, pp. 109-115.

Lurton Xavier, 2002. *An Introduction to Underwater Acoustics Principles and Applications*, New York, Berlin, Heidelberg, Springer.

Mantovani Roberto, 1889. "Les fractures de l'écorce terrestre et la théorie de Laplace," *Bulletin de la Société des arts et sciences de La Réunion*, pp. 41-53.

Marvin Ursula B., 1973. *Continental Drift. The Evolution of a Concept*, Washington, Smithsonian Institution Press.

Mayer Larry, 2006. "Frontiers in seafloor mapping and visualization," *Marine Geophysical Researches*, 27, pp. 7-17.

Mazzoli Enrico, 2020. *Un istriano nella Terra del Fuoco, Domenico Lovisato e la spedizione australe argentina 1881-1882*, Trieste, Libreria Editrice Internazionale "Italo Svevo".

Nonnoi Giancarlo, 2014. "Domenico Lovisato. Una camicia rossa sulle tracce del tempo," in Francesco Atzeni, Antonello Mattone (a cura di), *La Sardegna nel Risorgimento*, Roma, Carocci, pp. 419-446.

Oreskes Naomi, 1999. *The Rejection of Continental Drift. Theory and Method in American Earth Science*, Oxford, Oxford University Press.

Ortelius Abrahamus, 1596. *Thesaurus Geographicus, Recognitus et auctus*, Antwerp, Ex Officina Plantiniana.

Pellegrini Pablo A., 2019. "Styles of Thought on the Continental Drift Debate," *Journal for General Philosophy of Science*, 50, pp. 85-102.

Perry John, 1895. "On the Age of the Earth," *Nature*, 51, pp. 224-227.

Philips John, 1860. *Life on the Earth*, Cambridge, MacMillan and Co.

Taylor Frank B., 1910. "Bearing of the Tertiary Mountain Belt on the Origin of the Earth's Plan," *Bulletin Geological Society of America*, 21, pp. 179-226.

Tatsch Paul, 1954. "Search for the germ of Wegener's Concept of Continental Drift," *Osiris*, 1, pp. 157-167.

Sandra Herbert, 1991. "Charles Darwin as a Prospective Geological Author," *British Journal for the History of Science*, 24, pp. 159-192.

Scalera Giancarlo, 2003. "Roberto Mantovani an Italian Defender of the Continental Drift and Planetary Expansion," in Giancarlo Scalera, Karl H., Jacob (eds.), *Why Expanding Earth? A Book in Honour of Otto Christoph Hilgenberg*, Proceedings of the 3rd Lautenthaler Montanistisches Colloquium, Mining Industry Museum, Lautenthal (Germany), May 26, 2001, Roma, INGV, pp. 71-74.

Segala Marco, 1990. *La favola della Terra mobile*, Bologna, il Mulino.

Snider-Pellegrini Antonio, 1858. *La Creation et ses mysteries devoiles. Ouvrage ou l'on expose clairement la nature de tous les etres, les elements dont ils sont composes et leurs rapports avec les astres*, Paris, Franck et Dentu.

Sperber Irwin, 1990. *Fashions in Science. Opinion Leaders and Collective Behavior in the Social Sciences*, Minneapolis, University of Minnesota Press.

Suess Eduard, 1904. *The Face of the Earth (Das Antlitz der Erde)*, Oxford, Clarendon Press.

Urick Robert J., 1983. *Principles of Underwater Sound*, New York, McGraw-Hill.

Vaccari Ezio, 2013. "La geologia e la conoscenza della Terra," in Antonio Clericuzio, Saverio Ricci (a cura di), *Il contributo italiano alla storia del pensiero*, Roma, Istituto della Enciclopedia Italiana, pp. 535-539.

Wallace Alfred R., 1889. *Darwinism: an exposition of the theory of natural selection with some of its applications*, London & New York, Macmillan & Company.

Wegener Alfred L., 1912. "Die Entstehung der Kontinente," *Geologische Rundschau*, 3, pp. 276-292.

Wegener Alfred L., 1942. *La formazione dei continenti e degli oceani*, Torino, Giulio Einaudi.

Wilford John N., 1981. *The Mapmakers*, New York, Alfred A. Knopf.

Wilson John T., 1968. "Static or Mobile Earth. The Current Scientific Revolution," *Proceeding of the American Philosophical Society*, 122, pp. 309-320.

Wölfl Anne-Cathrine, Snaith Helene, Amirebrahimi Sam et al., 2019. "Seafloor Mapping. The Challenge of a Truly Global Ocean Bathymetry," *Frontiers in Marine Science*, 6/283, pp. 1-16.

Online sources

Berann Heinrich C., Heezen, Bruce C., Tharp Marie, 1977, World ocean floor Map, https://www.loc.gov/item/2010586277/.