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A Philosophical Analysis of The Rise of Wegener's Theory of Mobilism

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***Abstract*—Relevant data was collected from extensive literature search and the archives of PBS TV series captioned PLANET EARTH (circa 1985). We focused on titles and sub-titles of the Khunian Paradigm Concept of progress in science and the Lakatosian Research Programs with a hard core and protective belt.The two positions are presented in sequence and discussed. Both positive and negative heuristics of Khunian paradigms are highlighted. On the subject of Wegener's Hypothesis, however, the Lakatosian model appears more adequate The career of Alfred Wegener's Drift Hypothesis from the 1920s through to the post WWII era, culminated in the emergence of the Plate Tectonic theory among the Global community of English speaking Geologists in the early 1960s. It is our view that the two views of progress in science Khunian and Lakatosian, make the teaching of Plate tectonism easier at the undergraduate level of pedagogy.**

Keywords— Continental Drift, Khunian, Lakatosian, Wegener's Hypothesis, Polar wandering, Continental, Island arcs, Convection currents, paleomagnetism,Sialic crust, basaltic, Sima and Antarctica.

I. INTRODUCTION

The 1960s witnessed a significant revolution in earth science. The revolution in Geology involved the acceptance of a new physical theory to explain the irregularities that abound on the surface of the globe.

These irregularities viz., continents, oceans mountain chains and ocean islands, were not anticipated by most physical theories. The vast majority of geologists now believe that they result from the lateral movement of thin rigid plates covering the earth, a theory now known as "ate tectonics [1].This theory parallel s Alfred Wegener's theory of Contintal Drift, in which it was postulated that continents can move laterally. The historical relations of the two theories have been explored by a number of researchers such [2], [3] and [4].Some authors [4] dubbed the Geological revolution a Khunian revolution. Others like [2] tried to interpret the change by making use of Imre Lakatos' [5] analysis of scientific of scientific growth.

The three goals of of this article are first, to present a brief summary of the Khunian and the Lakatosian analysis of scientific growth, and scientific revolution. Second, to briefly review the historical career of WEGENER'S theory [6] from 1922 when it was first published in English Language, until the 1960s when it's parallel viz., plate tectonism was widely upheld by the global community of earth scientists. Third, to suggest which of the two models might be endorsed as appropriate for describing the recent revolution in Geology.

A. KUHN'S STRUCTURE OF SCIENTIFIC REVOLUTION.

Reference [7] argues that science has two phases, normal science and revolutionary science.

Normal science operates under a shared paradigm and often responsible for causing scientific revolutions.The most important eventing the history of science is therefore non-cummulative. Quite often, it involves changes that cannot be measured by a common standard. According to Kuhn, paradigms determine what problems to solve, the instruments to use, the inferring techniques and models to employ [8].

Normal science as defined by Kuhn [7] is Paradigm dominated research. A conceptual change occurs when the central commitments of a paradigm requires some modification. At this juncture, the scientist is confronted by a challenge to his basic assumptions. For inquiry to proceed, the scientist must acquire new concepts and a new way of seeing the world [9]. This type of conceptual change is termed "A scientific revolution by Kuhn".

B. LAKATOS' RESEARCH PROGRAMS

Reference [5] calls the scientists' central commitments as their theoretical hard core and suggests that these commitments generate "research programs "designed to apply them to and defend them from experience [9]. The question of Central concern for Lakatos' theory was 'How does one rationally decide what theory, if any, to accept as best explaining some set of phenomena? '

He suggested that theories come in series called research programs which are characterized by a positive and negative heuristic. According to quote: "The negative heuristic of the program forbids us to direct the modus tollens at this hard core. Instead we must use our ingenuity to articulate or even invent 'auxiliary hypotheses' which form a protective belt around this core, and we must redirect the modus

tollens to these". It is this protective belt axillary hypothesis which has to bear the brunt of test and get adjusted or even get completely replaced, to defend this hardened core (End quote). [5]'s position may be summarized as follows: A research program should be eliminated if another program has been proposed which has excess empirical content over the original and(predicts new facts), explains the success of the old one, and has some.of its excess empirical content corroborated. It is the job of the proponents of a research program to defend their research program by discouraging work on research programs which compete with their own and proliferate hypotheses to explain away apparent anormalies. One should expect scientists to act in accordance with the above statements.

Lakatos [5] not only maintained that research programs are characterized by a hard core, but that the hard core remains constant throughout the lifetime of a program.

C. THE RISE OF WEGENER'S HYPOTHESIS

The publication of the Smithsonian Institution(Marvin, 1973) provided a brief outline of the main premises of WEGENER'S Continental Drift Hypothesis. They are as follows :

The continents and ocean floors are fundamentally distinct. The continents are blocks of light granitic rock (sial), about 100kilometers thick, that floats isostatically in denser basaltic rock(Sima), out of which they project only about 5kilomeyers.The de set medium is exposed in the ocean floor.

The sial no longer completely covers the entire earth, whether it ever did can be left undecided. In any case, It's area has grown smaller and its thickness increased as a result of folding and faulting during Geologic time (earth history). It has also split into fragments.

Today, Continental rock covers only about one third of the earth surface. The Continental blocks retain the approximate outlines they acquired during a breakup that began in the Mesozoic. If the Tertiary folded mountains could be flattened out, the pieces could be reassembled into one large protocontinent partially flooded by shallow seas.

The correctness of the proposed reconstruction – made by fitting the blocks along the edges of the Continental shelves-is confirmed by the matching of truncated mountain ranges,sedimentary formations, basaltic dikes and flows, glacial tillites, and the distribution of fossil and living flora and fauna.

. The first sign of breakup are Continental rift valleys, and these gradually widen to new oceans. The Tertiary mountain blocks along their forward margins as they were passed together (India-Asia) or met resistance from the coed Sima of the Pacific floor (the American, Antarctic, and Australian Cordillera). Islands and Island arcs are remnants sloughed off in the, wake of drifting Continents.

The pattern of late Paleozoic climates I I ate that in addition to Continental Drift, polar wandering has occurred. Fossil distributions show that there has been an apparent migration of the earth surfaces relative to the poles for a distance of at least 4,000 Kilometers since the Permian.

The forces causing the drift of Continents are all intrinsic to the earth rotation. They include the Eotvos, or pole-fleeing force, which impels continents equator-ward, and tidal attraction of the sun and moon, which exact a drag on the crust, slowing its rate of rotation and so causing it to move westward with respect to the interior. These forces are very small but when applied for long periods of time they become effective enough to impel crusted blocks through the substratum, which opens ahead of them and closes behind them. "Geodetic determination of longitude and latitude repeated at intervals from various stations, show that Greenland and certain other continents and islands are moving at measurable rates".

At the time when the time when the Drift Hypothesis was proposed. It was not well received by the global community of earth scientists. It was ridiculed particularly by the English speaking geologists both in Great Britain and North America. The review of the Hypothesis gave no credit to the efforts of Wegener. Lakes review in the Geological Review was sharp and critical. [5] writes: "Wegener himself did not assist his readers to form an impartial judgment. Whatever his own attitude may have been originally, in his book he is not seeking truth, he is advocating a cause, and is blind to every fact and argument that tells against it".

[5] also concluded that Wegener has suggested much but proved nothing. The reviews of J. W. Gregory, W. B. Wright in NATURE (A. A. P. G.) organized by Van Waterschoot, and Van Der Gracht [10] were all opposed to Wegener 's view. However, there were a few strong advocates.

Most important supporters of the Drift Hypotheses were Authur Holmes, Van Der Gracht and Alex du Toit [10]. Reference [11] suggested a plausible mechanism for the horizontal movement of the continents, arguing that convection currents caused by heat generated by radioactivity could produce sufficient force. Most English speaking geologists thought very little of Wegener's Hypothesis.

The above summarizes the early career of the Hypothesis. According to [12], the hypothesis almost died a natural death in the 1940s.However it bounced back in the post war years as a result of the significant advances in oceanography and paleomagnetism. It also picked up a new name 'plate tectonics' proposed by Harry Hess of Princeton University in 1960 [13]. This marked the beginning of the Geological revolution. ". in the mid 1960's,almost literally overnight, the Geological community swung around and embrace the hypothesis of continental drift. "

This change had a significant impact on the global community of earth scientists. It affected all aspects of the discipline. It opened up new Vistas for interpreting Geological phenomena. Above all, it has triggered off some kind of controversy on the philosophical consequences of the revolution. Some philosophers of science dubbed it a Khunian revolution while some radically opposed this model without proposing any alternatives. A third group asserted that the scientific change fits the Lakatosian model better. An example is [2] who suggested that Lakatos model provides a plausible framework for analyzing the revolution in its historical context. The current, writers also subscribe to the Lakatosian model as superior to the Khunian model for conducting such a philosophical analysis. An attempt is made in the following section to describe (along the use of the Lakatosian model) the revolution, and to justify the appropriateness of using the model as opposed to the Khunian approach.

II. DISCUSSION AND CONCLUSION

The central commitment in Geological sciences is uniformitarianism proposed by James Hutton [14] and expanded by Lyell. Uniformitarianism is an evolutionary interpretive framework, employed by earth scientists in their study and interpretation of, Geological phenomena. Therefore, before one can adequately appraise the appropriateness of using either of these two models- Khunian or Lakatosian philosophical analytic model, for analyzing the historical career of the Drift Theory, one must critically evaluate the trend of events in the global community of earth scientists over time. To see how the central commitments were manipulated.

This evaluation will lead us to a better understanding of the type of revolution that occurred. One should know for example whether or not the central commitment to evolution and uniformitarianism were either modified or totally discarded in the process of accepting plate tectonism [15]. Furthermore, it will be of interest to know if earth scientists grappled with some fundamental principles with negative heuristics and how they solved such problems sequel to the Geological revolution of the 1960s. The character of the activities of earth scientists during the fifty year span of the career of Wegener's Hypothesis will either fit the Khunian model as proposed by [4] or the Lakatosian model [12].

The Khunian model insists that there must be a general dissatisfaction with the existing paradigm. A new intelligible paradigm must be proposed to replace the old. This new paradigm must suggest the possibility of a new research program, that is, open up new areas of inquiry

Looking into the literature beginning from 1922 Wegener's Drift Hypothesis [6] was confronted by two competing theories, but for the few influential advocates of the Hypothesis, it would have disappeared from Geological literature forever.

However, the logical philosophical analysis of Frankel provides an adequate insight to the state of affairs among the global community of earth scientists in the first half of the twentieth Century. Frankel used Lakatos' taxonomy to describe the stage of Geological science at the time when Wegener introduced his Drift Hypothesis. He identified two other research programs which were also well established when Wegener announced his theory. They were contractionism(hereafter, CON) and permanentism(hereafter, PERM). The hard cores of the three competing research programs are as follows:

CON:The earth has been contracting periodically since its birth, with the result that the sea floor and continents have interchanged throughout the history of the earth.

PERM:After an original contraction or setting out of continental and seafloor materials in accordance with their densities, the oceans and the continents have remained relatively the same. "Once a continent always a continent: once a basin always a basin" was the slogan of the PERM's.

DRIFT:The continents have displaced themselves horizontally with respect to each other. Certain continents now separated by vast oceans were once combined.

The CON research program faced two serious problems, namely, Geophysical investigation led to the discovery of radioactivity in the earth contradicting the thesis that the earth has been cooling. Secondly, the isostatic principles did not favor contractionism. CON's researchers like [16] provided the CON's program with auxiliary hypothesis that kept it alive until the 1960s.

The PERM similarly, was buttressed by Willis who attempted to give the PERM greater explanatory power on the paleontological and biological fronts by proposing Isthmian connections. This was not totally upheld by the AAPG 1926 Symposium due to some problems identified by Schuchett .

Whilst the CON and the PERM program. S were busy developing auxiliary hypotheses to support their hard cores(stated earlier) they sought for different ways to eliminate the Drift position. The supporters of DRIFT especially Holmes, Du Toit, Van Der Gracht, Joly and Wegener offered ammendments to protect its hard core.

Opposition to the idea of continental drift was two folds. "First, opponents argued that it was impossible for the continents to plight their way through the sea floor without breaking up since Sima, the basic sea floor material is mu h harder than sial, the basic continental material ". Second, "even if it were possible, there is no known force sufficient to propel the continents through the sea floor. Wegener and Van Der Gracht responded by distinguishing between rigidity and strength" [12].Through it all, the DRIFT became successful following novel developments in oceanography and paleomagnetism, coupled with the

introduction of seafloor spreading [13] and [17] by paleomagnetism data have produced three lines of evidence which are important to the theory of continental drift and plate tectonics.

These include evidence of polar wandering, evidence of continental displacement and rotation and evidence of reversal of geomagnetic field.

Furthermore, evidence for continental drift has been derived mainly from continents. However, during the 1970s, new support has come from studies of the ocean basins [4].The oldest marine sediments from any ocean are Jurrasic about 160,000,000 years old. The total thickness of deep ocean sediments viz., red clay and globigerina ooze (largely composed of one celled organisms) are said to be everywhere surprisingly little about 400 meters in the Pacific and 500 meters in the Atlantic. These accumulated at a mean rate of 5 millimeters in 1000 years in less than 200,000,000 years beginning in the Triassic. Deep sea drilling near ocean ridges has shown that the ages of sediments immediately overlying the bedrock in the South Atlantic increase linearly with distance away from either side of the mid-ocean ridge crest. The work of [18] also corroborates sea floor spreading. Linear magnetic anormalies symmetrically distributed in alternate strips along either side of oceanic ridge crests. The rates of spreading obtained by correlating oceanic and Continental rocks of the same polarities and assumed ages are identical to those that have been estimated from crustal separations: one to ten centimeters per year. The concept of seafloor spreading resulted to a revolution in Earth Science. Given this concept many new data and old puzzles began to fall into place, and geologists were forced to review the entire framework of global tectonics in terms of large – scale horizontal crustal movements.

Within a short time, Geological and Geophysical evidence for these crustal movements has been incorporated into a comprehensive system called Plate tectonics [4]. The conclusion drawn from this philosophical analysis of the career of the Continental Drift Hypothesis is that, the whole process of change which led to the global acceptance of plate tectonism lends support for the Lakatosian consisting of the hard core and the protective belt. The whole episode of Continental Drift Hypothesis supports the idea of a vast age (4.6 billion years) for the Earth. Perhaps, the concept of Continental Drift, when it was conceived in 1910 by Wegener poses a threat to the hard core of geological science. Reference [4] expressed some amazement about why it took the global community of Earth scientists almost fifty years to adopt the Wegener's brainchild. We opine a possible linkage between Catastrophism (linked to Scientific Creationism –[19] and the Drift Hypotheses. The Continental Drift Hypothesis continues its ghostly existence in the Geology literature in the form of plate tectonism.

In this format it fits Lakatos protective belt for the hard core of Earth Science, James Hutton's principles of Uniformitarianism.

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