EARTH SCIENCE

FROM FLAT EARTH TO PLANETARY TECTONICS

Synopsis

Theme - a fascinating natural science subject

This open exhibit follows the important development of the ideas and observations that explain the planetary forces which shaped the surface of our world. These forces are manifest in natural events such as earthquakes, volcanic activity and eruptions, mountain and deep sea trench building. In spite of the prevailing 'Flat Earth' Theory, early explorers and navigators risked falling off the edge of the world. In the Age of Discovery from the late 1400s to 1800, when the advances in geographic knowledge and scientific mapping of the planet became known, the origins of the Earth's continents and oceans, were passionately debated by Earth scientists.

The German, Alfred Wegener, first proposed his **Theory of Continental Drift**. Wegener published the theory in his 1915 book, "*On the Origin of Continents and Oceans*". The Theory states that parts of the Earth's crust slowly drift atop a softer more liquid core. The fossil record of life on Earth and geologic correlations support the Theory. Wegener hypothesized that there was a gigantic, single, super continent 200 million years ago, which he named *Pangaea*, meaning "all-earth" in Greek.

The super continent Pangaea was characterized by the abundance of the extinct plant *Glossopteris*, fern-like vegetation, the preserved fossils of which are found throughout India, South America, southern Africa, Australia, and Antarctica. Fossils of Mesosaurus, one of the first aquatic reptiles, are found in South America and South Africa suggesting that the two continents were once joined. The work of Austrian Eduard Suess and South African Alex du Toit backed the idea of Wegener's Theory.

Pangaea started to break up into two smaller super continents, called Laurasia and Gondwanaland, during the Jurassic period, 200-175 million years ago (MYA). By the end of the Cretaceous period, 65 MYA, the continents were separating into land masses that looked more like our modern-day continents.

The Theory of Continental Drift lent supported the idea that the Earth's crust is divided into huge, thick, more ridged plates that drift atop the softer mantle material. The plates are made of rock and are from 80 to 400 km thick. The plates move very slowly both horizontally and vertically. Over long periods of geologic time, the plates also change in size as their margins are added to by accretion, crushed together in mountain building, or pushed back into the Earth's mantle via subduction.

The Science of Plate Tectonics, meaning "plate structure", was developed in the 1960's. This new science attempts to explain the movement of the Earth's plates, document the plate boundaries scientifically, and the cause of earthquakes, volcanoes, oceanic trenches, mountain range formation, and other geologic phenomenon. The Earth's plates are moving at a rate that has been estimated at 1cm to 10cm per year. Most of the Earth's seismic activity, volcanos and earthquakes, occur at the plate boundaries as the plates interact.

The top layers, including the plate material, are called the crust. Oceanic crust, the crust under the oceans, is thinner and denser than continental crust. Crust is constantly being created and destroyed; oceanic crust is more active than continental crust. At the boundaries of the plates, various deformations occur as the plates interact; they separate from one another, seafloor spreading, collide, forming mountain ranges, slip past one another in subduction zones, in which plates undergo destruction and remelting, and slip laterally.

Since the Earth's crust solidified billions of years ago, plates of its crust have been drifting all over the globe. The map of the Earth is always slowly changing; not only are the underlying plates moving, but the plates change in size. Also, sea levels change over time as the temperature on Earth varies and the polar ice melts or freezes to varied extents, with water covering or leaving exposed different amounts of continental crust.

Continental drift and Plate Tectonics models are useful in the prediction of natural disasters, volcanic eruptions, earthquakes and tsunamis. The science is also used to predict the preferred location of economic natural resources such as oil, coal, minerals, fresh water and geothermal energy.

Scope - early mapping basis through theory and application

This exhibit follows the development of the theory of Continental Drift and the scientific application of Plate Tectonics. The influence of Alfred Wegener, who first proposed Continental Drift in 1915, is traced and his defence of his theory is discussed. Wegener's untimely death in 1930 put advocacy for the theory in abeyance for three decades. The deep sea drilling observations and SONAR sea floor mapping of the 1960s resulted largely in the verification of Wegener's ideas and the rise of the Science of Plate Tectonics to explain the forces involved in the Earth processes.

Material Available - the difficult theme elements took years to assemble

Advances in geographic knowledge, and scientific mapping of the planet presented a scientific puzzle as to the origins of the Earth's continents and oceans. Wegener triggered serious consideration of the origin of the continents and oceans in 1915. Wegener was honoured with stamp issues from Germany and Berlin in 1980 on the centennial of his birth.

Subsequently, several countries have illustrated the time sequence maps of drifting continents. All the stamps showing continental drift maps are shown in the exhibit. The mechanics of plate tectonics are illustrated with philatelic material showing volcanos, earthquakes, geophysics, seismicity, biology, paleontology, chemistry, subduction, ocean floor spreading and paleoclimatology. The catastrophic, plate tectonic, earth processes which endanger human life are highlighted.

The effect of these Earth processes in concentrating economic deposits of oil and valuable mineral is explained. Pictorial postmarks and commercial meters showing continental drift and plate tectonics are challenging. A number of philatelic elements including stamp varieties essays, plate and die proofs, different types of postage stamps, booklets, booklet panes, stamped and stampless covers, official post office folders etc. are shown in addition to stamp issues.

32 pages of the 96 pages (1/3 of the exhibit) contain picture postcards, non-postal charity labels, Cinderella issues, maximum cards, 'create your own' stamp issues, space launch covers, Map and table drawing, philatelic and first day of issue covers, which contribute important parts of the narrative.

Highlights - enclosed in red outlines in the exhibit

- 1865 Prussian stampless legal cover with boxed Wegener postal marking - scarce
- a number of die proofs (several signed) from French Territories - scarce
- progressive proofs of zircon radioactive age determination stamps at Langlade - few produced
- chromalin proof showing time zones from Tonga - only five known
- die proof of unissued oil field stamp of Poland General Government - scarce
- die proof 10f water well of French Occupation of Fezzan - scarce

References - see "References" on the exhibit title page

CONTINENTAL DRIFT & PLATE TECTONICS

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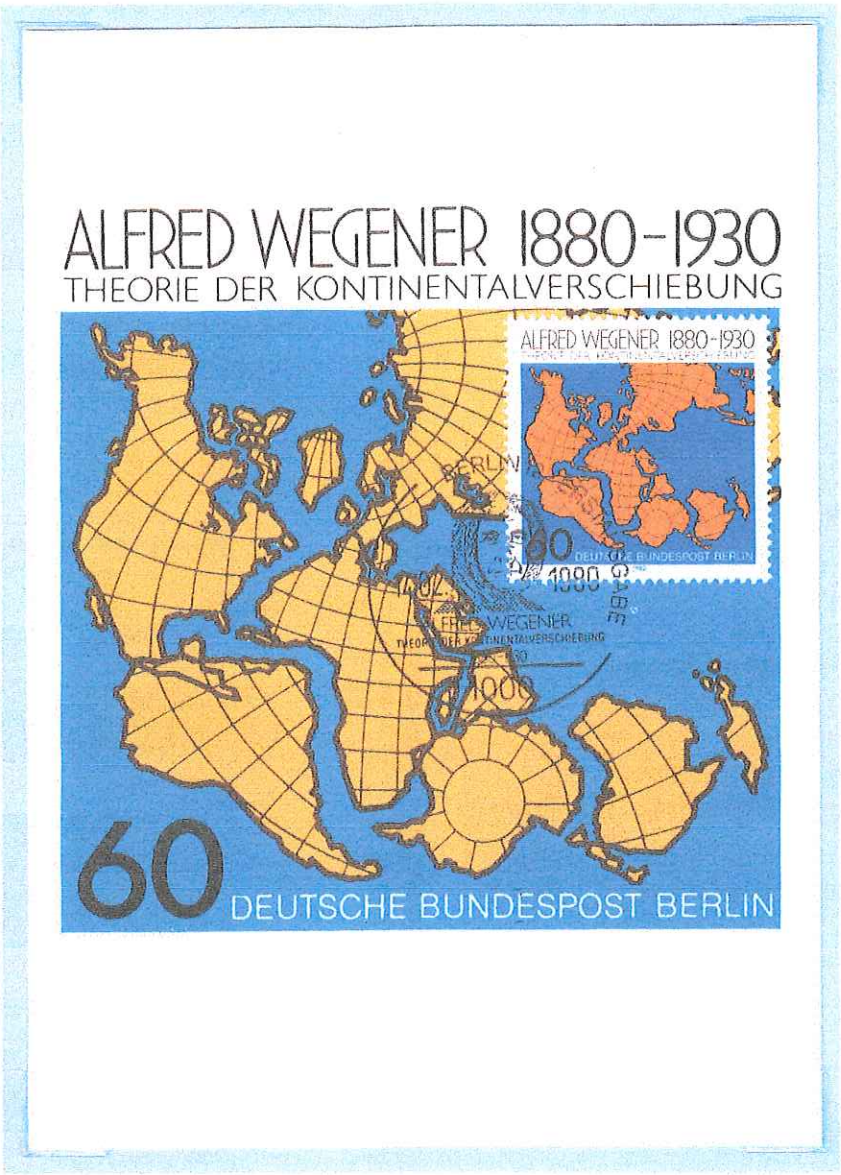

A postcard franked with a stamp showing a map of the distribution of continents and oceans in the Tertiary Period.

The map is repeated, enlarged, on the post-card. The latitude-longitude grid shown is the modern day position.

Postmark is dated on the first day of issue

Note the position of the coast of west Africa and eastern coast of South America.

The postmark of Berlin shows Alfred Wagner in his hooded parka.

The Arctic explorer proposed the Theory of Continental Drift. This theory forms the basis of much of modern Geology and the new Science of Plate Tectonics..

Purpose: This thematic exhibit follows the development of the theory of Continental Drift. Alfred Wegener, the German scientist, was the first to use the term. The theory evolved, over time, into the modern Science of Plate Tectonics.

Treatment: The advancement of Geology through the age of discovery, scientific mapping of the planet, geologic mapping and the realization that the Earth's surface is in constant motion revolutionized Earth Science. The life history of Alfred Wegener and his Earth theory is followed. His struggles to covert the skeptics is chronically examined. Vindication came, after his untimely death in 1930, with the advancement of Geophysics in the 1960s. Wegener' genius was the recognition that all the factors, geodesy, geology, geophysics, seismicity, biology, paleontology, chemistry and paleoclimatology must all contribute towards the understanding of Earth processes and history.

Research / knowledge: The exhibitor is a graduate Geologist.

Significance: To human beings, nothing holds more significance than our home planet Earth. Understanding the Earth and Earth processes is important to life and prosperity.

References: Wegener, A., 1928, The origin of continents and oceans, English translation of the fourth German edition by Biram, J., Dover Publications, New York, 246 p.

Oliver, J., 1990, Plate Tectonics: The discovery, the lesson and the opportunity, in The Restless Earth, 24th Nobel Conference, Harper & Row, p.1-15