The Theory Of Plate Tectonics: Alfred Wegener And Harry Hess

Considerable speculation surrounded Alfred Wegener's Plate Tectonic Theory that was first published in 1915. Critics argue that Wegener did not obtain resolute evidence to support his ideas. Even though Wegener’s theory was later discredited, his proposal was a stepping stone for others in the scientific community to explore and build on plate tectonics and continental drift. Since 1915, we have made numerous discoveries. Harry Hess and his cognizant discovery of Seafloor Spreading is a fundamental idea in the theory of plate tectonics. Harry's ideas revolutionised the knowledge we once knew about geological processes in the 20th century. Collating all imperative evidence to the proof of plate tectonics, regarding the profile of the ocean floor, we are able to convey these elements through a model. Features of the model provide insight into proving Wegener’s theory, labels illustrating the evidence they provide.

Mid-ocean ridge and seafloor spreading is the most indisputable piece of evidence regarding plate tectonics. Wegener theorized plate tectonics and the mid-ocean ridge however Arthur Holmes proved convection in earth’s mantle, thus creating divergent plate boundaries. Balsic magma rises from hot and cold convection cells in the mantle creating upwelling underneath the spreading centre at the divergent boundary. The magma hardens, resulting in new oceanic crust being created. To balance this process subduction takes place at convergent boundaries. Oceanic trenches occur when dense seafloor subducts beneath the low-density continental or oceanic lithosphere, plunging deep into the upper mantle, accumulating trench sediment. This allows for the process of seafloor spreading to occur without building momentous amounts of oceanic floor and allow for the creation of various volcanoes and seismic activity.

In the 1950s the idea of plate tectonics was further researched by Vine and Matthews in the form of paleomagnetism with evidence deriving from polar wandering. Iron convections in the earth’s outer core called the Geodynamo act as an electrical conductor, generating a magnetic field. The earth’s magnetic field is toroidal as if a magnet is horizontally aligned with the equator through magnetic inclination, pointing towards the North Pole. utilizing this magnetic field we can analyse the paleomagnetism in rocks on the oceanic floor. When the ocean floor solidifies from divergent boundaries the magnetic minerals within the rock will directly align with the earth’s magnetic field. Magnetic alignment is maintained within the rock, allowing us to observe the change in polarity of the ocean floor. Seafloor spreading was not a proven theory however the confirmation of magnetic polarity provided conclusive evidence. You can actively see the change in sea rock magnetism at even intervals moving outwards from the mid-oceanic ridge, varying in magnetism consistently changing between 90-degree polarities, thus proving the theory of seafloor spreading.

Seamounts are a fundamental element in observing the movement of tectonic plates. The largest seamount is 4207m above sea level however if you’re measuring from its base it is a monumental 10 100m tall. From these astonishing heights, seamounts can also come in the form of submarine volcanoes, stratovolcanoes, shield volcanoes, volcanic and island arcs and guyots.

Guyots, discovered by the late Harry Hess were first published in his conclusive scientific paper

the “history of ocean basins” -1962. Hess deduced that guyots where elevated volcanoes that over time, eroded and repositioned. As the oceanic plate moves due to seafloor spreading the volcano moves along with it. Therefore, the volcano will cease to be fueled by the magma plume forcing the volcano to become dormant. Erosional impacts will force the volcanoes peak to flatten, creating guyots. For example, a specific guyot located in Ethiopia used to be situated in the Red Sea. observing these guyots migrate and progressively flatten provides evidence for Harry Hess’s theory of seafloor spreading which indicates plate tectonics.

Submarine or Subduction Volcanoes often occur near the perimeter of oceanic divergent plate boundaries. The rate of tectonic plate movement is essential when determining volcano types and eruption activity levels. Submarine volcanoes that are located near convergent plate boundaries (subduction zones) are submerged by water. The pressure supplied to their exterior forces their eruption to leave linear tracks in the form of seamounts along the oceanic basin. The magma that rises from the subduction zone is classified as basaltic. Chemical reactions change the silica levels present in the magma by depleting the magnesium concentration. This is called fractional crystallisation. Due to this and the addition of high viscosity gases exiting the plume, submarine volcanoes are extensively aggressive. Nearly all submarine volcanoes have been recorded near convergent boundary subduction zones in considerable numbers, leading to the ever-mounting conformation of Wegener’s plate tectonic theory.

Shield volcanoes primarily form because of low viscosity basaltic magma, flowing consistently down slight gradient slopes away from the summits central vent. Multitudes of shield volcanoes are present in the Hawaiian Islands. This may disconcert the theory of plate tectonics as these islands reside in the middle of plate tectonics. Whereas volcanoes tend to form along the edges of plate boundaries none the less, shield volcanoes provide insight into plate tectonics. Hot spots, as mentioned before in the Ring of Fire allow us to track plate movement. Plumes of heated rock from within the upper mantle create volcanoes in the given position. As the plate tectonic shifts into another position, a new volcano will form in that exact spot above the hot spots plume, thus generating a line of varying shield volcanoes positioned in the direction that the tectonic plate is moving.

We can observe hydrous minerals in basaltic oceanic crust. When the rock comes into contact with hot liquids, they conduct hydrothermal alterations. As the oceanic crust descends deeper into the upper mantle, the pressure will increase. Once it reaches a significant pressure, the hydrous minerals will begin metamorphism. The minerals are denser and cannot encompass bonded water, therefore the water upsurges into the overriding crust. When the water mixes with the heated magma, melting temperatures will decrease resulting in partially melted ultramafic rock that produces mafic magma. This is termed flux melting and comprehensively explain why there is heightened magma activity around subduction zones. This magma convecting under the subduction zone will rise to the surface of the ocean floor creating volcano arcs. The documentation of these volcano arcs tell us where zones of divergence and subducting plates lye, providing evidence of plate tectonics.

The Ring Of Fire spanning from the tip of South America, across the Bering Strait and over to New Zealand spans an immense 40 000 km. Shaped like a horseshoe, the Ring of Fire contains an extensive multitude of active and dormant stratovolcanoes. The Ring of Fire results from plate boundaries. We can observe convergent, transform and divergent boundaries in this region and it is a recurring zone for volcanic and seismic activity. In accordance with National Geographic statistics at least 90% of all earthquakes can be linked to the tectonic activity

occurring in the Ring of Fire along with 75% of all active volcanoes on earth are located here. The East Pacific Rise is a major location of seafloor spreading. The largest group of volcanoes, stratovolcanoes can be found here, exemplifying the effect of plate tectonic boundaries on the ocean and its environment.

A magnitude of hot spots in the Ring of Fire where heat is expelled from the earth's mantle exit through fractures in the crust to form volcanoes in the region. Geologists are still debating whether hot spot volcanoes result from plate tectonic however all other volcanoes derive from boundary action.

The Ring of Fire is the most common area for triple junctions to be observed. Where three plates meet at 120 degrees, triple junctions are created as the three plates transform, converge and diverge along each other's boundaries. The mid-ocean ridge is a crucial element in one of the most extreme triple junctions. These junctions lead to explosive volcanic and seismic activity thus giving this location its name, the Ring of Fire.

Rift valleys occur along triple junction zones. Two extensions of the triple junction split to form oceans and the aulacogen (the failed rift) forms into a rift valley. For example, the Pangaea supercontinents two arms opened to the ocean whilst the aulacogen forms the rift valley through the continental crust. We also find these rift valleys in oceans, generated through the action of seafloor spreading. These rift valleys differ from standard rifts as they are created due to plate tectonics, not erosional processes. Rift valleys are also a hotspot for geologic activity with an abundance of vents lining their boundaries.

Not only in the Ring of Fire but globally earthquakes can be graphed along these plate boundaries, giving us an insight into the plotting of tectonic plates depending on the variety, location and magnitude of these tremors. When tectonic plates meet at transform boundaries along the ocean floor and move past each other they catch on rocky areas of the plate, jarring and building pressure. The pent up pressure releases at supersonic speeds creating P and S seismic waves either triggering continental destruction or tsunamis.