Stage 3: 12-7 Million years ago

During this period, the Pacific plate continued to obliquely subduct in a north-west direction under the indo Australian plate south of Fiji, while the indo—Australian plate probably moved northeast. The new stresses resulted in a major change in the nature of the plate boundary with the end result being splitting of the VityazArc and the formation of a transform boundary north of Fiji is called the Fiji fracture zone (Figure 4b) At this boundary the two major plates were moving past each other. This marked the end of continuous subduction at the Vityaz Trench, and the eventual break up of the Vitayaz Arc

Stage 4: 7 Million years ago– Present

Following the breakup, the movements of the plates led to the formation of a northeastward—dipping subduction zone along the New Hebrides Trench (Figure 4b) Previously the pacific plate was subducting westwards under the indo–Australian Plate on the Vityaz Trench but now the the indo—Australian Plate began to subducting northeastward under the Pacifc Plate at the New Hebrides portion of the Vityaz Arc.

Of the Vityaz Arc. This reversed subduction eventually led to renewed volcanism on the New Hebrides Arc.

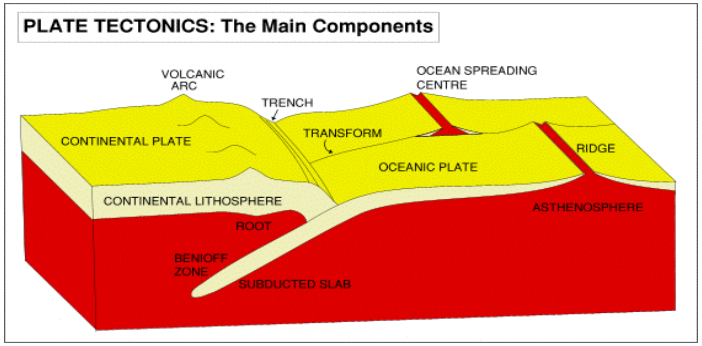
At about the same time, the New Hebrides Arc rotated clockwise away from the Vitiaz Trench. The divergence of Fiji and New Hebrides was accompanied by seafloor spreading and the opening up of the North Fiji Basin in between New Hebrides and Fiji (Figure 4b).The North Fiji Basin is aback –arc basin related to the New Hebrides Arc.

Another major event during this period was the splitting up of the Lau– Tonga portion of the old Vityaz Arc (figure 4c) . The Lau-Tonga Arc split apart into the Lau Arc and the Tonga Arc as volcanism and later seafloor spreading formed the Lau Basin . The Lau Basin is a back arc basin related to the Togan arc. Much of the Lau basin developed in the last 2.5 million years. As a result of the seafloor spreading in the Lau basin , the Lau arc became isolated from effects of subduction at the Tonga Trench portion of the old Vityaz Trench. Therefore volcanism stopped in the Lau arc but continued in the Tonga Arc. At present there is active island arc volcanism on the Tofua arc on the Western side of the Tongan Arc on the western side of the Tonga Arc. This is related to westward subduction of the Pacific Plate under the Indo– Australian Plate at the Tonga trench.

Summary

Fiji therefore represent a portion of the old Vityaz Arc which was split up, and rotated clockwise to its present position. It forms a mini –plate, known as the Fij Plate (Fig.2). The breakup of the Vityaz Arc probably reflected in the strong faulting and folding of 12 to 7—million year old rocks in southwest Viti Levu. This was also a period of great volcanic activity in Fiji and the whole region. Fiji is located at the indo– Australian and the Pacific plate boundary between two opposite– facing subduction zones (figure 5) and hence has a very complex tectonic history . The stresses created by the opposingplate movements have resulted in the formation of transform faults such as the Fiji Fracture Zone to the north and the Hunter Fracture Zone to the south. Seafloor spreading resulted in divergence and opening up of the North Fiji Basin and the Lau the Lau Basin.

Fiji and the Lau are no longer active volcanic island arcs, as there is no subduction of rifting within the Fiji islands but they formed from similar processes in the past. There is, however active seafloor spreading occurring at the present day in the Lau Basin to the east and in the North Basin to the West of Fiji– these are both examples of back –arc or marginal basins. However, Vanuatu and Tonga are still active volcanic islands arcs, as subduction is still occurring under these arcs and therefore volcanism occurs within these islands



SUGGESTION FOR FURTHER READING

(All articles are available in the MRD Library)

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MINISTRY OF LANDS AND MINERAL RESOURCES

PLATE TECTONIC HISTORY OF FIJI

MINERAL RESOURCES DEPARTMENT

Structure of the Earth

The earth is made up of three concentric zones: the crust, mantle and core (Figure 1) The crust is the thin outer layer forming the continents and the ocean floor. Oceanic crust is thinner and more dense than continental crust. Under Viti Levu the crust is enriched in O, Si, Al, Ca, Na and radioactive elements. The mantle is the middle layer composed of iron and nickel. The inner part of the core is liquid and extremely hot.

The lithosphere is the solid part of the Earth, up to 120 km thick, composed of rocks and minerals, which in turn, compose the crust and part of the mantle. Geologists study the lithosphere because it is the most easily accessible part of the Earth.

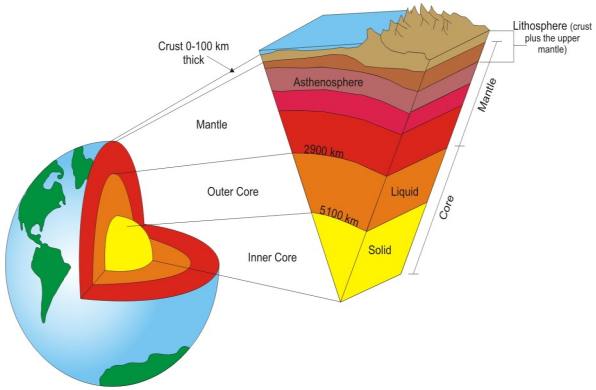


PLATE TECTONICS

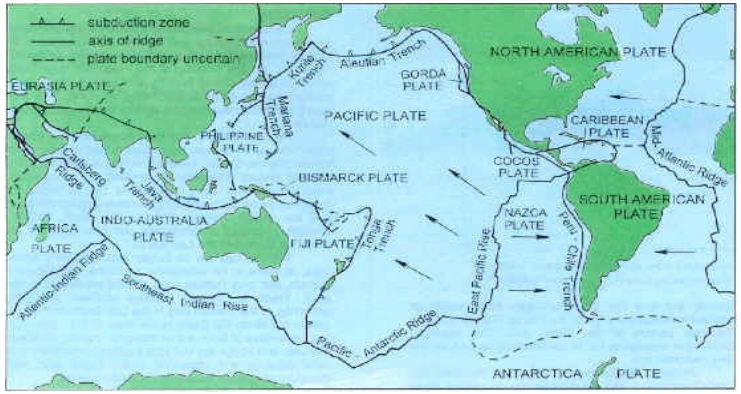
Our planet Earth is under constant change, and evidence that the Earth is still active can be seen whenever a volcano erupts or an earthquake shakes the land. The lithosphere or outermost shell of the Earth, which includes the crust and upper mantle, is broken up, like a cracked egg, into a number of rigid plates which move around because of forces in the upper mantle

The boundaries of these plates are zones of intense activity, and associated with them are many of the large scale geological features produced by such processes as mountain building, volcanism, creation and destruction of seafloor, and earthquake activity.

The movement and deformation of the plates is known as **plate tectonics.** Tectonic movements, which indicate instability of the earth crust, produce faulting (fracture and displacement) , folding, subsidence and uplift responsible for the formation of many great mountain ranges and ocean basins.

Plate Boundaries

Plate boundaries are where plates meet and move against each other (Figure 2) they are usually the locations of many violent earthquakes and volcanoes. Earthquakes and volcanoes tend to occur in belts (for example, the "Ring of Fire" on which Fiji is located, surrounding the Pacific Ocean). These belts are the locations of plate boundaries.



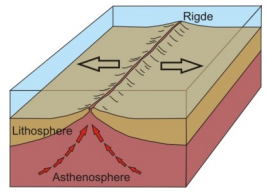
Pacific Lithosphere

There are three types of plate boundaries, divergent, convergent and transform.

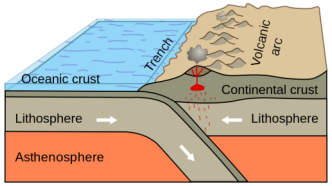
Divergent boundaries (constructive boundaries) are where adjacent plates move apart and new crust is created (Figure 3a) . In the major oceans, there are long underwater mountain ranges called mid– ocean ridges. Mid- ocean ridges develop at edges of diverging plates and are the sites of volcanism and shallow earthquake activity. Along the centres of the ridges, new rock is forming from molten magma coming up from the upper mantle, along fissures. The rocks produced are basaltic in composition. The addition of new rock from below helps to push the plates apart and widen the oceans. This process is also known as seafloor spreading. An example of a mid– ocean ridge is the Mid Atlantic Ridge in the Atlantic Ocean.

Convergent boundaries (destructive boundaries) are where two adjacent plates move towards each other and crust is destroyed (Figure 3b) . Along convergent boundaries are crumpled mountain ranges, deep-sea trenches, shallow and deep earthquakes and volcanoes. (a) divergent; (b) convergent, (c) transform fault, (d) block diagram showing all three types of plate boundary motion.

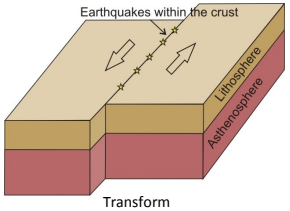
The edge of the thin plate usually sinks under the other plate at an angle of between 30o and 70o, usually forming a deep trench. This process is called subduction, and the movement of the plates as they adjust produces earthquakes,. As a plate edge sinks into the hot mantle, the rocks will be squeezed and heated and part of it begins to melt. The rock melt, or magma, thus formed would float upward, some of it reaching the surface as lava erupting from Volcanic vents.



Divergent



Convergent



Transform

The resultant volcanism often forms a chain of volcanoes along the plate boundary , known as the volcanic island arc. The plate boundary can be seen at the Earth's surface as a deep depression or ocean trench. The islands of Fiji, Vanuatu, Lau and Tonga were formed as volcanic island arcs by subduction—related processes ; however, Fiji and Lau are no longer active island arcs.

Transform boundaries are where plate slide along each other in opposite direction, and no new crust is created . The famed San Andreas fault of California is an example. There the Pacific Plate slides past the American plate in a north westerly direction at a rate of 10 mm per year. When arcs are stretched they split, initially forming a rift and eventually a back– arc spreading centre. The weakest area of the upper plate is near the volcanic front (where volcanism is occurring) and the plate is both the hottest and the thickest crust. Therefore the arc splits within about 50 km of the volcanic front. The basin that usually opens up behind the volcanic island arc is known as a back—arc basin or a marginal basin and it usually becomes filled with lava and sediments. The North Fiji Basin and the Lau Basin are examples of back-arc basins.

The Tectonic History of Fiji

In the south west Pacific two large plates, the Pacific plate and the indo—Australian Plate, are moving towards each other, that is converging (Fig2). This area of the South Pacific was formed in the last 65 million years of Earth's history by the growth of volcanic island arcs and associated marginal and oceanic basins. Fiji's tectonic history is very complex but it can be summarised in four major stages.

Stage 1: 40-28 million years ago

During this period it is generally thought that there was a continuous volcanic island arc system, known as the Vitayaz Arc , which included New Hebrides (Vanuatu) Fiji, Lau and Tonga. The exact orientation of this arc is not known but possible interpretation is shown in Figure 4a. This arc was formed by westward subduction of the Pacific plate beneath the Indo—Australian plate at the Vityaz Trench, parts of which are still visible today. In Fiji rocks which are remnants of the old Vitiaz Arc are found only in western Viti Levu in the Yavuna Group rock sequence, which is 40 to 28 million years old.

Stage 2 : 28-12 Million years ago

The tectonics of the area in this stage were very similar to the previous stage, the key difference being a change in relative plate motions. The Pacific / indo Australian plate boundary was recognised in this period as the movement of the Pacific plate change direction from a westward motion to a more north westward motion. This led to oblique or diagonal north westward subduction of the Pacific plate under the Indo—Australian plate at the northern part of the Vityaz Trench and increase stresses in this region. The subduction was therefore a particularly shallow angle to the plate boundary in the area to the northwest of Fiji , whereas to the south there was little change.

In Fiji another volcanic island arc was formed along with associated sedimentary Basins, that produced volcanic and sedimentary rocks of the Wainimala Group which are expose today in southern Viti Levu and in the Yasawa and Mamanuca groups of islands. There was continued Volcanism on the Lau– Tonga Arc due to the northwestward subduction of the Pacific plate under the indo Australian Plate along the Vityaz Trench. Fiji was therefore caught in an area of increasing stresses during this period.

Instructions of plutonic rocks were common, and the earlier –formed volcanic and sedimentary rocks were weakly folded, faulted and metamorphosed. Uplift near the end of this period may have produced the first significant land masses of Fiji, mostly on Viti Levu