

The Geology of the Island of Newfoundland (*adapted from Appendix A*)

Introduction

If you take a trip across the island of Newfoundland you will go from one ancient continent to another and have crossed an entire ocean in between. This may seem impossible, however it is true geologically. As you drive west across the Avalon Peninsula you are passing rock outcrops that were once part of an old African continent called Avalonia. Between Clarenville and Gander you cross the Dover Fault and leave this ancient continent behind. As you continue west you will encounter rocks that were formed in an ancient ocean called Iapetus. Just past the Baie Verte Junction you leave this zone and find yourself on the edge of an old North American continent. The rocks exposed here formed on a continental margin about 500 million years ago. With your drive across the island of Newfoundland complete, you have indeed crossed an ocean and travelled from one ancient continent to another.

New Evidence for Plate Tectonics

In the 1960s, a Canadian geologist named J. Tuzo Wilson was becoming more and more convinced that the ideas of Wegener and others were indeed correct. Evidence continued to point to opening and closing oceans, sea floor spreading and continental collisions. At that time a young Newfoundland geologist joined him in this thinking. Harold (Hank) Williams brought Wilson to the island of Newfoundland, where plenty of rocks are exposed at shorelines, river valleys and inland. Here these scientists along with many others spent their summers studying the rocks and trying to see how the island of Newfoundland could fit into this 'new' model called plate tectonics. Based on their observations, they were able to group rocks into three zones according to their origin, age and degree of deformation. These zones are called the Avalon Platform, Central Mobile Belt, and Western Platform.

Rock Descriptions

Avalon Platform

The Avalon Platform of the island of Newfoundland includes the Burin, Bonavista and Avalon Peninsulas. The rocks in this zone consist of late pre-Cambrian volcanic, plutonic and sedimentary rocks with Paleozoic sedimentary rocks lying on top. The sedimentary sequences formed from terrestrial deposition as well as shallow marine deposition. Those sediments which were marine in origin, were laid down on a continental margin and therefore contain marine fossils. These fossils include trilobites as well as the more recently discovered Ediacaran fossils at Mistaken Point near Portugal Cove South and others near Catalina. No other rocks on the island of Newfoundland are like these. Compared to those found through Central Newfoundland, rocks from this zone are relatively undeformed. Rock units of the same age with similar structural features and fossils are found on the other side of the Atlantic Ocean in Britain, France and North Africa.

Central Mobile Belt

The Central Mobile Belt extends from Gambo in the east to Baie Verte in the west. The rocks in this zone are early Paleozoic (Cambrian– Ordovician). The sedimentary rocks are indicative of a very deep marine

environment. There are also volcanic rocks throughout that show island arc features. These are volcanic islands that grow upwards and protrude above sea level as continuous eruptions under the sea build higher and higher volcanic mountains. A present-day example of this geological environment would be the islands of Japan. The rocks of the Central Mobile belt represent those of a deep ocean. The fact that they are now highly deformed and metamorphosed tells us that a significant tectonic event occurred here.

Western Platform

Like the rocks of the Avalon Platform zone, those of the Western Platform are pre-Cambrian at the base with early Paleozoic rocks on top. Also, the Western Platform contains sedimentary rocks that were deposited in a shallow marine environment. These limestones and shales contain marine fossils that can be found from Stephenville all the way up the Great Northern Peninsula. There are microfossils such as radiolaria as well as stromatolites, graptolites, brachiopods and trilobites. The trilobites are of the same age as those found within the Avalon Platform zone, but represent different species. Western Platform trilobites are directly related to those in other parts of eastern North America.

Earth's Changing Surface

Our planet has a continually changing surface. Over vast expanses of time continents rift apart and oceans basins develop. These newly formed oceans grow and molten material rises at spreading ridges to create new ocean floor. As continents move further apart, erosion from the land and deposition below the sea generates continental margins. Eventually the process goes into reverse. As oceans close, subduction creates active volcanic mountain belts and island arcs. Complete closure of an ocean means that continents that were once thousands of kilometers apart slowly collide forming new mountain chains. This is the story of the island of Newfoundland.

Conclusion

The geological development of the island of Newfoundland is tied directly to plate tectonics. In fact, the rocks of this island once helped support what was a new theory. Now, widely accepted are the ideas of continents splitting apart, oceans forming and closing, and continents coming together again. The zones of the island of Newfoundland are direct evidence that this happened here.

The figures below represent the plate tectonic history of the island of Newfoundland

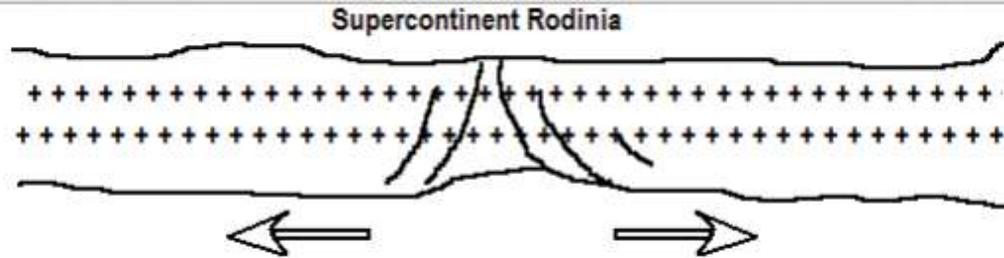


Figure 1: 750 million years ago. The Supercontinent Rodinia begins to rift and break apart.

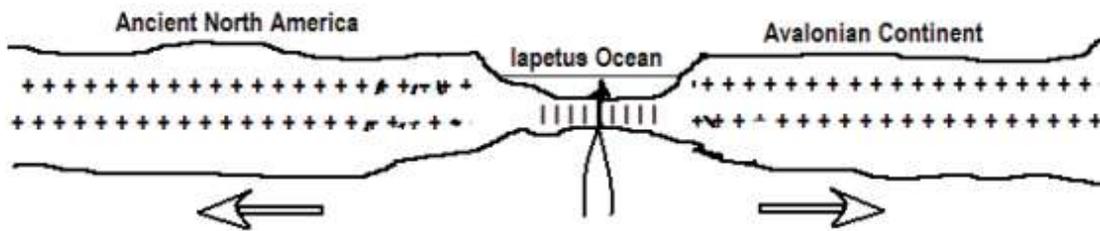


Figure 2: 510 million years ago. Rodinia splits apart forming Ancient North America and Avalonia. Mafic mantle material intrudes creating new ocean crust and an ocean called Iapetus opens between the continents.

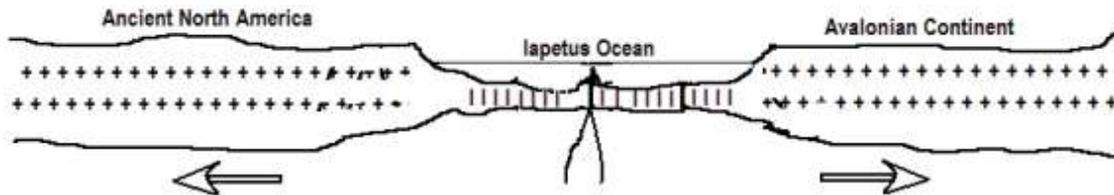


Figure 3: 480 million years ago. Iapetus continues to open with deep sea sedimentary rocks and volcanic rocks forming. At the margins of the continents sediments are deposited and marine organisms evolve and thrive.

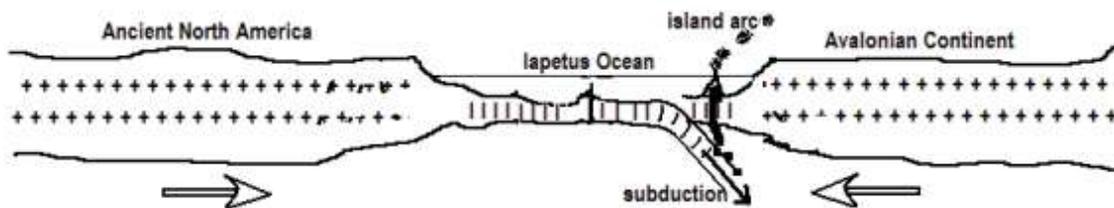


Figure 4: 475 million years ago. Changes in mantle convection reverse direction and the continents begin to move together. Iapetus begins to close. Ocean floor is subducted. Melting in the mantle sends molten rock upwards forming an island arc.

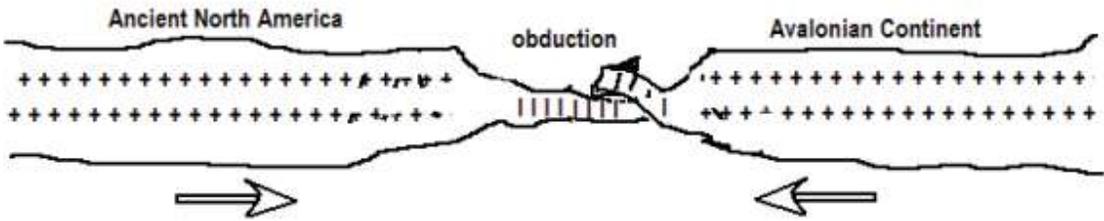


Figure 5: 440 million years ago. Iapetus is almost completely closed. In the final stages of closure ocean floor material called ophiolite is obducted onto the margin to the west.

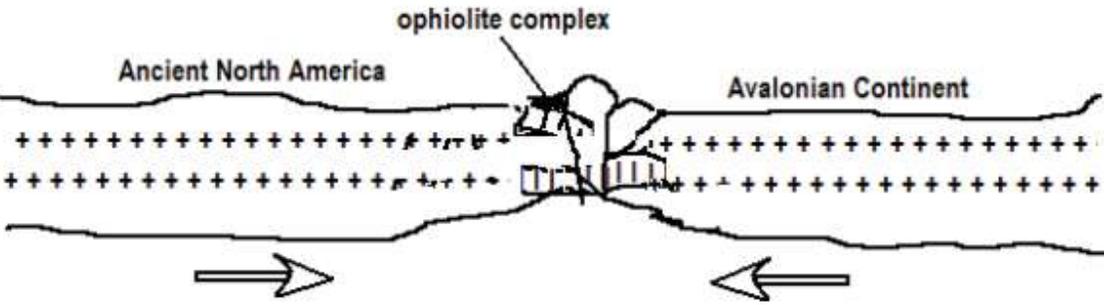


Figure 6: 380 million years ago. Closure of the Iapetus is complete and a new supercontinent called Pangaea is formed. The Appalachian Mountain chain is formed from a continent - continent collision. Remnants of the ancient ocean are highly deformed and caught in between the old continental margins.

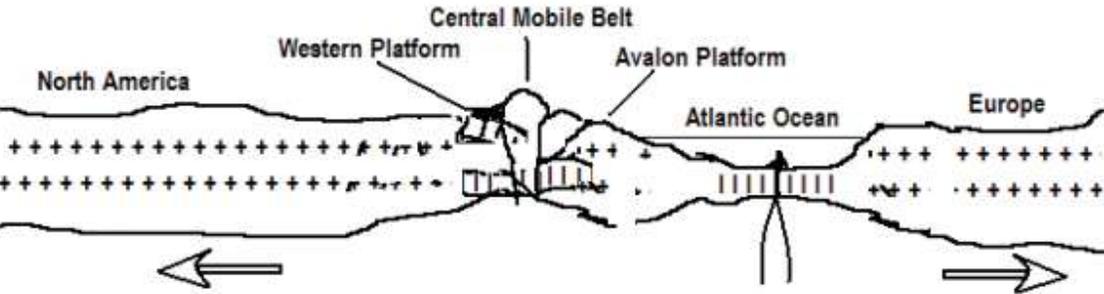
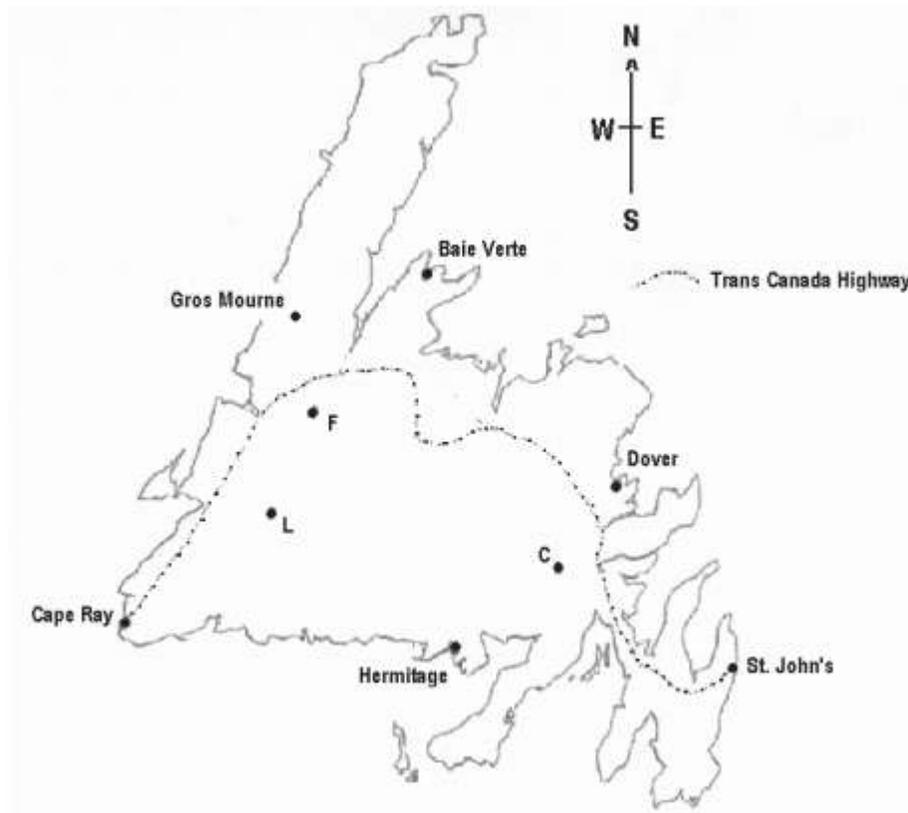


Figure 7: 170 million years ago. Once again the convection in the mantle reverses, rifting the continent. This time, however, the split occurs to the east leaving a piece of the old Avalonian Continent behind. The Atlantic ocean is shown opening.

Questions

- 1) Follow the steps below to create a geological map of the island of Newfoundland.
 - i. Draw a line from Dover through point C to Hermitage. Label this line the Hermitage - Dover Fault and label the area to the east the Avalon Platform.
 - ii. Draw a line from Baie Verte through points F and L to Cape Ray. Label this line the Cape Ray – Baie Verte Line Fault. Label the area to the west the Western Platform.
 - iii. Label the area between the fault lines the Central Mobile Belt.
 - iv. Label Gros Morne as the site of an ophiolite complex.



- 2) In what type of environment did the Avalon Platform rocks develop?
- 3) How are the rocks found on the Western Platform similar to those of the Avalon Platform?
- 4) How are the Western and Avalon rocks different?
- 5) Give two ways that the Central Mobile Belt rocks differ from the other two zones.

- 6) How has the geology of the island part of Newfoundland been used to support plate tectonics theory?
- 7) The opening and closing of the Iapetus Ocean occurred over millions of years.
 - i. When did the supercontinent Rodinia rift and break apart?
 - ii. For how many years did Iapetus open?
 - iii. What mountain chain formed once Iapetus completely closed?
 - iv. What supercontinent formed with the closure of Iapetus?
 - v. What is obduction?
- 8) As Iapetus closed, subducting sea floor created a very volcanically active area with plenty of earthquakes. Central Newfoundland is now represented by remnants of this. What place on earth today is like this?