FCAT Review Lesson Plate Tectonics

Our home planet is a dynamic, constantly changing, place to live. Every week, news reports tell of another earthquake, volcanic eruption, landslide, tsunami, or some other geologic event. All of these show that the Earth is in flux.

It has only been in the last 100 years that this has become understood. Before that, it was widely believed that the Earth was as it had always been. In fact, when Alfred Wegener put forth his idea of Continental Drift it was widely ridiculed as fallacy. Wegener was resolute that he was correct though, and he brought forth a bunch of evidence to prove it. He pointed out that the continental shelves of Africa and South America fit together like jigsaw puzzle pieces. Further, he showed that fossil beds and geologic features on the two continents matched up (see Figure 1). He also pointed out that other continents had similar match ups around the world.

Figure 1. Africa and South America Fit together

So Wegener had some proof that something like this was happening, what he did not have was an explanation for how the whole thing might work. His proposal was that the continents were like giant ice breaker ships, busting their way through the oceanic crust. This idea was countered with questions of where the energy for that would come from to push the plates.

Sadly, Wegener died before he could come up with an explanation. His ideas had caused enough of a stir that others had started working on them, and finally an American, Harry Hess, figured out that the sea floor shows evidence that it is spreading in certain places all around the globe. This provided the rest of the puzzle, and lead to the theory of Plate Tectonics.

Plate Tectonics states that the lighter crust is floating upon a hot, dense asthenosphere, and that convection within the asthenosphere carries the plates along as if they were on a conveyor belt. Moreover, the crustal plates in some places are colliding with each other, causing changes in landform, such as mountain ranges, and volcanoes. In other places, the plates are pulling apart from each other, forming rift valleys. In still other places, plates slide past each other, forming earthquake prone regions, like along California's San Andreas Fault.

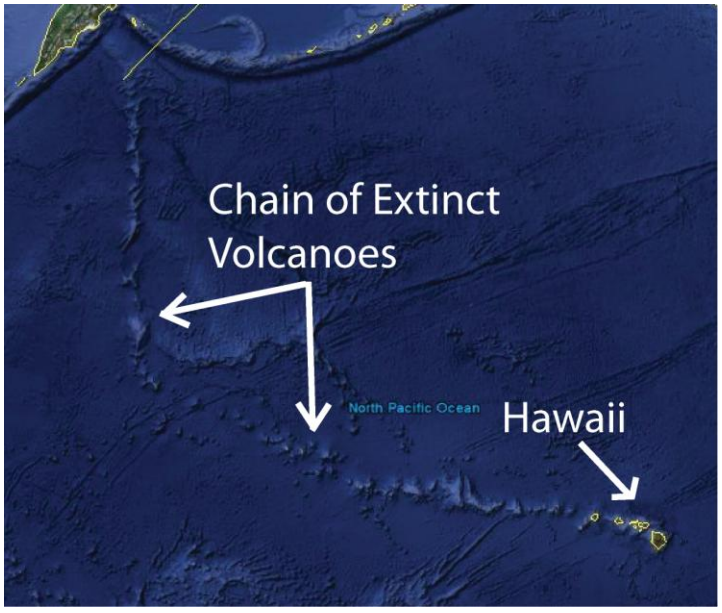

Figure 2. The Hawaiian Islands and Emperor Sea Mount Chain
Captured from Google Earth

This idea has come to be widely supported since the 1960's, and much more information has come to light since then supporting it. One of the most interesting places to look for evidence that the crust is moving is the Hawaiian Islands. All of the islands in the chain have volcanic origin, but only one island has active volcanoes, and it has two. The rest of the islands are all extinct volcanoes. The further northwest along the chain you go, the older the volcanoes are. In fact, if you look at the sea floor northwest of the Hawaiian Island chain, you will see a long chain of extinct volcanoes that stretches all the way up to Siberia (see Figure 2). If you look closely at Figure 2, you can also see that the Pacific Plate has changed directions over the years, or perhaps that it was forced to turn. If you look along the top of the picture, you can also see part of the Aleutian Islands, and Kamchatka Peninsula. These are part of the Ring of Fire, the chain of volcanoes that surrounds the pacific ocean. The Pacific Plate is being subducted, or forced down below the lighter

continental plates. As it dives down, the temperature rises, and the oceanic crust melts. This forms the magma that forms the volcanoes of the Ring of Fire. This is referred to as a convergent plate boundary.

Another place to look for evidence of plates colliding is the "top" of the world. The Himalayas Mountains were born by the collision of the Indian Plate (continental crust), with the Asian Plate (also continental crust). The two plates colliding, with approximately equal densities, caused a deformation upward. This has pushed trillions of tons solid rock up to an altitude topping out at over 29,000 feet. This is also referred to as a convergent plate boundary. The fact that this region is so earthquake prone is testament to the fact that this mountain range is still very much a work in progress, and in fact still growing.

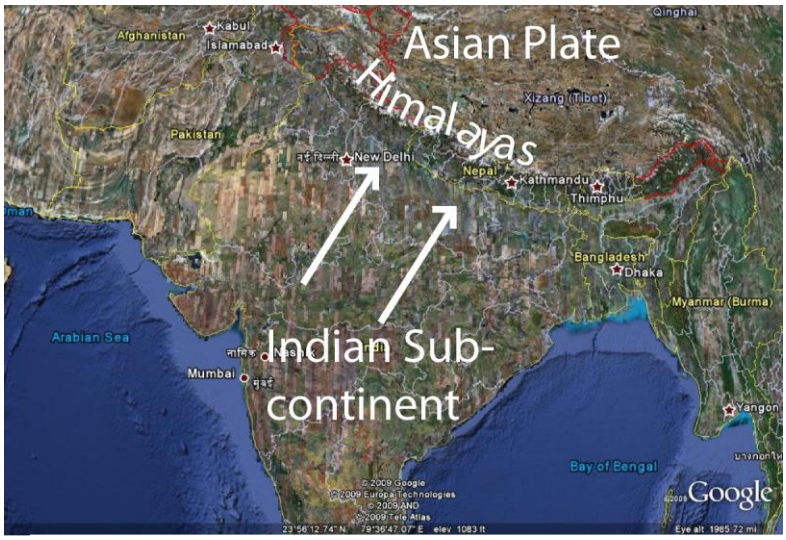

Figure 3. The Himalayas are pushed up by the collision two plates

Another place to look for evidence of plate movement of a different sort is the East African Rift Valley. In this region, two continental plates are literally being pulled apart from each other. The result is a chain of low volcanoes, some of which are referred to as lava lakes (see Figure 4). This type of boundary is referred to as a divergent plate boundary. Many more divergent plate boundaries are visible on the sea floor.

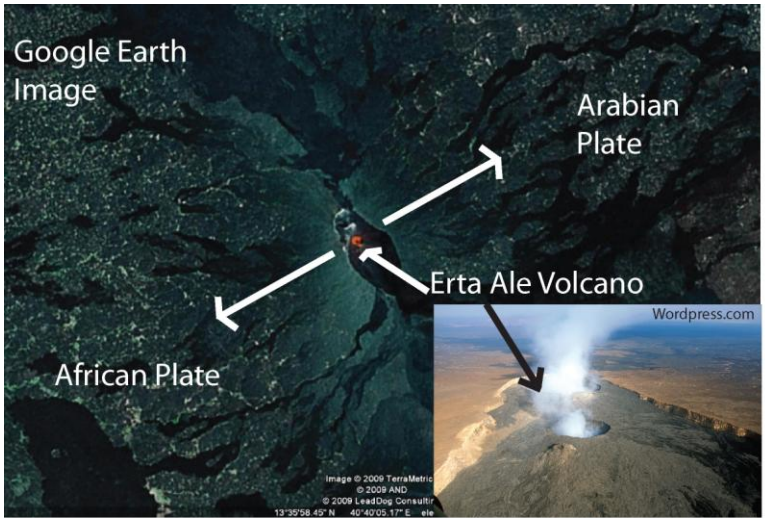

Figure 4. The East African Rift Valley, and Erta Ale

There are many more places that you can look to for evidence of plate tectonics. I would like to leave you with Alfred Wegener's original idea that the continents fit together like a jigsaw puzzle. Figure 5 shows several different images of how the continents have fit together throughout our planets history. Every collision has changed the shapes of the plate to make it the way that it is today.

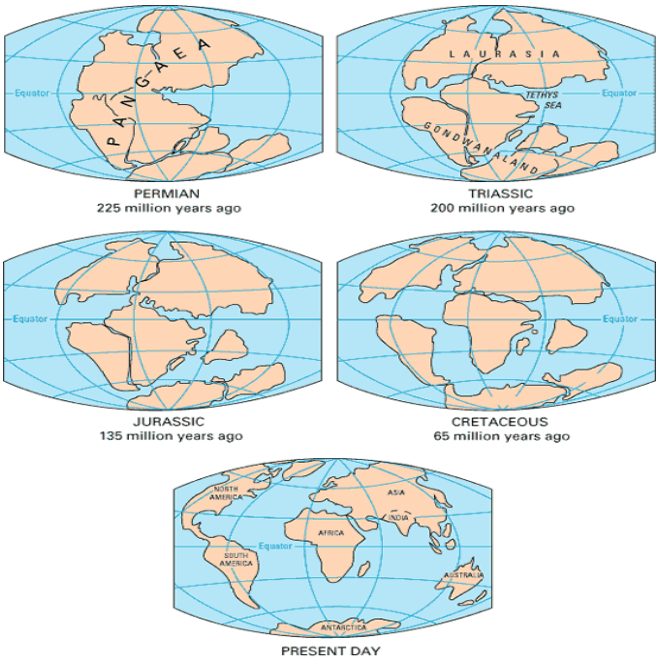

Figure 5. Five Globes from USGS

On the web, go to http://pubs.usgs.gov/gip/dynamic/dynamic.html	Read through the historical perspectives, developing the theory, and understanding plate motions

Feel free to use the historical perspectives page, and anything else that you have read to answer the following questions:

INVESTIGATION:

1. *250 Million Years ago:*
    a. *Where were all the land masses during this time?*

    b. *What evidence do we have to support the fact that the land masses were once all together? (look at your legend)*

    c. *Why do you think this theory wasn't generally accepted by the scientific community?*

2. *Present:*
    a. *What happens to the water when the supercontinent broke apart?*

    b. *What evidence do we have that plate movement is continuing today?*

    c. *List some of the features that are a result of plate movement.*

3. *Future:*
    a. *What will continue to fill in the spaces between the moving continents?*

    b. *How might the future movement of the plates effect cultures and climates? Where will Florida be?*

Questions

1. Why is the fossil record on South America and Africa so compelling when used as a line of evidence to support that the Earth is made of moving plates?

2. What type of geological feature would you expect to find along the west coast of South America and why?

3. What geologic event is most likely to occur when an oceanic plate collides with a continental plate? What about when a continental plate collides with another continental plate? Why do these two convergent boundaries form two different geologic landforms?

   Ocean with continental: _____

   Continental with continental: _____

   Why are they different: _____

4. What is the driving force that makes the plates move?

Post Questions

1. Geologists know that plate boundary locations have changed throughout the history of Earth. Current land feature locations provide evidence of the location of past plate boundaries. What topographic change would occur if a new subduction zone formed along the eastern coast of the United States?
   A. High rigid mountains would form
   B. North America would shift to the north
   C. Formation of a volcanic arc along the coast line
   D. There would be no evidence of the newly formed plate boundary

2. The Hawaiian Islands are a line of volcanic islands in the middle of the Pacific Ocean. The most common location for volcano formation at a plate boundary. What is a possible explanation for the formation of an active volcanic island chain in the middle of a plate?
   A. an old boundary used to be there
   B. a new boundary will form there soon
   C. the crust is too thin and magma breaks through
   D. an upwelling of magma consistently operates in that area

3. Surface volcanic activity is distributed around the globe but generally localized to convergent plate boundaries. An area of large lava flows can be found at divergent plate boundaries which are generally found in the oceans. At these sites, new land can be formed. How does the planet adjust to these new additions to the crust without getting larger?

   A. Subduction zones recycle crust back into the mantle.
   B. Mountains are formed and the extra crust rises upward.
   C. Subduction zones fold the crust and add it to the continent.
   D. Valleys form and the extra crust is folded back into the mantle