

AGAP Antarctic Research Project

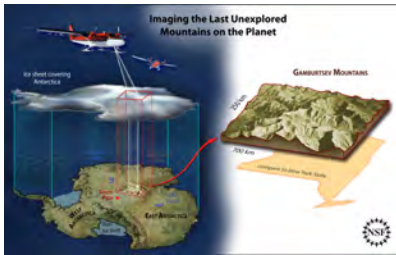


Image by Zina Deretsky, NSF



Image from - <http://news.bbc.co.uk/1/hi/sci/tech/6145642>

Build Your Gamburtsev Mountain Formation



Mountain Building: Remember mountain ranges can be built in different ways. With the Gamburtsev Mountains there are several possible theories, but with the mountains under ice, there is little data available. Let's focus on the two main theories, **collision** and **hot spot** volcanic activity. Select one theory to support. Your task is to create a model of your mountain building event and explain why you picked it, how your model supports your theory, and what 'tools of the trade' from our geophysical tools you could use to test your theory.

The Gamburtsevs, the Result of a Collision?

Mountain belts are formed along boundaries between the Earth's crustal (lithospheric) plates. Remember, the Earth's outside crust is made up of plates (or sections) with pieces that are slowly moving. When the different plates collide they can push or fold the land up forming raised areas, or mountains. The European Alps and the Himalayas formed this way.



Proto Antarctica Other Continent

The sections of Earth's continental crust are constantly shifting. During the Cambrian Period, a time between ~500 and 250 Ma, the piece of crust that would become Antarctica (we will call this proto-Antarctica) was on the move! Early in the Cambrian it was located close to the equator, a much milder climate than its current location, but as the Cambrian Period advanced proto-Antarctica moved slowly south. The

collision theory suggests that as these pieces of continent moved, like bumper cars they collided with each other.



Build It – Print the Antarctic map that is attached. Using modeling clay build your model. Remember where the continents collide they cause thick lines or folds in the crust. These collisions create large amounts of heat from the huge pressure of the continents pushing against each other, and the weight of the crust. This heat causes melting and forms metamorphic rocks. If you could take a knife and cut away the outer edge of the mountains you would see accordion-like folding in the interior of the mountain range. You can try this by stacking the foam pieces. Put your hands flat on either end of the pieces of stacked foam. Slide your hands together. See how they foam folds up? This is like the folding of the Earth when mountains form. Remember to build in these folds.



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How could you test it? This region of Antarctica is difficult to get to and the geology is buried under miles of ice. Planes with geophysical tools work well in this type of area. **Gravity**, combined with **radar**, can be used to help determine mountain building events.

Gravity - As the continents collide they form *linear (in a line) sections of crust as they are deformed*. This folded crust stacks up, forming mountains with dense mass. Gravity will readings will tell you where there is folding by this increased mass and a higher than expected gravity reading. Next to the mountain there would be a corresponding low.

Radar data will be important to combine with the gravity data. Ice is transparent to radar but not bedrock. Radar energy bounces very strongly off the mountains and valleys beneath ice sheet. This will assist in developing a 'picture' of the surfaces below, providing information the shape of the mountain formation so we can tell if it is linear.

The Gamburtsevs, The Result of Volcanic Activity?

Hot spots in the Earth's interior forces hot molten rock (magma) to erupt through the surface of the Earth's crust. Over time this rock builds to form mountains. Yellowstone and Hawaii are examples of a hot spot volcanic mountain.



During the Cenozoic period (~65 Ma), after the breakup of super continent, Pangea, Antarctica was moving slowly South to its current position, having separated from what is currently Australia. Debate exists among scientists about why hot spots occur, but one main theory is that they are a fixed heat source lying beneath the Earth plates. As the plates move slowly over a hot spot, hot mantle forces its way up through the crust forming a volcano. More volcanoes form as the plate continues to move creating a mountain range. Many hot spots are located in the interior of plates...like the center of East Antarctica where the Gamburtsevs are. The hot spot theory suggests that ~65 Ma, as proto-Antarctica moved over a developed hotspot, volcanic mountains formed which we know today as the Gamburtsevs.



Build It - Print the Antarctic map that is attached. Using modeling clay build your model. When you build your mountain remember mountains formed by hot spots will be volcanic so red clay is a good color for them. It takes millions of years for plates to travels over a hot spot forming a series of mountains. These volcanic mountains will be made of iron rich magma so they will be magnetic. Place one of your magnets under the very edge of your mountains to represent this.

How could you test it? This region of Antarctica is difficult to get to and the geology is buried under miles of ice. Planes with geophysical tools work well in this type of area. We will test this theory using **magnetics** and **radar** information.



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Magnetics - In geophysics, a magnetometer is used to collect magnetic properties of the rocks under the ice sheet. Rocks in the Earth's crust have a magnetic signature which relates to what they are made of their structure and when they were made. By collecting magnetic information on the underlying rocks we can attempt to determine what type of rock makes up the crust, how old the rock (or continental crust) is, and how this area matches together with other continental crust in other parts of the Earth. Hot spot volcanic rock is **iron rich**. You can use your second magnet as a magnetometer to test if your mountain is magnetic.



Radar data - will be important to combine radar with the magnetic data. In volcanic structures there is a lot of weight being added to the surrounding plate. The crust responds to the weight by sinking around the base of the volcano, in a circular shaped **depression** much like a **moat circling a castle**.

Ice is transparent to radar but not bedrock. Radar energy bounces very strongly off the mountains and valleys beneath ice sheet. This will help characterize the surfaces below, providing information on whether the area around the base of the mountain formation has a circular depression.



Gamburtsevs