Team Number _____

This is the Dynamic Planet (Earthquakes and Volcanoes) test for Division B.

You may divide up the test, but if you do, please put your team number on every page.

The tiebreakers on this test are

1. The total score on Section A (the short answer section)
2. The score/completeness of answer on problem B.1.
3. The total score on Section D
4. The total score on Section E

Thank you for putting in the time to learn about this field. I hope that you find this test challenges you to put what you've learned into context.

Good luck!

Scores:

_____ A (30 points)

_____ B (20 points)

_____ C (20 points)

_____ D (20 points)

_____ E (10 points)

_____ TOTAL

A. Identification/Short answer (5 points each)

1. What kind of crater is shown in the center of the picture and how did it form?

Maar, formed by a phreatomagmatic eruption when groundwater comes into contact with hot lava.

2. The image at left shows the aftermath of a flood of debris caused by Hurricane Mitch as it moved over the Casita Volcano in Nicaragua in 1998. What are such debris floods called when they are connected with volcanos and how to you know this is one?

They are called lahars, note that the flows consist of mud rather than rock.

3. The picture at left shows the aftermath of an eruption of the original "Geysir". Where is it and why does it (and other geysers erupt periodically instead of steadily?

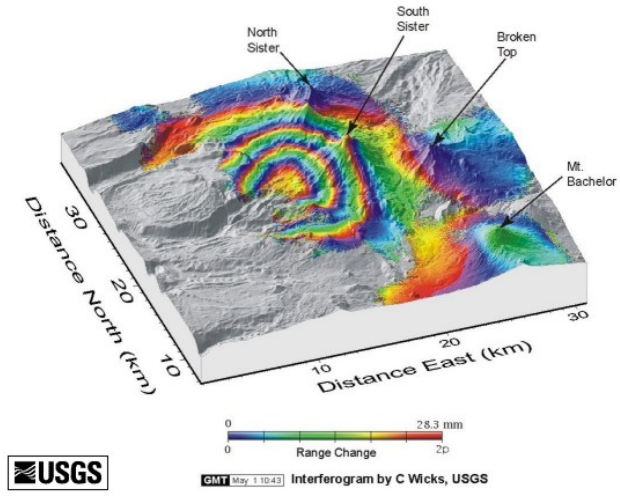
"Geysir" is Icelandic. This is not Old Faithful, which was found by Westerners about 1000 years after Iceland was settled! Technically it's on the European side of Iceland, but only barely. Geysers erupt periodically because there is a chamber beneath in which water heats up, building up pressure until it flashes into steam emptying the chamber, releasing the pressure and allowing the cycle to start again.

4. The rock at left is rhyolite. This rock is felsic. Tell me what this means about the eruption that created it.

Felsic lavas are high in silicate and are very viscous. This means that they tend to plug up vents are get ejected in more violent eruptions than mafic lavas.

5. What is the feature on the right called? What sorts of eruptions build such features (Hawaiian, Vulcanian, Plinian, Ultra-Plinian or phreatic?)

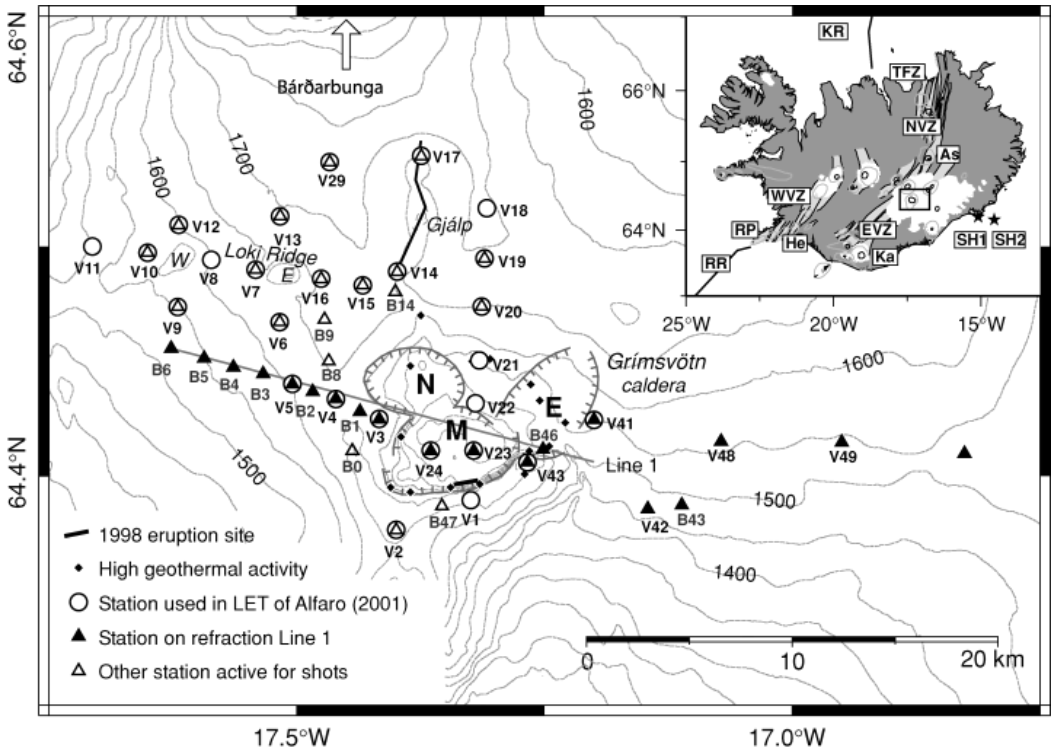
This is a spatter and cinder cone. It is associated with Hawaiian volcanism.



6. The image at left shows an image made by combining two passes of a Synthetic Aperture Radar over the Three Sisters volcano in Oregon to make an interferogram. A single rainbow shows a change in range of ~28mm with successive changes adding more of a change. What do these changes indicate about this volcanic system?

The colors show a systematic change in the height of the volcanoes with an intense bulge (a change of 10 cm in the center!) , indicating that a lava chamber underneath the volcano has either filled or emptied between the passes.

2. Using earthquakes to learn about volcanoes (20 points)



The map above (from Alfaro et al., Geophysical Journal Intl., 2007) shows a map of seismic stations around the Grimsvotn caldera in Iceland. Geographic context is given by the map in the upper right. The triangles show seismic stations.

1. Design a strategy using earthquakes generated in the North Volcanic Zone and stations V21 (north of the caldera), V2 (south of the caldera), V16 (northwest of the caldera) and V5 (west of the caldera) to evaluate whether there is a magma chamber underneath Grimsvotn. (Hint: how would the presence of magma alter the P and S waves?) (15 points, T2)

Because S waves can't travel through liquid and P waves are slowed down in liquid earthquake waves travelling from V21 to V2 would exhibit slower speeds and a larger decay of S-wave amplitude than waves travelling from V16 to V5.

2. The map in the upper right shows multiple volcanic zones, the North (NVZ), east (EVZ), west (WVZ) and Reykjanes Peninsula (RP). Why do these zones all trend in the same general direction? (5 points)

The plate boundary runs in this direction. As the plates are spreading, lines of volcanoes follow normal faults that develop as a result of this spreading.

C. Definitions/ID (2 points each)

1. Richter magnitude: Measure of earthquake size based on amplitude of seismic waves.

2. Rayleigh Wave: A surface wave in which the motion is in the same direction as the propagation (similar to water waves)

3. Thera: Volcano in Mediterranean that is thought to have wiped out Minoan civilization (and possibly given rise to legend of Atlantis).

4. Black smoker: A hydrothermal vent on the ocean bottom in which precipitating minerals form a black cloud.

5. Mercalli Magnitude: Magnitude scale based on destructiveness.

6. Dike : A volcanic intrusive feature where lava cuts through layers of rock.

7. Mount Redoubt: Alaskan stratovolcano that has erupted within past year.

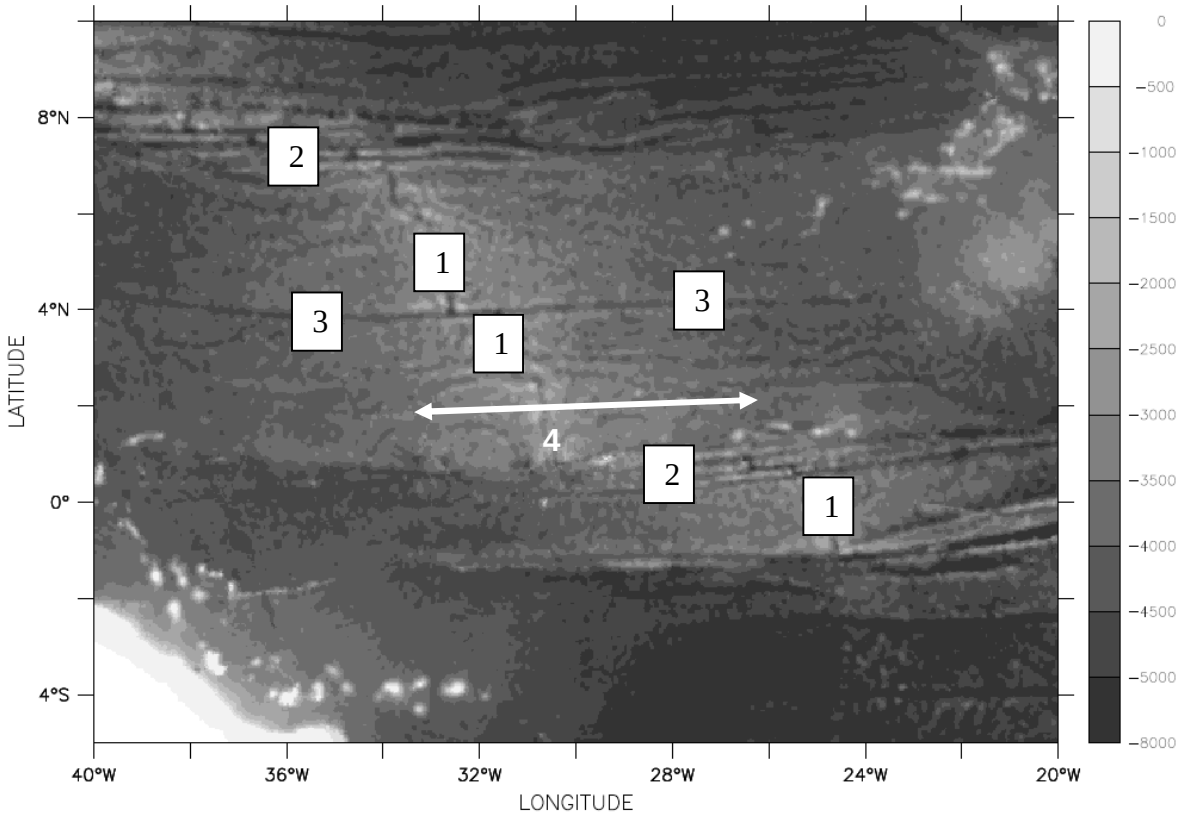
8. Pumice: Light, bubbly rock formed from volcanic explosions.

9. Aesthenosphere: The layer underlying the lithosphere that is relatively plastic, allowing the plates to flow over it.

10. San Andreas Fault: An important transform fault in California.

D: Topographic interpretation (20 points)

The picture below shows the bottom of the central Atlantic

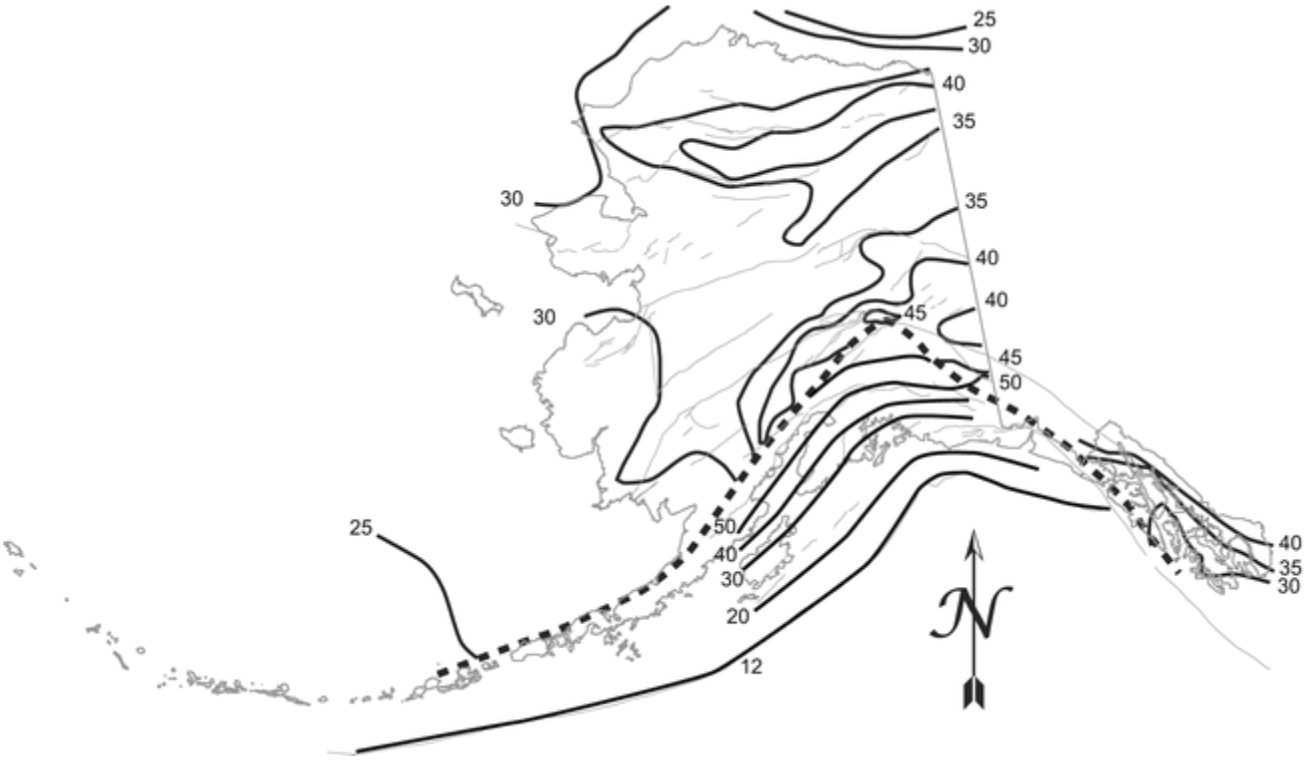


Topography (m)

Identify on the map (4 points each)

1. Areas where you would expect normal faulting. Along the ridge crest.
2. Areas where you would expect transform faulting.
3. Areas where you would expect to find an aseismic fault. Old transform faults off ridge crest.
4. The direction of plate motion.
5. Lines of constant magnetic anomaly. Draw lines parallel to ridge crest

E. The Moho



The figure above shows the depth of the Mohorovic discontinuity in and near Alaska.

1. Describe the pattern of Moho depth (5 points, T2).

The Moho is shallow in the south, deepends and you move northward to the Alaska coast, reaching a depth of 50km just inshore of the coastal margin. It then shallows to about 35 km again in the middle of Alaska with a deeper riges to the North.

2. Why is it shallow in some locations and deeper in others? (5 points)

The Moho marks the bottom of the crust. Continental crust is lighter than ocean crust. Thus, like an iceberg, it has deeper roots. The deepest part of the Moho is where the oceanic crust is subducting under the continental crust.