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Origins for Deep Marine Lava Flows Along the Western Flanks of the Galapagos Island Platform

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Abstract

The Galápagos platform is characterized by a complex magmatic plumbing system attributed to a hot spot mantle plume in addition to the Galápagos spreading center. The resulting topography involves a chain of volcanos that sit on top of a large submarine platform that rises 3.5 km above the surrounding seafloor. Additionally, there are extensive rift zones surrounding the platform. Side-scan sonar maps of the seafloor indicate consolidated bodies of rock (up to 30 km in length) on the western flanks of the Galápagos platform, which are interpreted as individual large lava flows. Two of these lava flows have been sampled using a submarine remotely operated vehicle (ROV) on a Nautilus research cruise (#064) in order to determine how they relate to one another and to the greater Galápagos magmatic system. It is unknown the source for these uncharacteristically long flows because of the variety of magmatism for this region. Potential magmatic sources for these flows are the adjacent subaerial volcano Fernandina or a submarine rift zone, which can be traced radially outward from the Galápagos platform. 25 samples have been collected for geochemical analyses to investigate the origin of these deep marine flows. First, glass has been collected from all 25 samples using a binocular microscope, and has been cleaned twice using a Sonicator. Next, these samples were dissolved in a series of acids for solution ICP-MS analysis, to determine trace element contents of the lavas that comprise the flows. The data from the two flows will be compared to determine if they have the same source. Next the deep water flow compositions will be compared to previously studied remotely operated vehicle (ROV) on a Nautilus research cruise (#064) in order to determine how they relate to one another and to the greater Galápagos magmatic system. It is unknown the source for these uncharacteristically long flows because of the variety of magmatism for this region. Potential magmatic sources for these flows are the adjacent subaerial volcano Fernandina or a submarine rift zone, which can be traced radially outward from the Galápagos platform. 25 samples have been collected for geochemical analyses to investigate the origin of these deep marine flows. First, glass has been collected from all 25 samples using a binocular microscope, and has been cleaned twice using a Sonicator. Next, these samples were dissolved in a series of acids for solution ICP-MS analysis, to determine trace element contents of the lavas that comprise the flows. The data from the two flows will be compared to determine if they have the same source. Next the deep water flow compositions will be compared to previously studied submarine samples [1], and to subaerial samples of Fernandina volcano. Results will have implications for the Galápagos magmatic plumbing system, as it generates these large deep-marine flows.

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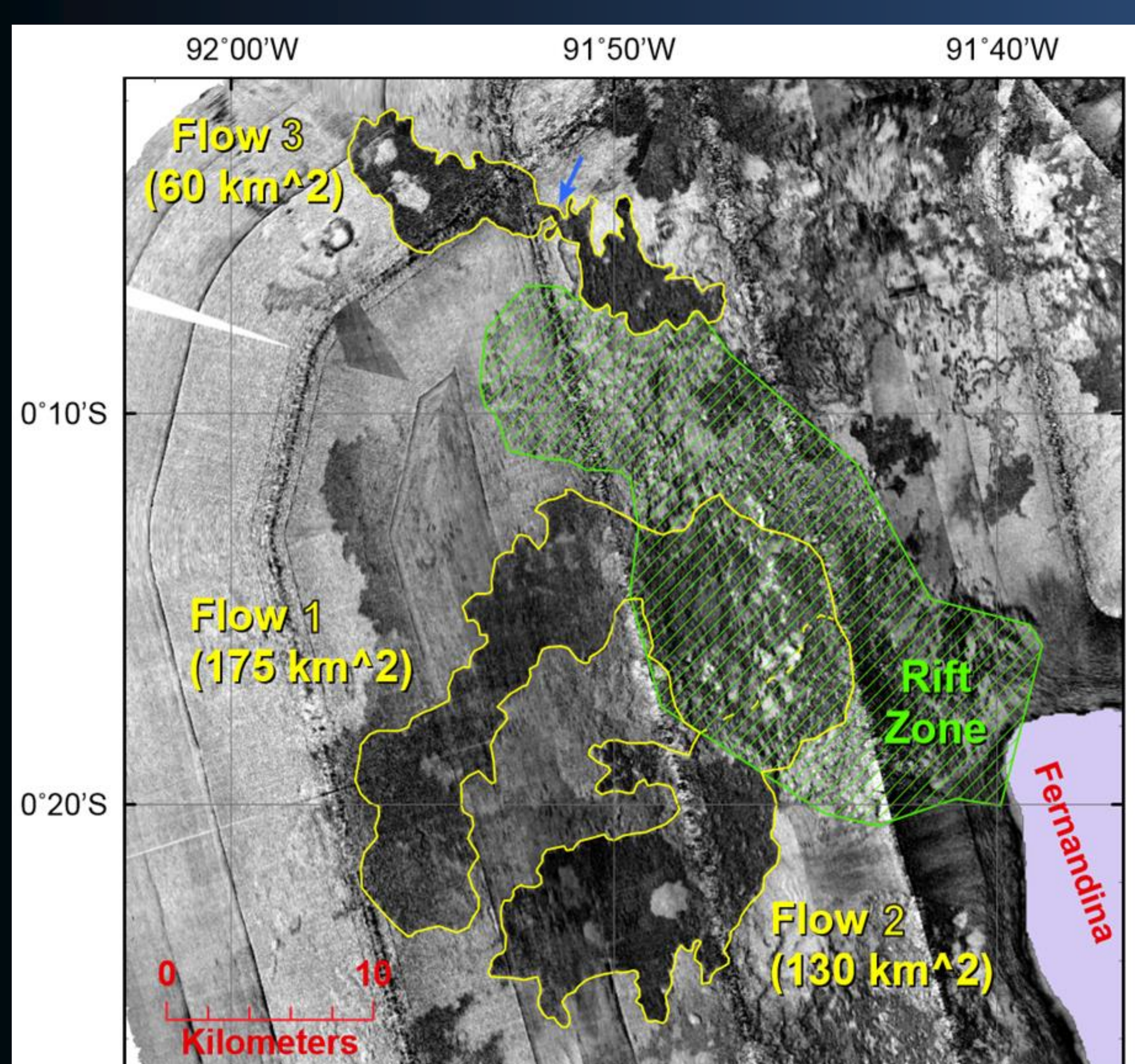
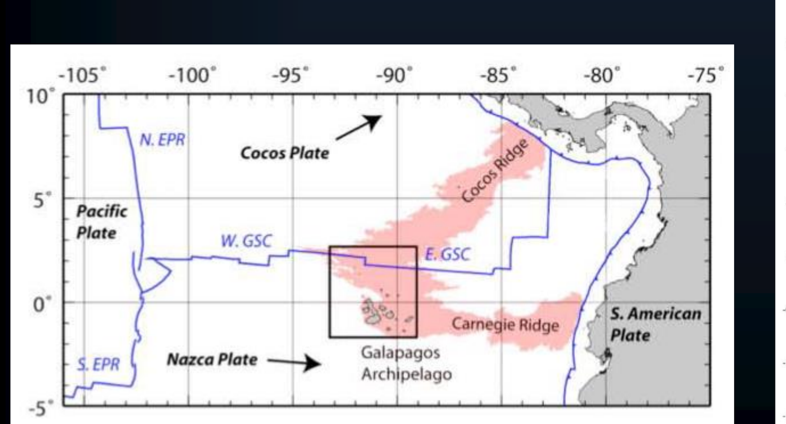
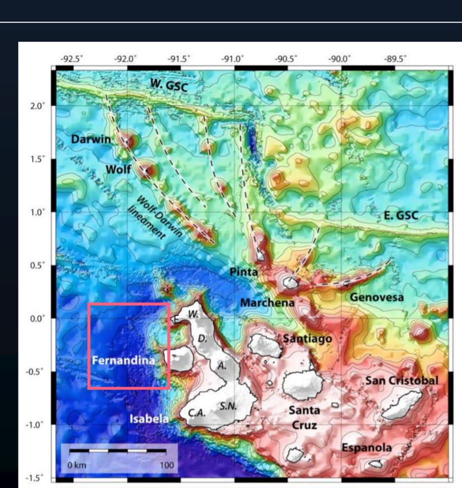
Introduction

- Side-scan sonar maps of the leading edge of the Galápagos platform show unusually large lava flows
- However, the source of these large lava flows at >3000 m water depths is unknown
- The flows may be related to the adjacent subaerial volcano (Fernandina), a radial rift system, or may originate from the base of the Galápagos platform
- To understand the flows, 25 lava samples were collected and analyzed from two of the largest flows
- Samples were collected from 4 regions:
  1. end of flow 1
  2. the seafloor between flows
  3. end of flow 2
  4. top of flow 2

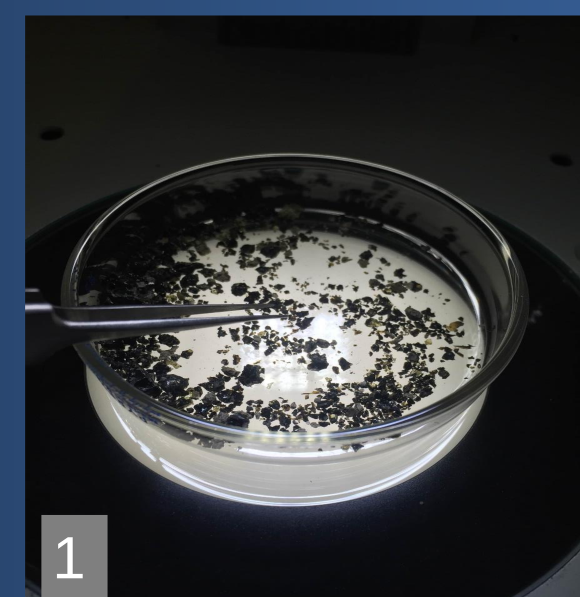


Questions:
- Is each flow a single composition?
- Are both flows the same composition?
- What causes the variations in composition?
- How do the compositions compare to other nearby submarine lavas?





Methods



1 Use a binocular microscope to pick 50 mg of glass from all 25 samples, avoiding phenocrysts

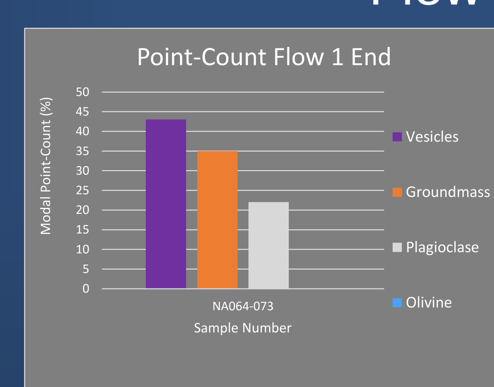
2 Clean glass using a Sonicator to remove salt and sand

3 Dissolve glass samples and dilute for analysis

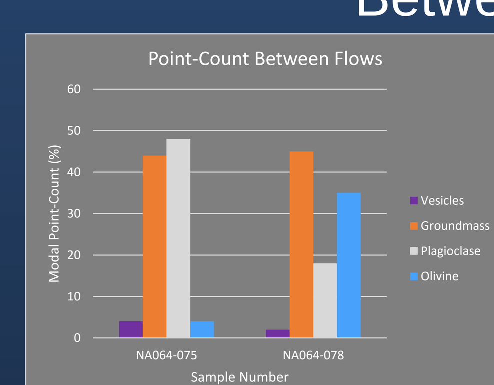
4 Run liquefied samples using ICP-MS to measure trace and some major elements in samples

Samples

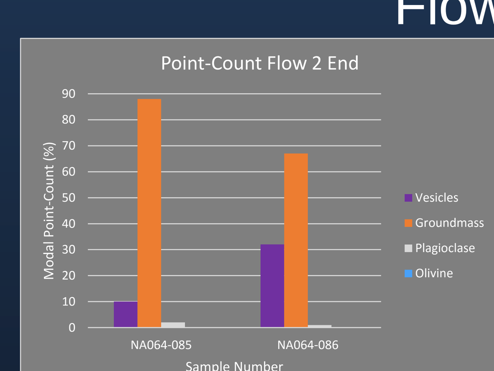
Flow 1 End

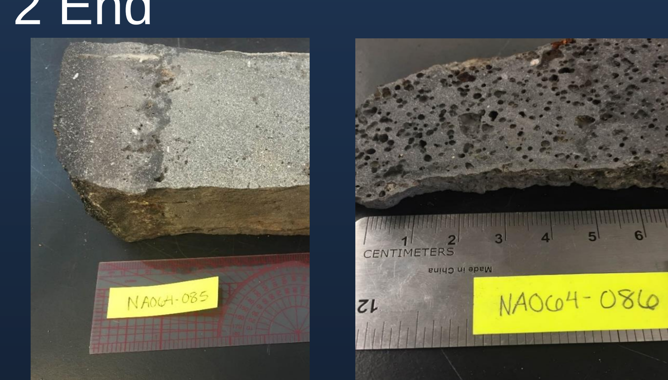


Between Flows

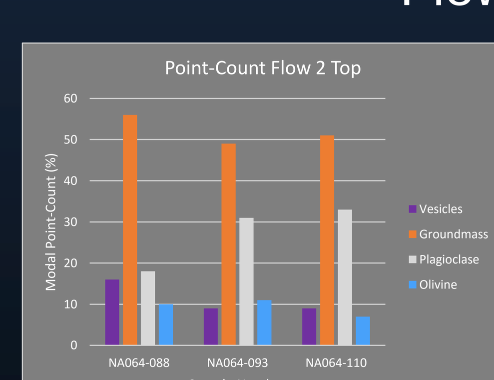


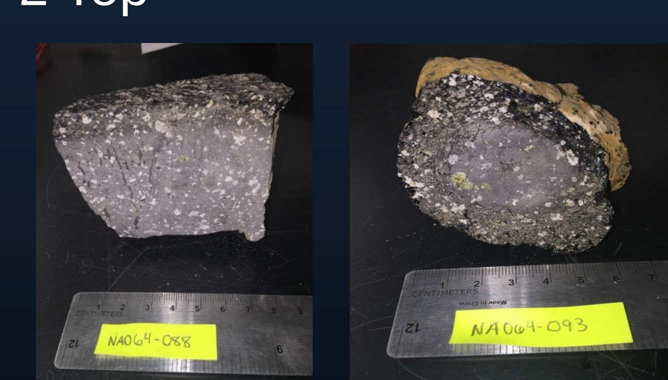
Flow 2 End





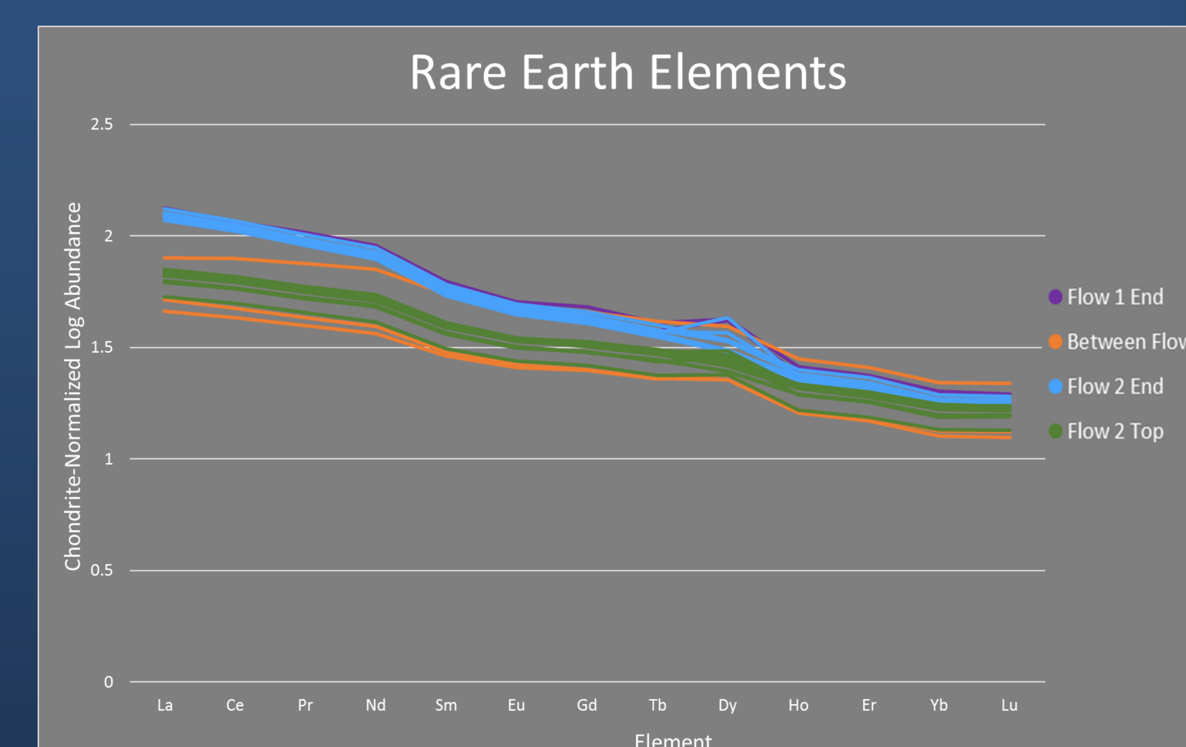
Flow 2 Top



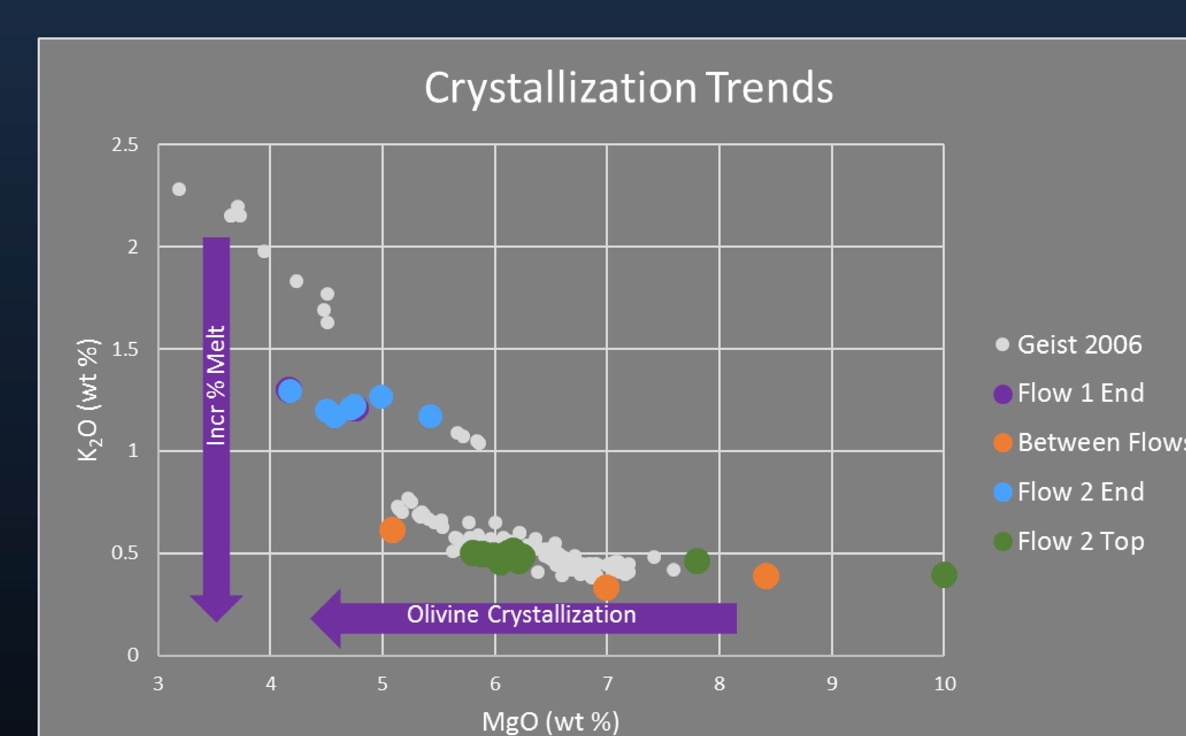


Point-Count Results
- Two flows are petrologically different
- Flow ends are relatively aphyric
- Flow top and between flows are phaneritic

Results



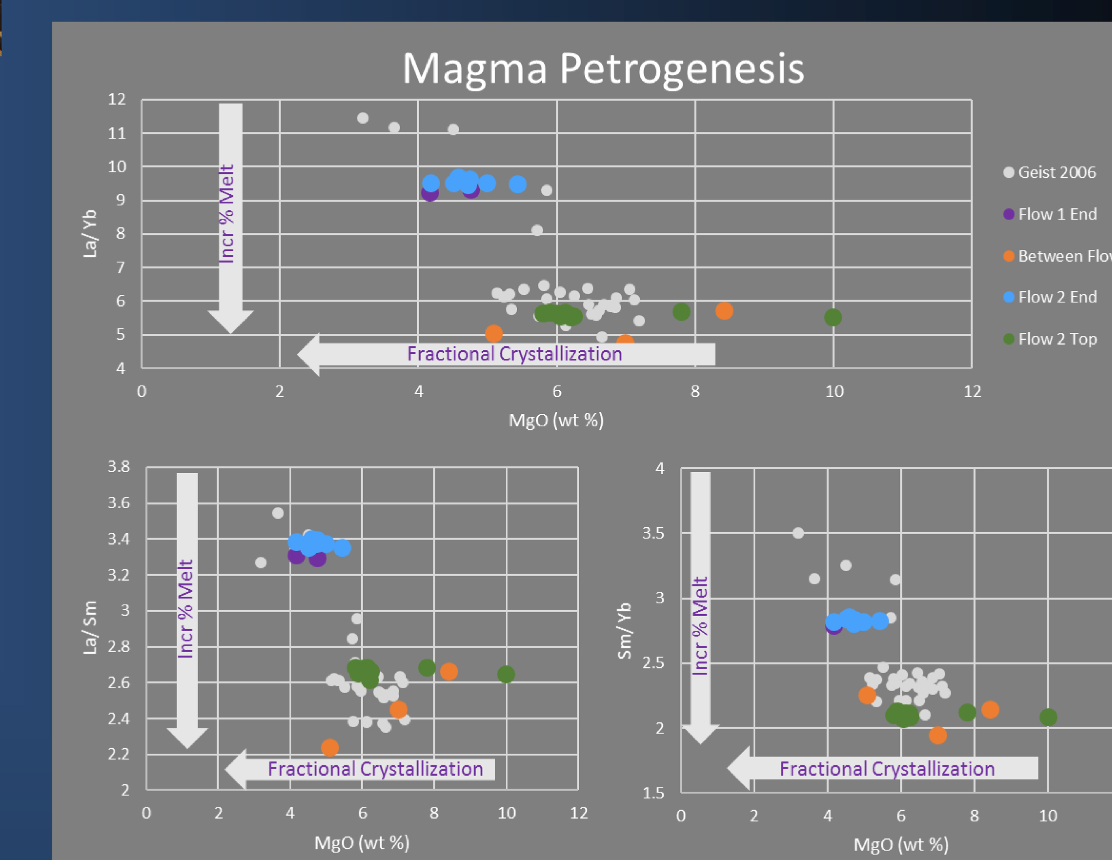
- The flows are compositionally heterogeneous
- Flow 2 has two distinct trace element patterns, suggesting it is not a single eruption
- The variability in Flow 2 trace element patterns indicates a change in the percent melting
- No Eu anomaly, so no plagioclase crystallization



- K_2O incompatible during crystallization
- K_2O increases slightly, while MgO decreases with olivine crystallization

Discussion

- Lavas from the ends of Flow 1 and 2 have higher La/Yb, La/Sm, and Sm/Yb ratios (lower % melt)
- Lavas from the top of Flow 2 and Between Flows have relatively low La/Yb, La/Sm, Sm/Yb (higher % melt)
- Lavas from Flow 2 have different trace element ratios, suggesting that there were two different eruptions



Comparison with lavas from Geist et al., (2006):

- High La/Yb flows (Flow 1 and 2 ends) resemble previously studied lavas from the southern most rift zone
- Low La/Yb flows (upper 2nd flow and between flows) resemble lavas from the northwestern Fernandina

Conclusion

- There are at least 3 different lava flows with varying compositions
- Lavas at the ends of the flows formed from a higher % melting compared to lavas at the top of Flow 2
- Flow 2 Top lavas have trace element ratios comparable to Geist (2006) rift zone flow
- Fractional crystallization occurs within an individual flow
- Plagioclase is present in the rock but was not a crystallizing phase in magma, so they must be xenocrysts brought up during eruption

References

Geist, D.J., Fornari, D.J., Kurz, M.D., Harpp, K.S., Soule, S.A., Perfit, M.R., and Koleszar, A.M., 2006, Submarine Fernandina: Magmatism at the leading edge of the Galápagos hot spot: Geochemistry, Geophysics, Geosystems, v. 7, no. 12, doi: 10.1029/2006gc001290.