Subsurface Biosphere Initiative Project: Hawaii Giant Landslides and its Strength

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Objectives

To determine if bacteria impact the formation of giant landslides.

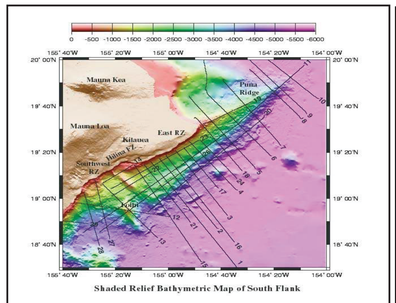
Methods

To conduct preliminary experiments to determine if it is possible to detect changes in the strength of the material that makes up the island margin desposits as the material is weathered.

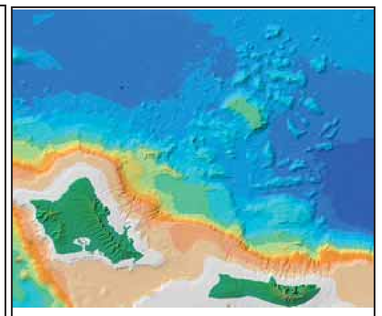
Step 1: To fabricate cylinders of granulated volcanic rock from Hawaii.
Step 2: To test the strength of these cylinders both in a non-destructive and destructive manner before and after they have been subjected to weathering treatment.

Introduction

Giant Landslides



The South flank of the Kilauea volcano on the Big Island is thought to be the site of an active submarine landslide, the Hilina slump. The South flank is creeping seaward at rates up to 10 cm/yr and occasionally experiences large earthquakes.



Debris from enormous landslides off Oahu and Molokai extends hundreds of kilometers

Kilauea Volcano

Kilauea volcano lava flow. Kilauea has been erupting for the past 25 years.

When the lava flow enters the ocean, it forms what is known as a hyaloclastite.

Facts!

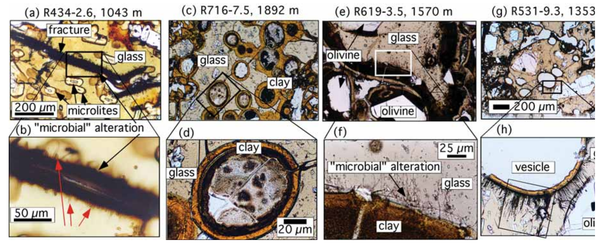
Q: What are the consequences of giant landslides?
A: Giant Hawaiian landslides have resulted in huge land losses and future landslides could result in enormous losses of life, property, and resources. Tsunamis are generated during these landslides that have carried rocks and sediments as high as 1,000 feet above sea level. Slides generate large eathquakes, too.

Q: When was the eruption and what happened?
A: Currently, Kilauea volcano has erupted lava almost continuously from its east rift zone since 1983-1990. The lava erupted by the Kilauea volcano repeatedly invaded communities alongs its Southern Coast, destroying more than 180 homes, a visitor center in Hawaii Volcanoes National Park, highways, and treasured historical and archaeological sites.

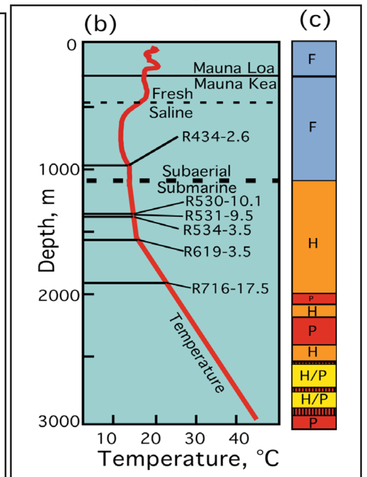
Q: What is a hyaloclastite and how does it form?
A: Hyaloclastite is a breccia rich in black volcanic glass, formed during volcanic eruptions under water, under ice or where subaerial flows reach the sea or other bodies of water. It has the appearance of angular flat fragments sized between a millimeter to a few centimeters. The fragmentation occurs by the force of the volcanic explosion, or by thermal shock during rapid cooling. Hyaloclastite are up to a kilometer thick beneath the edge of Hawaii. See next panel.

A Closer Look

Hyaloclastite and its depth in the Hawaii Scientific Drilling Program



Photomicrographs of fresh and altered glass from the Hawaiian Scientific Drilling Program.
(a, b) Fresh and altered glass from the subaerial section. (b) Channels are about 10 μm long and 4 μm in diameter.
(c, d) Hyaloclastite from 1892 m. Glass shards are surrounded by clay and vesicles are lined with clay. No "microbial" channels are seen at this depth.
(e and f) Fresh and altered glass from hyaloclastite from 1570 m. Glass fragments and olivine are surrounded by clay. "Microbial" alteration of the glass is in the form of fine (1 μm diameter) tubes that penetrate the glass. This glass does not have the dark boundary between glass and clay as seen in R531-5.9, or the red oxidative alteration of R434-2.6.
(g and h) Photomicrographs in plane polarized light of hyaloclastite Unit 198. This sample is from 1353 m below sea level. Olivine up to 500 m and circular and ovoid vesicles up to 200 μm are present. Vesicle rimmed with 10 μm thick layer of yellow clay and dark tubes that extend into glass and up to olivine.



The horizontal thin dashed line is the fresh - saline water boundary. Underwater eruptions occurred below the heavy dashed line. Major lithologic units: F lava flows; H hyaloclastites; P pillow basalts

Preparation

Lab Equipment

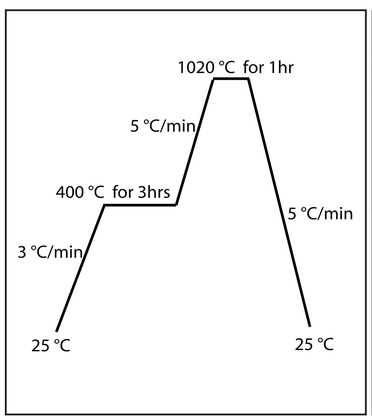
This is the press that is used to consolidate the Kalapana basalt glass before it is sintered.

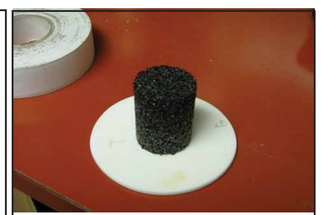
The tools here are used to make the sample its size and shape. The press is done manually and requires applying 16,000 lbs to create a sample. The sample is shown below.

The mortar, pestle and plastic stirrer are used to mix both the Kalapana basalt sand with the PVB, a binder also known as polyvinyl butyral.
A 5 wt % solution of PVB was used to bind the sand.

Sintering Process

The test sintering temperature started at 500 °C and went up to 1020 °C. At 1000 °C is when the sand begin to sinter, but at 1020 °C is when it is more stable.





The sample successfully sintered at 1012 °C for one hour. The cylinder is a 1.125" diameter and 1.2" height.

Calculation

Physical Properties of sample

Final mass, m_f = 42.4780 g
Final dimension = 1.222" height and 1.129" diameter

Vol. of cylinder = (Π*d²*L)/4
Vol. of cylinder = 1.223 in^3 or 20.04 cm^3

Density of cylinder = 42.4780 g / 20.04 cm^3
Density of cylinder = 2.12 g/cm^3

Known density of glass = 2.772 g/cm^3
Vol. of solid = 42.4780 g / 2.772 g/cm^3 = 15.324 cm^3

Void ratio (e) = vol. of space / vol. of solid
e = (20.041 cm^3 - 15.324 cm^3) / 15.324 cm^3
e = 0.308
Porosity (n) = e / (1+e)
n = 0.235

Results

Sinter #	Size (mm)	Press. (lbs)	Temp (°C)	Time (hrs)	Comment	Color of sinter
1	0.841-2	7000 3min.	500	1	No sintering took place	Grayish-black
2	0.841-2	7000 3min.	600	1	No sintering took place	Grayish-Black
3	0.841-2	7000 3min.	700	2	No sintering took place	Dark-yellowish brown
4	0.841-2	7000 3min.	800	2	No sintering took place	Dark-yellowish brown
5	0.841-2	7000 3min.	900	1	Certain parts sintered	Dark-yellowish brown
6	0.841-2	7000 3min.	950	1	Certain parts sintered	Dark-orange brown
7	0.841-2	7000 3min.	1000	1	Sintered crumbly edge	Light brown/ orange
8	0.595-0.841	7000 3min.	1000	1	Sintered-slight crumbly edge	Light brown/ orange
9	0.841-2	7000 3min.	1020	1	Sintered, better w/ finer size	Reddish brown/ orange
10	0.595-0.841	7000 3min.	1020	1	Sintered to strong solid	Reddish brown/ orange
Sample A	0.841-2	<7000 5 min.	1020	1	Failed:Press. too low	Grayish brown
Sample B	0.841-2	<7000 5 min.	-------	-----	Failed:Press. still too low	Grayish black
Sample C	0.595-0.841	16000 3 min.	1020	1	Sintered successfully	Reddish brown & dark brown
Sample D to I	0.595-0.841	16000 5 min.	1020	1	Sintered successfully	Reddish brown & dark brown

Future work

* Non-destructive test.
  - Testing sound velocity.
  - Elastic Waves Test.
* Unconfined Compression Test.
* Triaxial Compression Test
* Chemical alteration / hydrous alteration / Biological alteration followed by non-destructive and destructive test.

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Acknowledgements

I would like to thank the following people for their assistance with this project : Martin Fisk, Jerry Yamamuro, David Cann, Eric Patterson, Jason Ideker, Skip Rochefort. The SBI for funding this research internship opportunity.