Pito Deep - Revisiting Pacific Lower Crust, the 3rd Dimension of Magnetic Stripes and Long Lost & New Found Hydrothermal vents

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Objectives:

- Report on the AT37-08 Atlantis cruise to Pito Deep (Jan/Feb 2017)

- Present preliminary results: - lateral heterogeneity

- Implications for the size & shape of magma accretion zones & both fast & slow spreading ridges

- New hydrothermal vent discoveries

- Future work
Close to one of the few places in the Pacific Seafloor that has a crack in the crust that allows access to the interior of oceanic crust.
Why is having a crack through the center important?

Bathymetry (m)
Why - provides section through the crust

Penrose Model for Ocean Crust

From Chutas (2007)
Why does Pito Deep exist?
Easter Microplate
6.56 Million Years Ago

From Kavanagh, Gee, Maher, Doran, Naar
Atlantis: multibeam bathymetry

50 km

40m Resolution
Rotated Fault Blocks

Scarps up to 4km high

Naar et al., 1991)
Provides the third dimension:

Helps address the following questions

The composition & nature of fast spread crust?

How does it grow?

The third dimension of the magnetic stripes?

Constraints on the shape/dimensions of the magma accretion zone
Straw-man models for lower crust (frozen magma chamber) formation

Gabbro-glacier flow

*e.g.* Quick and Denlinger (1993)

Hybrid-multiple Sill

*e.g.* Kelemen et al (1997)
Each model makes testable predictions

Modified from Coogan, 2014
The Survey Sites & the problem-mass wasting

The three survey sites

~ 35km from Area A to Area C
The Mass wasting problem

Snowt Range, Laramie
Sentry: to pick sample targets

5m Resolution
Jason to collect samples
Collected 413 samples (5000 lbs) - mostly all from outcrop & oriented

10 cm

3-D Photography

L. Kavanagh
Troctolites
Orientation device
For perspective:

El Capitan

 Courtesy of the USGS
3-D visualizations of rock outcrop
Area A

- Basalts
- Dikes
- Gabbros

- 4200 m
- ~ 500-600 m
- ~ 500 m
- 3000 m
Area B
Comparison of Oman ophiolite & Pito

Oman

~50-200 mbsd

- HT isotropic ophitic gabbro
- Melt lens level

~150-300 mbsd

After Nicolas et al 2009

Pito

41 mbsd

45 mbsd

72 mbsd

386 mbsd
Area C - similar stratigraphy

- Basalts
- Dikes
- Oxide Gabbros (<200m)
- Gabbros
- Troctolites

Approximate distances:
- 4000 m
- 4400 m
- 4800 m
- ~700 m
Interim results

- Cumulates near the Dike gabbro transition
- Orientation of layering complicated
- Lateral heterogeneity
- Some similarities to Oman
Magnetics - Jeff Gee
Scripps

Area A

Area B

Projected Distance (km)

Projected Distance (km)

Depth (km)

Depth (km)

C2An.2n

C2An.3n

Dike

Gabbro

C2An.1r

C2An.2r

C2An.2n

C2An.3n

Anomaly 200m
above source

Mag. (A/m)
Implications- wide accretion zones

- Sleep 1975
- Henstock et al. 1993
- Dunn et al. 2000
- Han et al. 2003
Other constraints- Speedometry

Faak & Gillis 2016
Testable with zircon geochron
Geochron- Atlantis Bank

Solidus temperatures

$\text{Solidus} \approx 850^\circ\text{C} = \text{margin of the mush zone/magma chamber}$

Rioux et al. 2016
Hydrothermal vents
Pito Seamount

60m resolution

(Nautille - 1993; Naar et al, 2004)
Pito Seamount

2.5 km

Sentry

1 m resolution
New Site?
Hydrothermal Vents (reconnaissance)
- 7 active vents; > 50 chimneys (up to 22 m tall) discovered (many dead)
- active black smokers discharging >370°C water
- fauna
2017- 4K video
Outreach

- 33 ship-to-shore webcasts to K-12 schools, aquariums, universities & institutions across the United States, Canada, and UK. Reached 1053 students + members of the public.

- Website- 12,000 page views, Twitter, Facebook

- Miniboat- with Middle UW School
The last sunset
Summary....

Lot's to do
Outreach: the Jackelope & Kon-Tiki

- **Jackelope**
  - 79 days,
  - 2200+ miles
  - (~ 1.2 miles/day)

- **Kon-Tiki**
  - (1.7 miles/day)

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