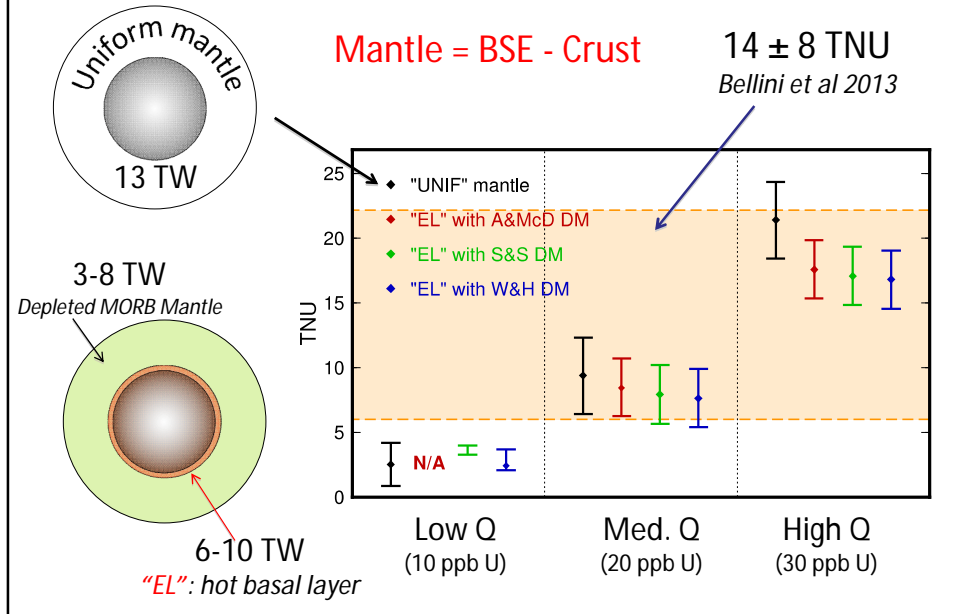
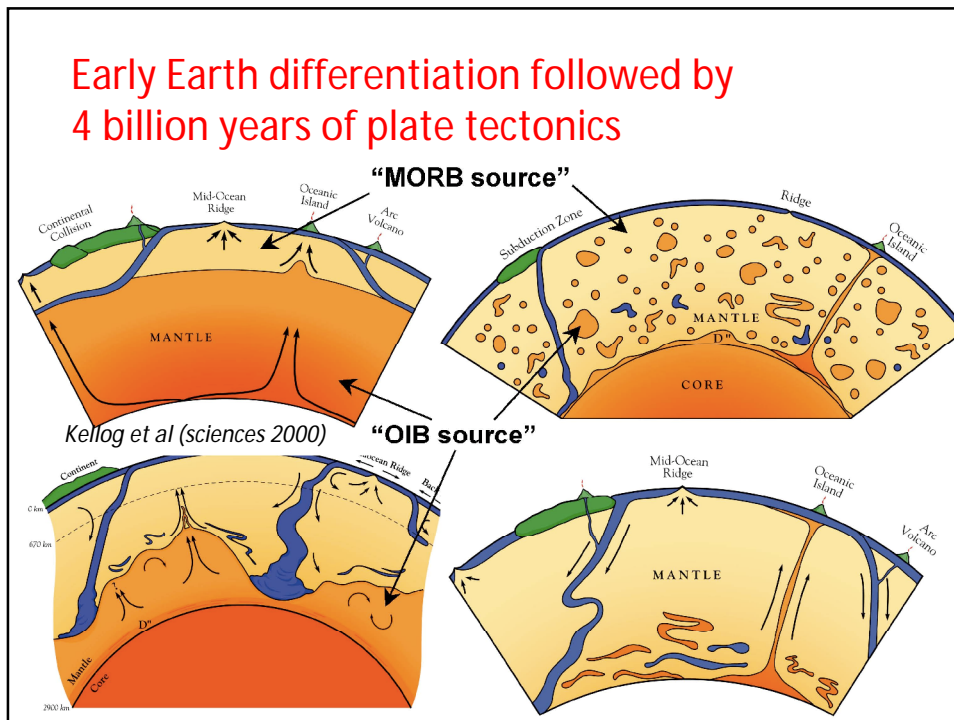


# Mantle flux: need for Hanohano

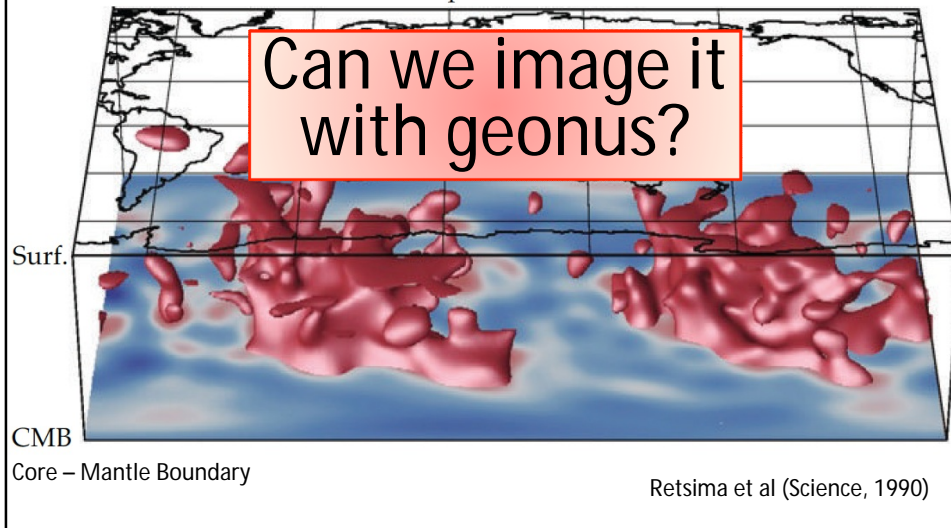


# Early Earth differentiation followed by 4 billion years of plate tectonics

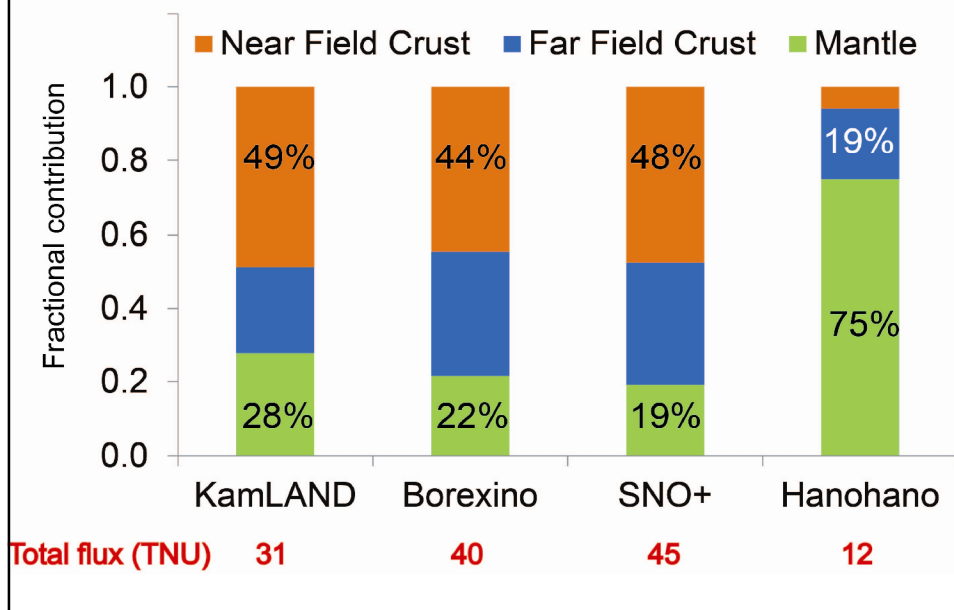


## What's hidden in the mantle?

Seismically slow "red" regions in the deep mantle

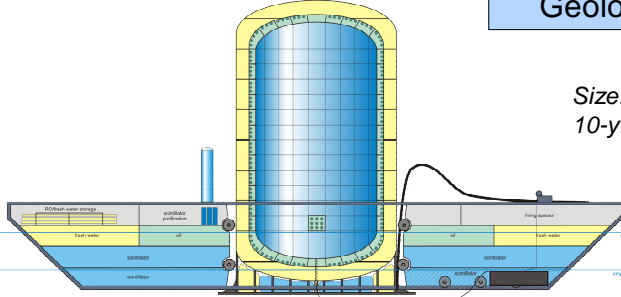


## Geoneutrino contributions to detectors



# Hanohano

An experiment with joint interests in Physics, Geology, and Security

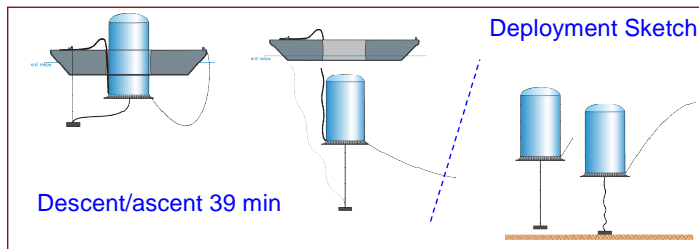


Size: scalable from 1 to 50 kT  
10-yr cost est: \$250M @ 10 kT

- multiple deployments
- deep water cosmic shield
- control-able L/E detection

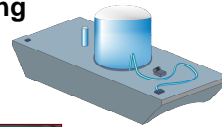
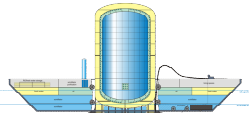
## A Deep Ocean

$\bar{\nu}_e$  Electron  
Anti-Neutrino  
Observatory



## Engineering Studies

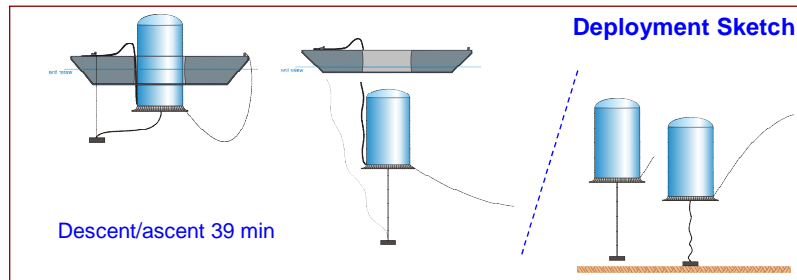
Makai Ocean Engineering



- Studied vessel design up to 100 kilotons, based upon cost, stability, and construction ease.
  - Construct in shipyard
  - Fill/test in port
  - Tow to site, can traverse Panama Canal
  - Deploy ~4-5 km depth
  - Recover, repair or relocate, and redeploy

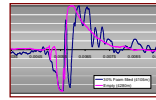
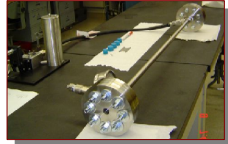
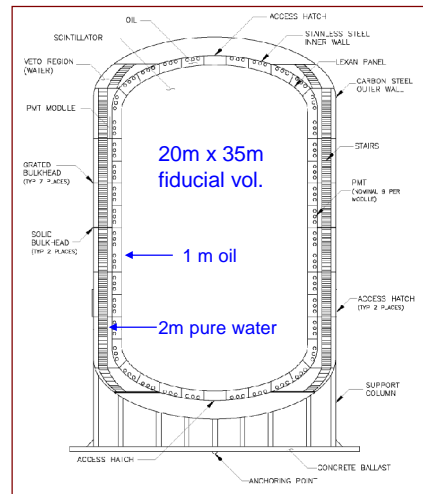


Barge 112 m long x 23.3 wide



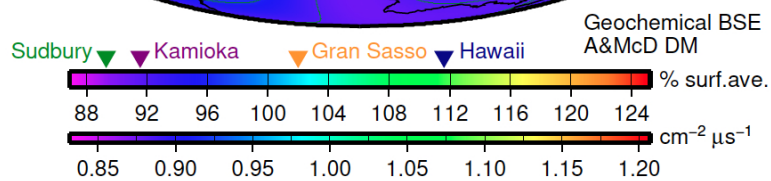
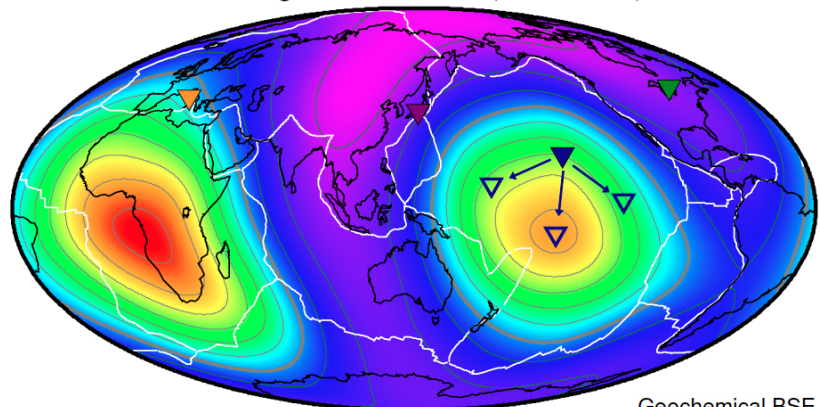
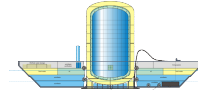
## Addressing Technology Issues

- Scintillating oil studies in lab
  - P=450 atm, T=0 ° C
  - Testing PC, PXE, LAB and dodecane
  - No problems so far, LAB favorite... optimization needed
- Implosion studies
  - Design with energy absorption
  - Computer modeling & at sea
  - No stoppers
- Power and comm, no problems
- Optical detector, prototypes OK
- Need second round design

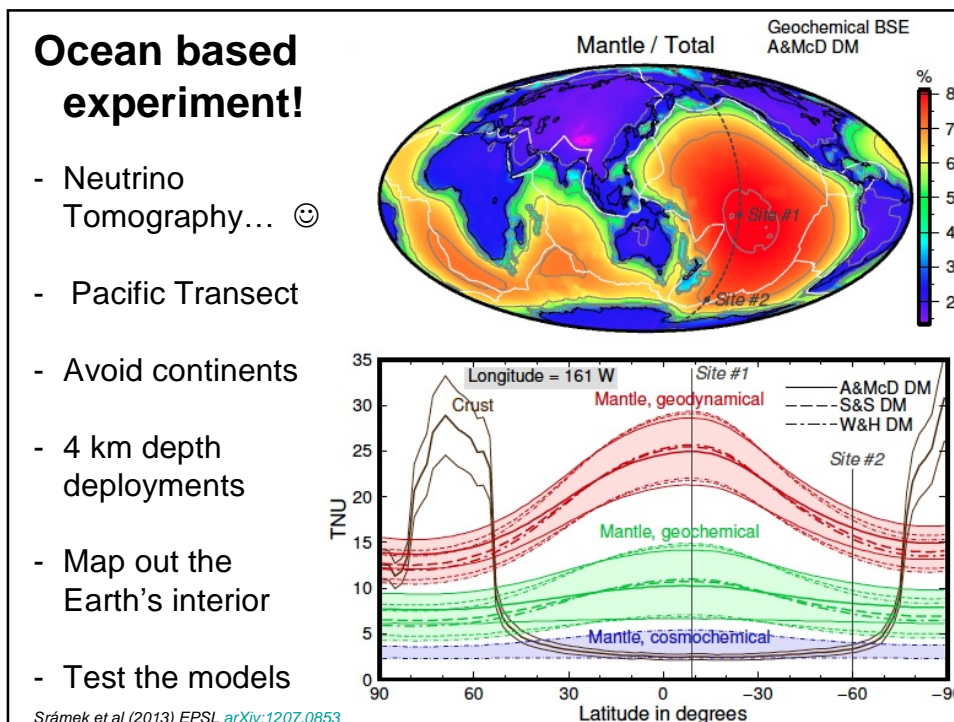
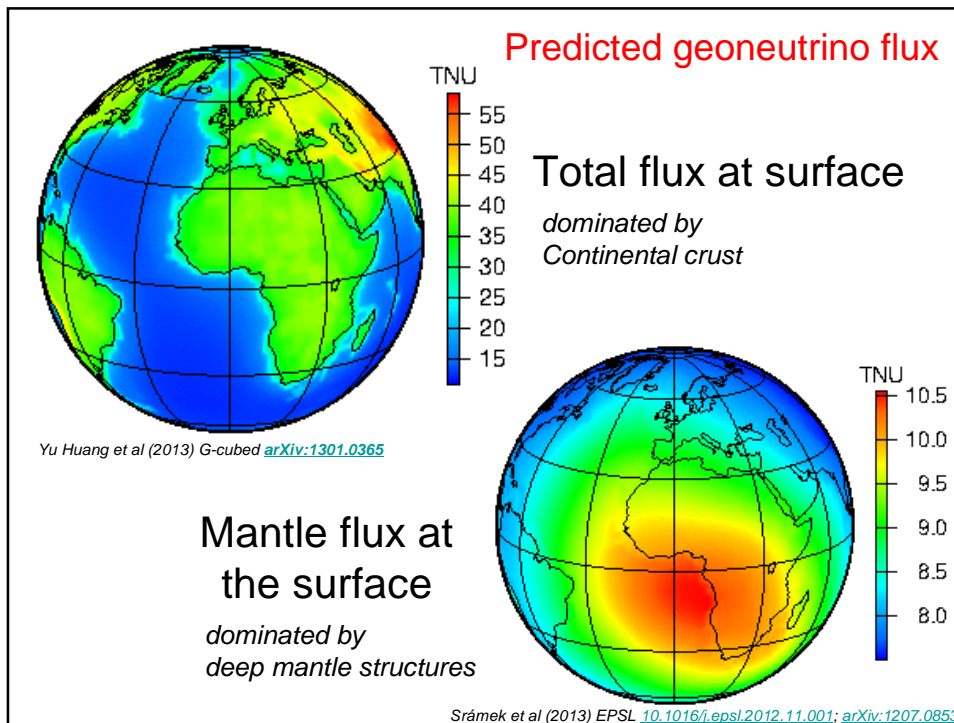


## Testing Earth Models

Mantle geoneutrino flux ( $^{238}\text{U} + ^{232}\text{Th}$ )



Srámek et al, 2012, EPSL



Future:

## -Neutrino Tomography of the Earth's deep interior ☺

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### **Hanohano- 10 kt-yr Exposure**

- Mantle flux U geoneutrinos to ~10%
- Heat flux ~15%
- Measure Th/U ratio to ~20%
- Rule out geo-reactor if  $P > 0.3$  TW

- **There is also plenty of Neutrino Physics..**
- **And much astrophysics and nucleon decay too....**