Wed. Apr. 11, 2018

- Lunar Geology Intro. for Wed. lab
- Finish “Environmental” Applications (Ocenas)
- Start Hewson paper (if time)

- Reading:
  - Skim Sabins Chapter 10. Oil Exploration
  - Read Hewson et al. 2005 "Seamless geological map generation using ASTER in the Broken Hill-Curnamona province of Australia." Remote Sensing of theEnvironment 99: 159-172
    - (link on class website "Reading List" Page

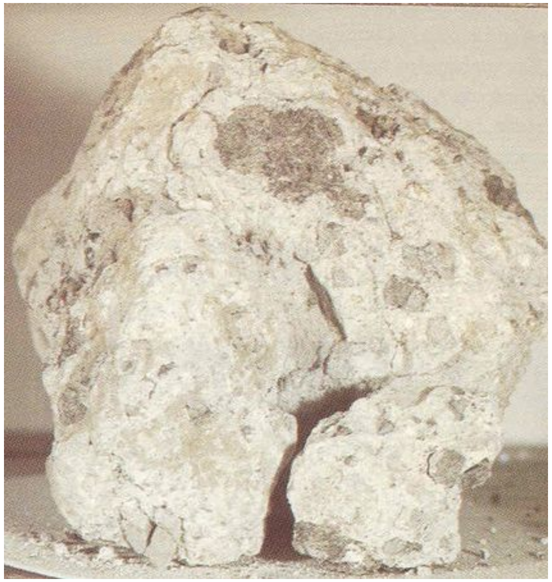
Lunar Geology-- Overview

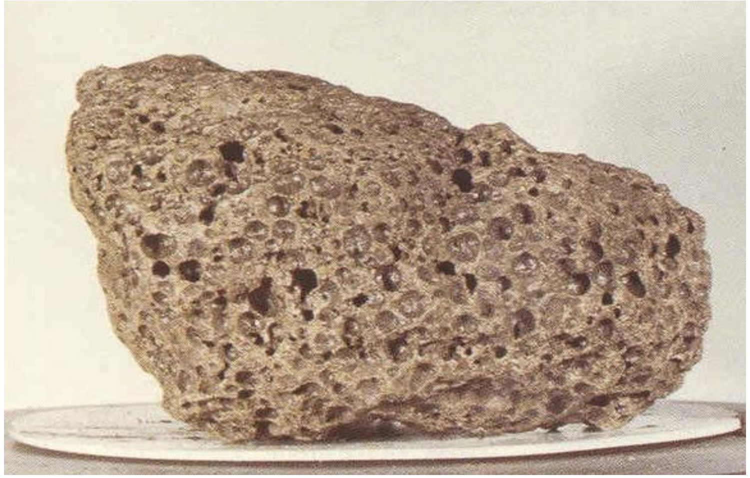
- Maria vs Terrae division
- Basalt vs. Anorthosite

Composition of Mare vs. Highlands

- Highlands: ANORTHOSITE

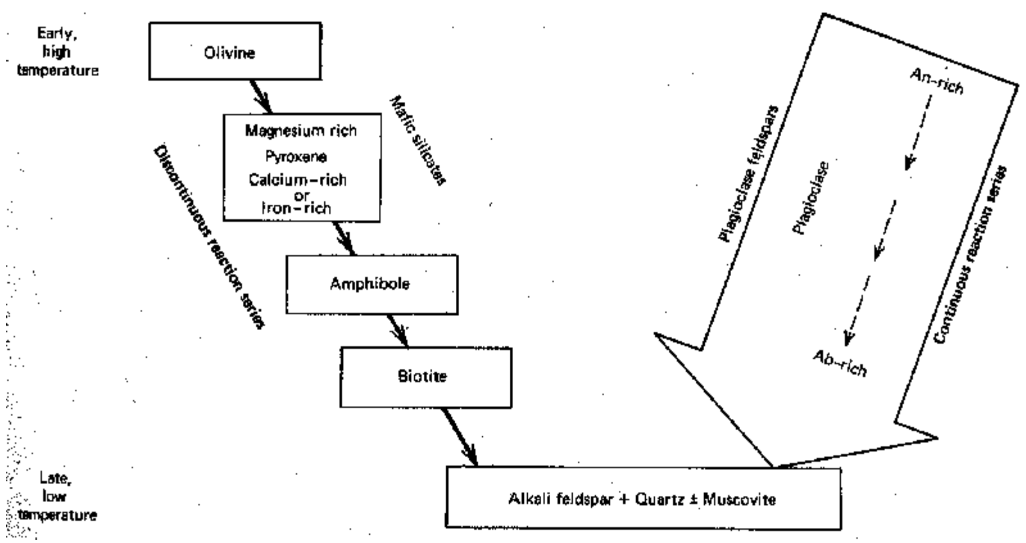
  (Ca feldspar)
  - Result of very early global magma ocean
    - If you melt lunar mantle completely, and let lighter material float to top, that top material will be ANORTHOSITE
  - Surface layers are "impact breccias"
- Mare: BASALT
  - Result of partial (10%) melt of mantle
    - First melting component has composition of basalt
  - Highly vesicular because because of "low" atmospheric pressure, even with (possible) low volatile abundances



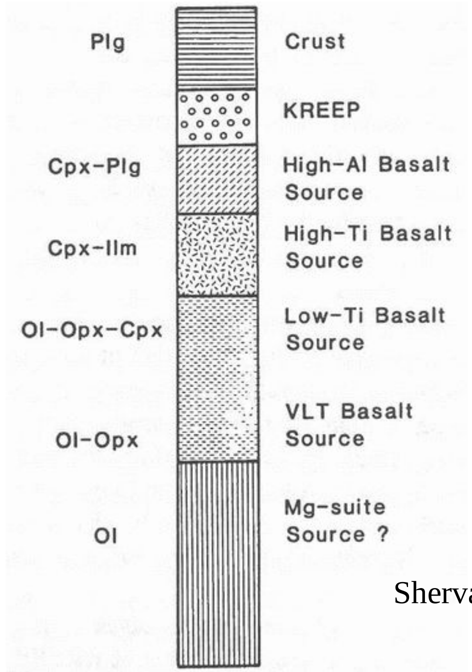


From "The New Solar System" by Beatty et al.

Origin of the Anorthosite? Bowen reaction series

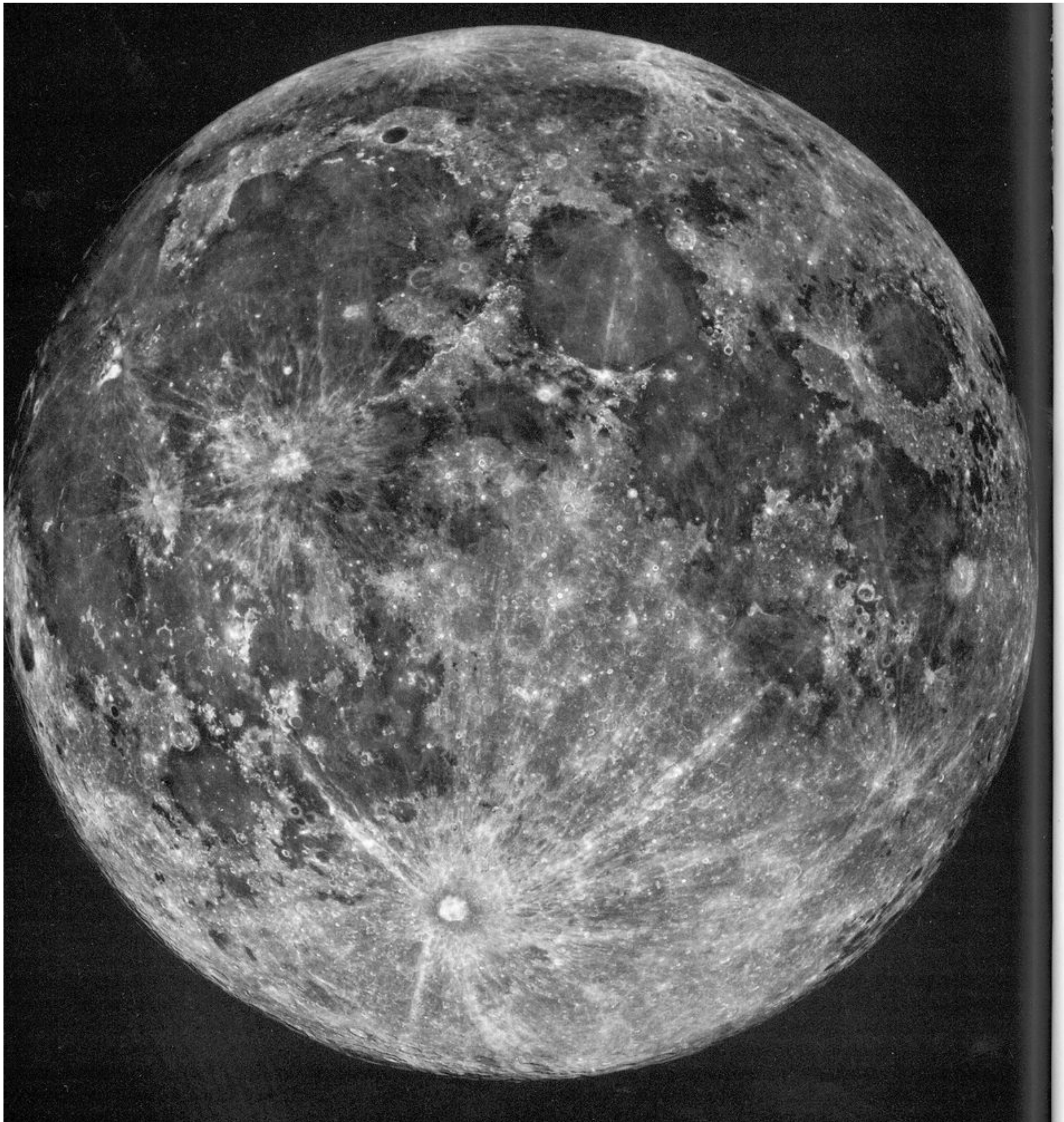


Bowen reaction series from Dietrich and Skinner1979



Shervais & Taylor

- Anorthite and olivine are first minerals to crystallize
- Anorthosite is lower density than the melt and will float (especially for dry lunar melts)
- Olivine and pyroxene are denser and will sink



Different composition basalts

- Fe and Ti content vary and control albedo
- May represent changing thermal state of interior, and shifting source regions

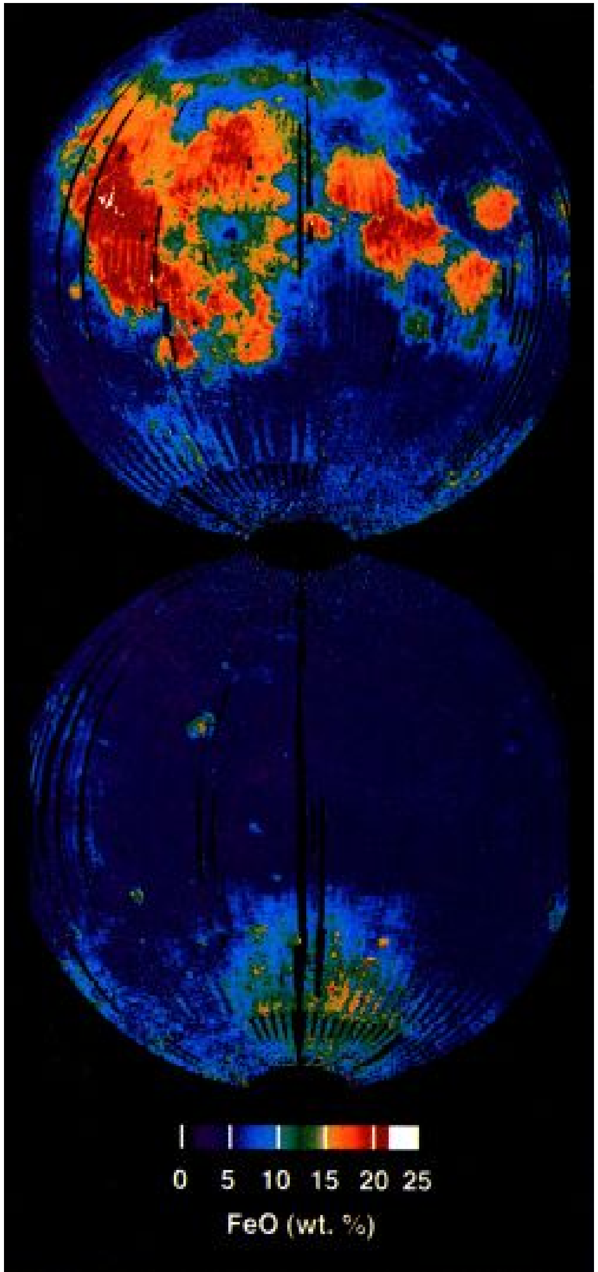
Simple Albedo/Color Effects

Edge of Mare Serenitatis is darker, bluer

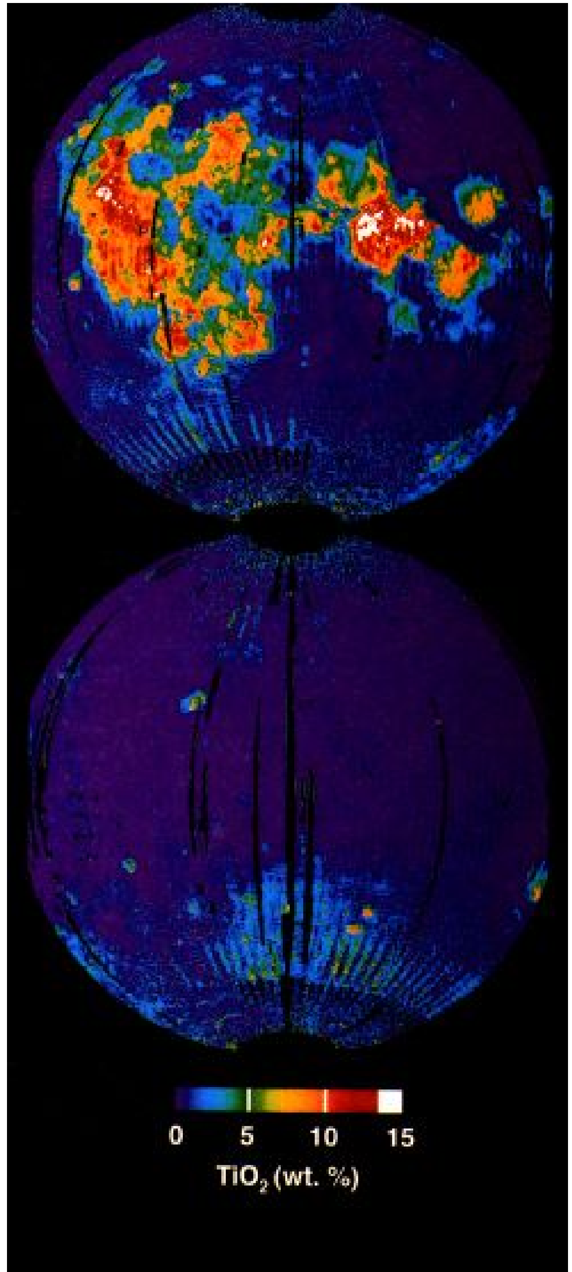
Several flows of different albedo, color in Mare Tranquillitatis

Olympus E-620 Image   2009_10_03   Contrast stretched slightly

Spectral mapping



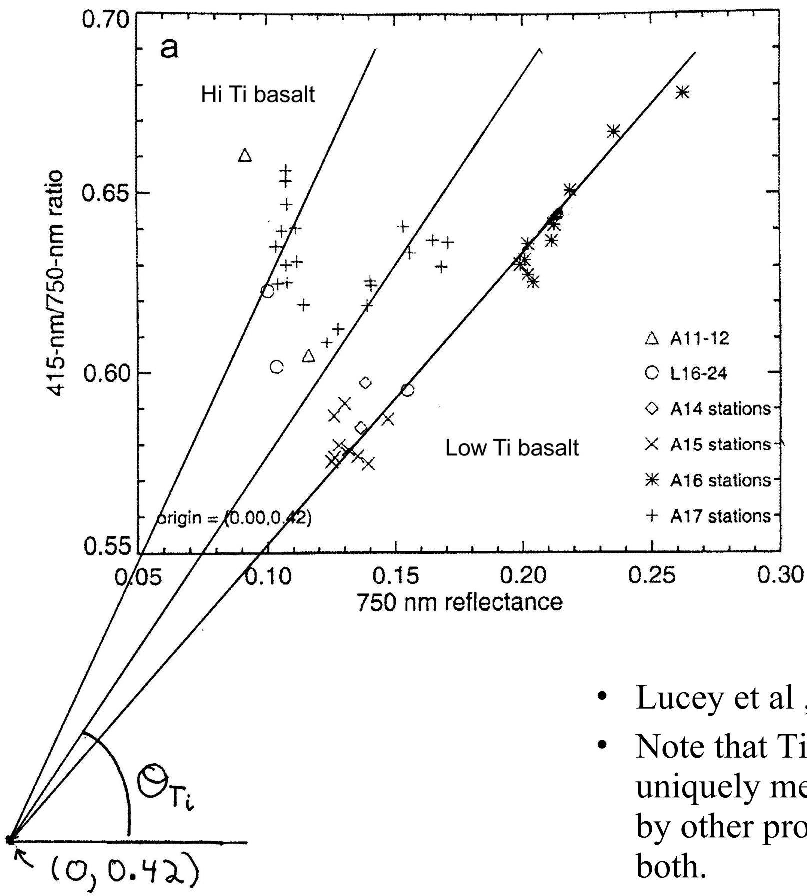
Fe abundance

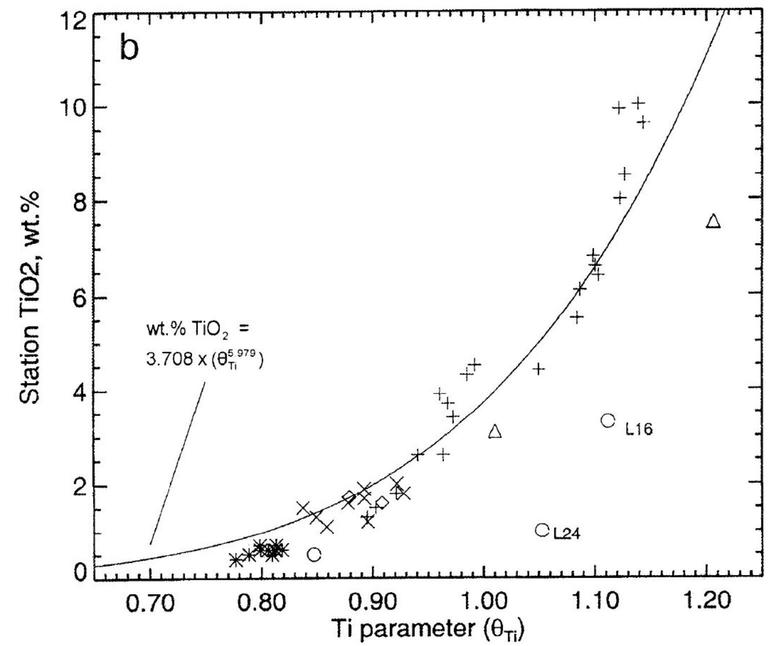


Ti abundance

- Lucey et al , based on Clementine images
- Note high Ti abundance in Tranquillitatis and the rim of Serenitatis

Spectral angle method for Ti

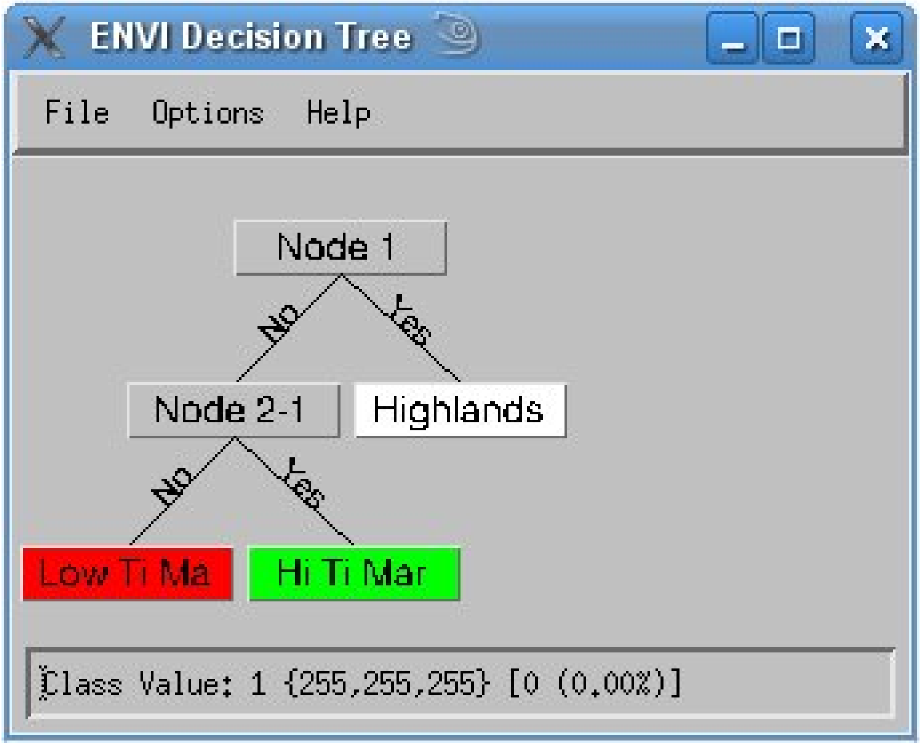




- Lucey et al , technique, for Ti
- Note that Ti rich basalt is both dark and blue, but neither alone is enough to uniquely measure Ti as both observational measurements can be affected by other properties like Fe abundance, grain size. You need to measure both.
- Samples of constant Ti abundance fall along lines in left plot.

- Calibrated using observations at locations with measured Ti abundance from returned lunar samples, using right plot to convert θ to Ti aboundance
- Note Ti not actually in form of TiO_2, but abundances typically given in terms of oxide percent.

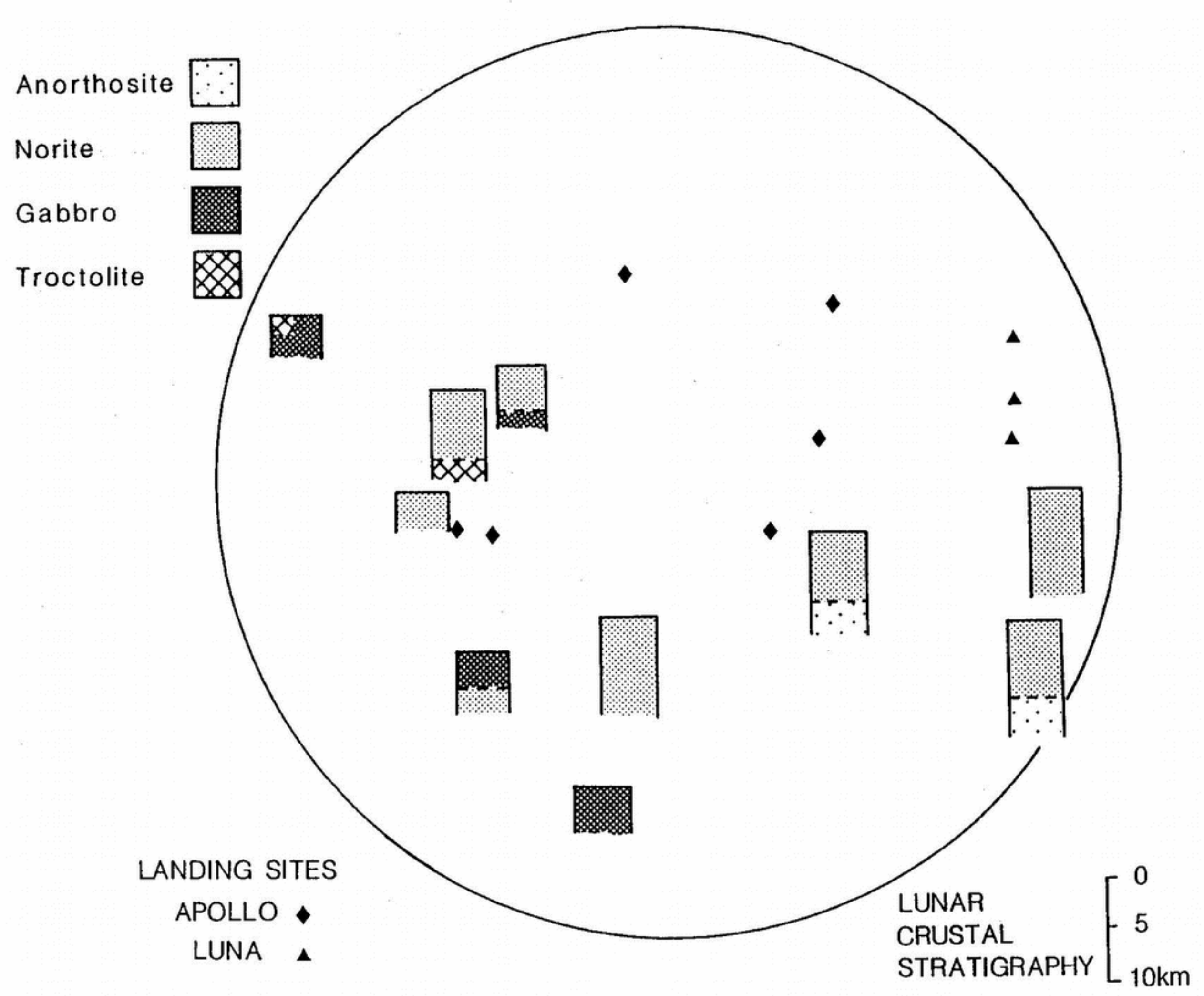
Decision Tree Classification



- Create a decision tree where, based on some observed parameter, you first assign each pixel either to Class A or Class B
  - In this case, use NIR Albedo to assign pixel to either highlands or mare
- Continue to add branches to the tree making further decisions based on other observed parameters
  - Here, decide whether a mare pixel is high Ti or low Ti basalt based on a threshold Ti abundance
- Continue adding branches (decision "Nodes") till you have each pixel fully classified

Determining vertical structure

- Remote vertical stratigraphy by comparing composition of crater walls (shallow material) vs. central peaks (deep material)

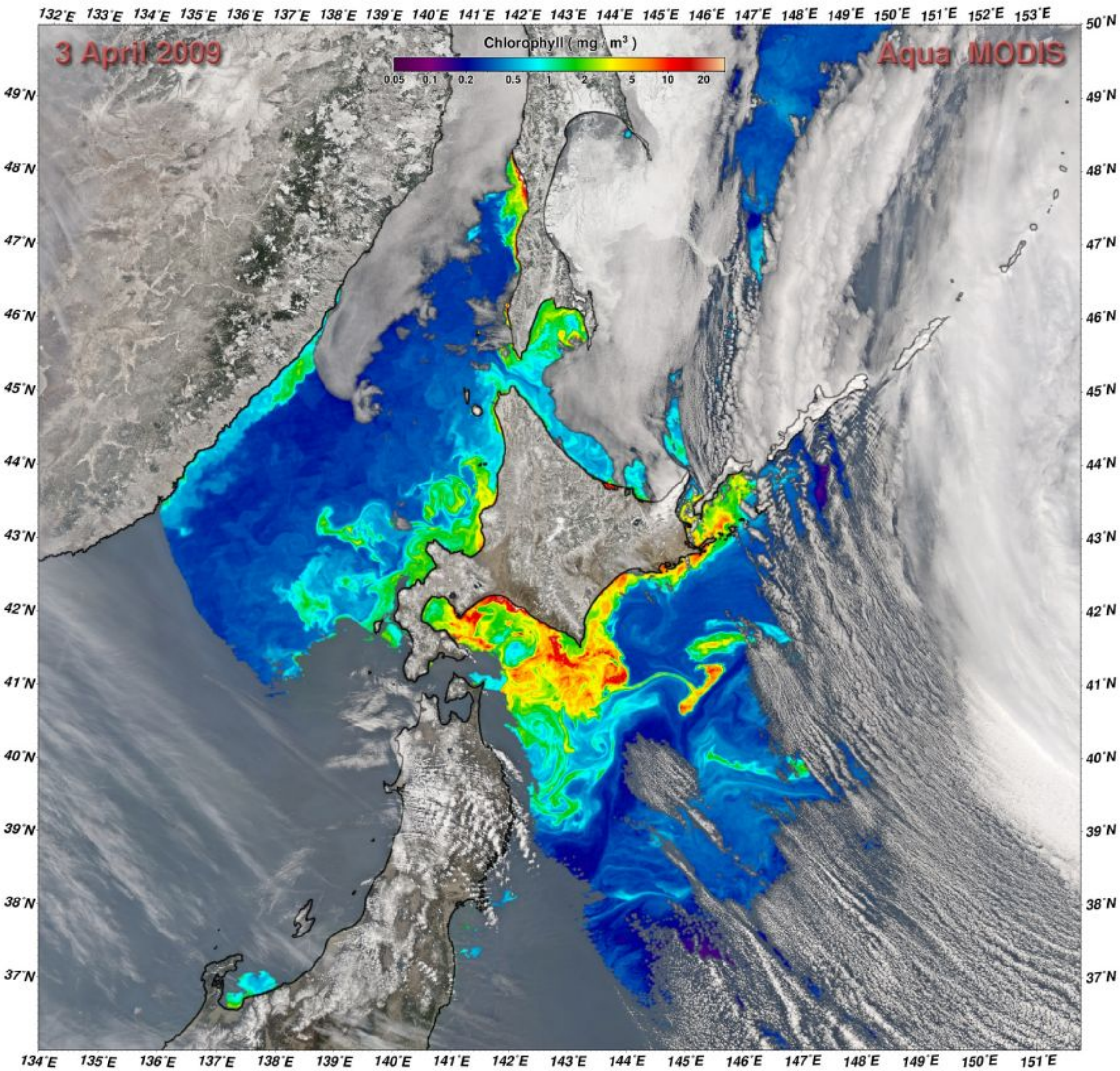


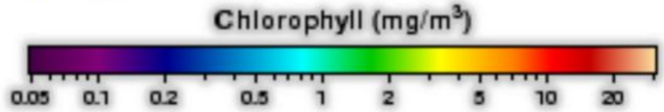
Pieters 1993

Ocean Remote Sensing

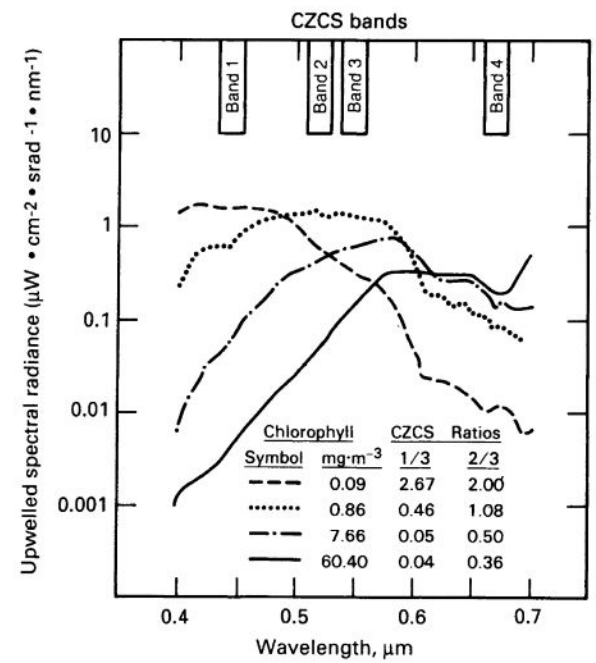
- Chlorophyll abundance
- Oil slicks
- Side-Scan Sonar
  - WHOI Side-Scan Sonar Search for Air France 447 debris
- Ocean Bottom Topography (bathymetry)
    - WHOI Side-Scan Sonar Search for Air France 447 debris

Modis: Channels for cholorphyll detection

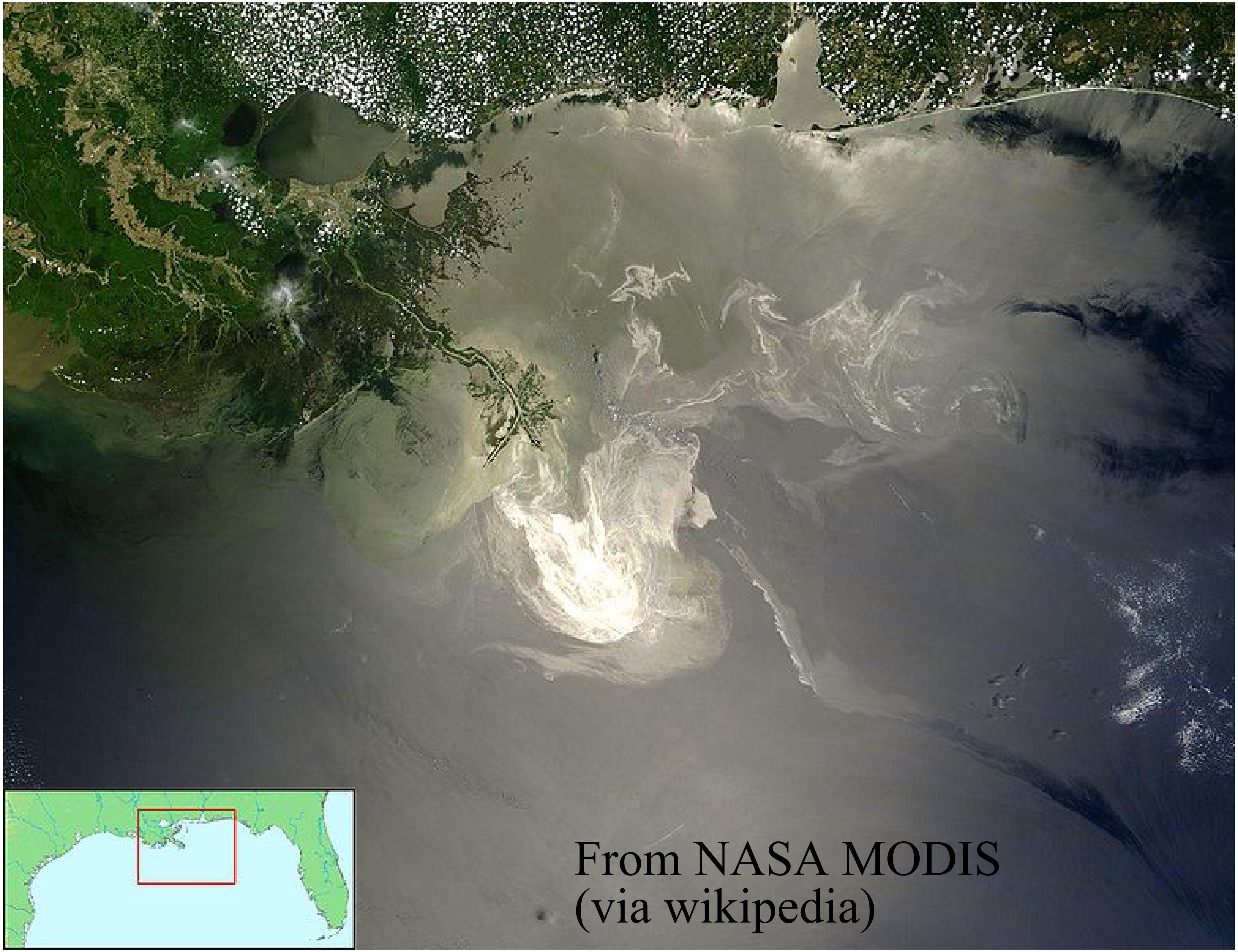




- Follow-on to work described on Sabins pg. 301 Fig 9-4) with earlier CZCS (Costal Zone Sensor)

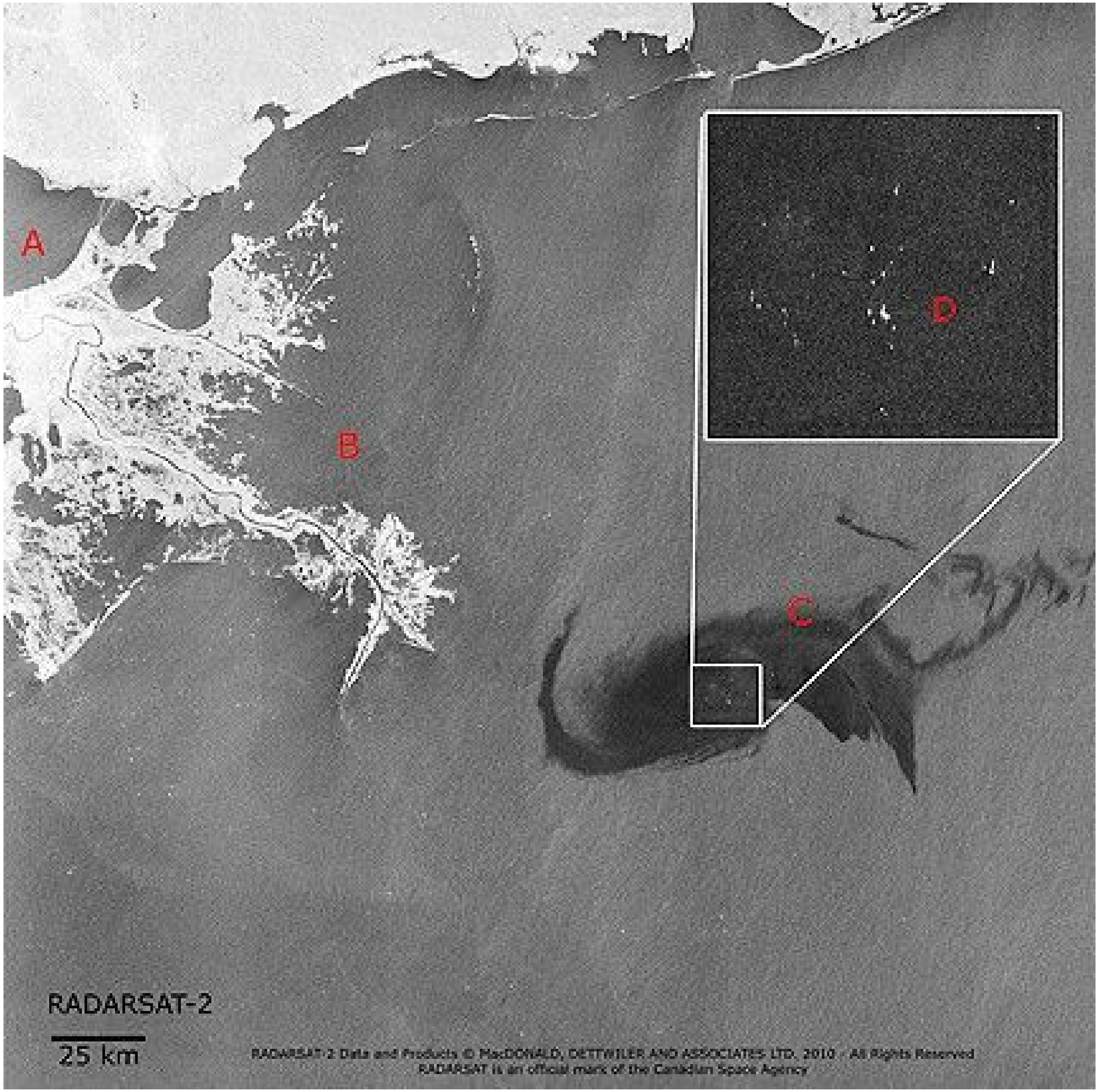


Oil Slicks: Deepwater Horizon Spill 2010



From NASA MODIS
(via wikipedia)

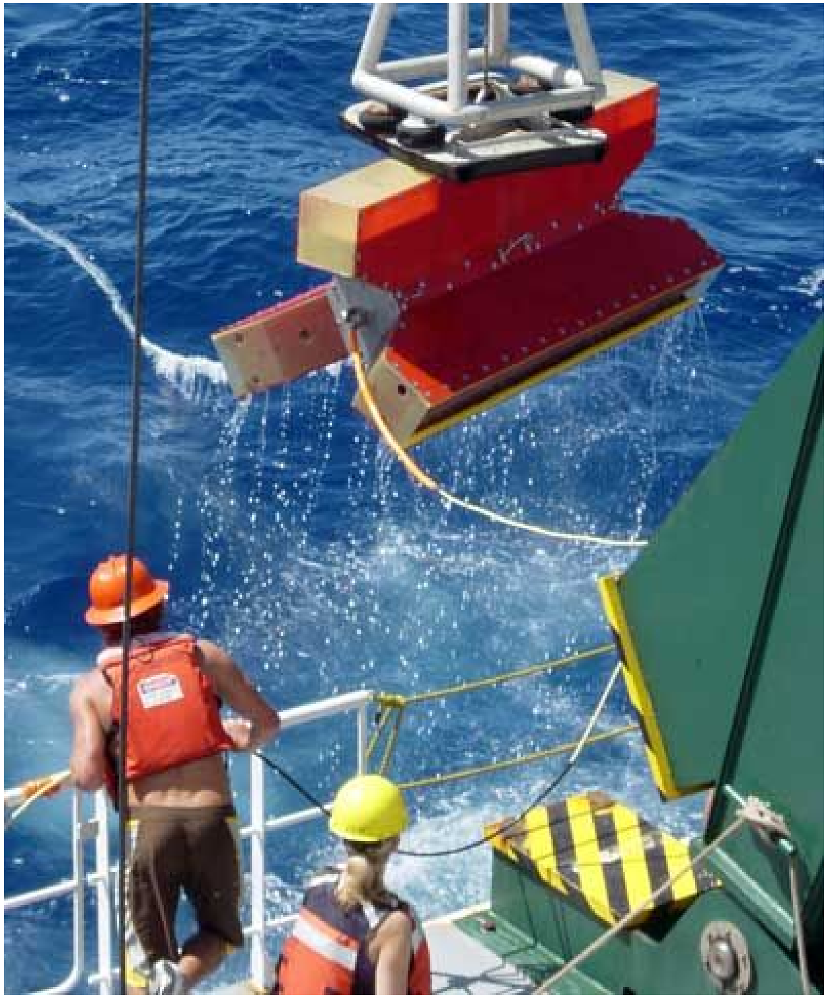
Oil Slicks: Deepwater Horizon Spill 2010



Ocean Floor Topography

- Bathymetry -- traditional work limited to ship tracks
- Indirect observations available from ocean surface height
  - Provide global (but low resolution) picture of sea floor
- Side-Scan Sonar – Analogous to synthetic aperture radar but using sound waves rather than EM ones

Side-Scan Sonar



- Sound rather than EM Radiation
- In other ways, very similar to synthetic aperture radar

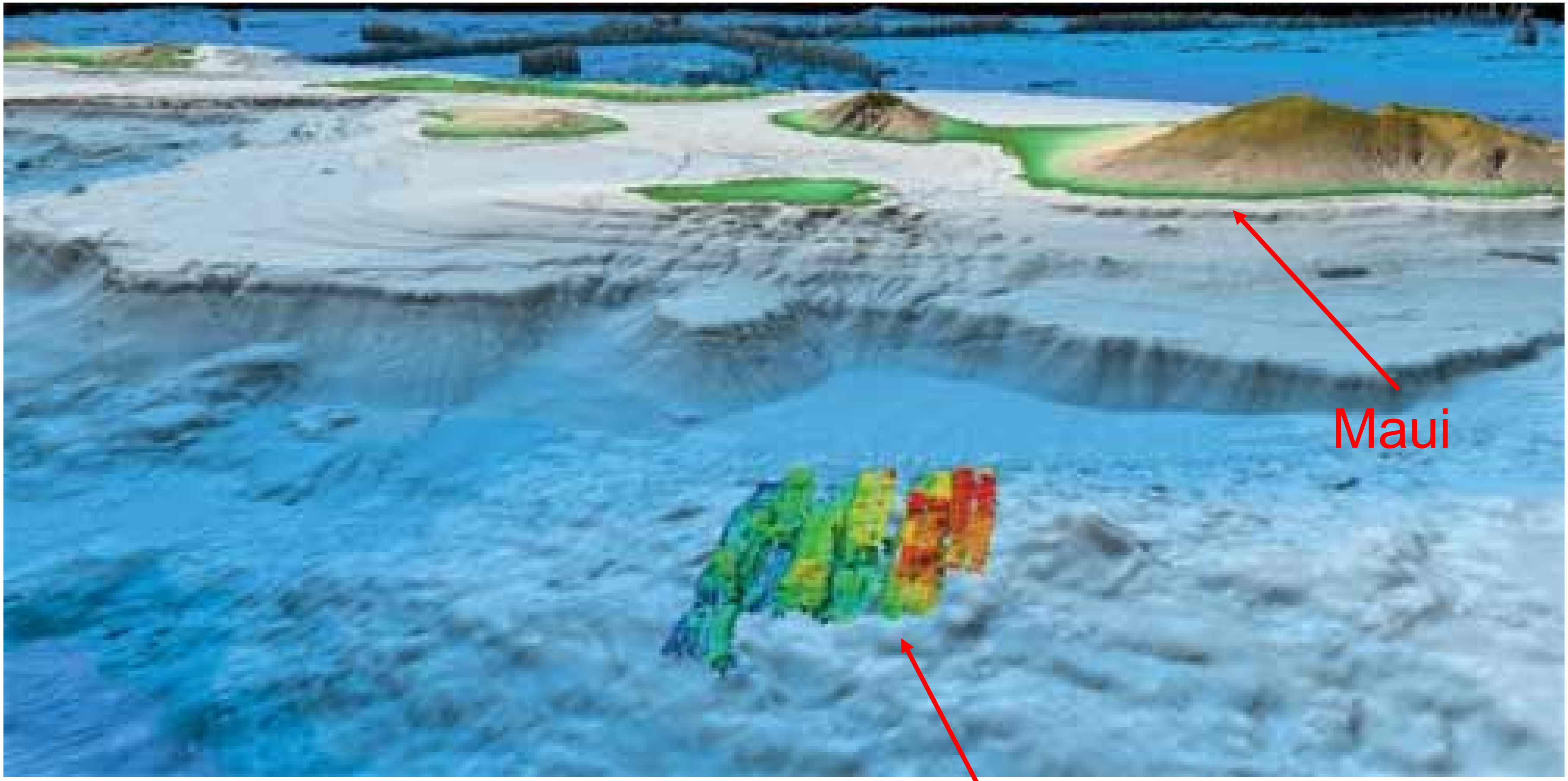
- Examples of Geological Results Friday

- Also will briefly cover Ocean Productivity Section

- http://www.soest.hawaii.edu/HMRG/MR1/

- University of Hawaii System

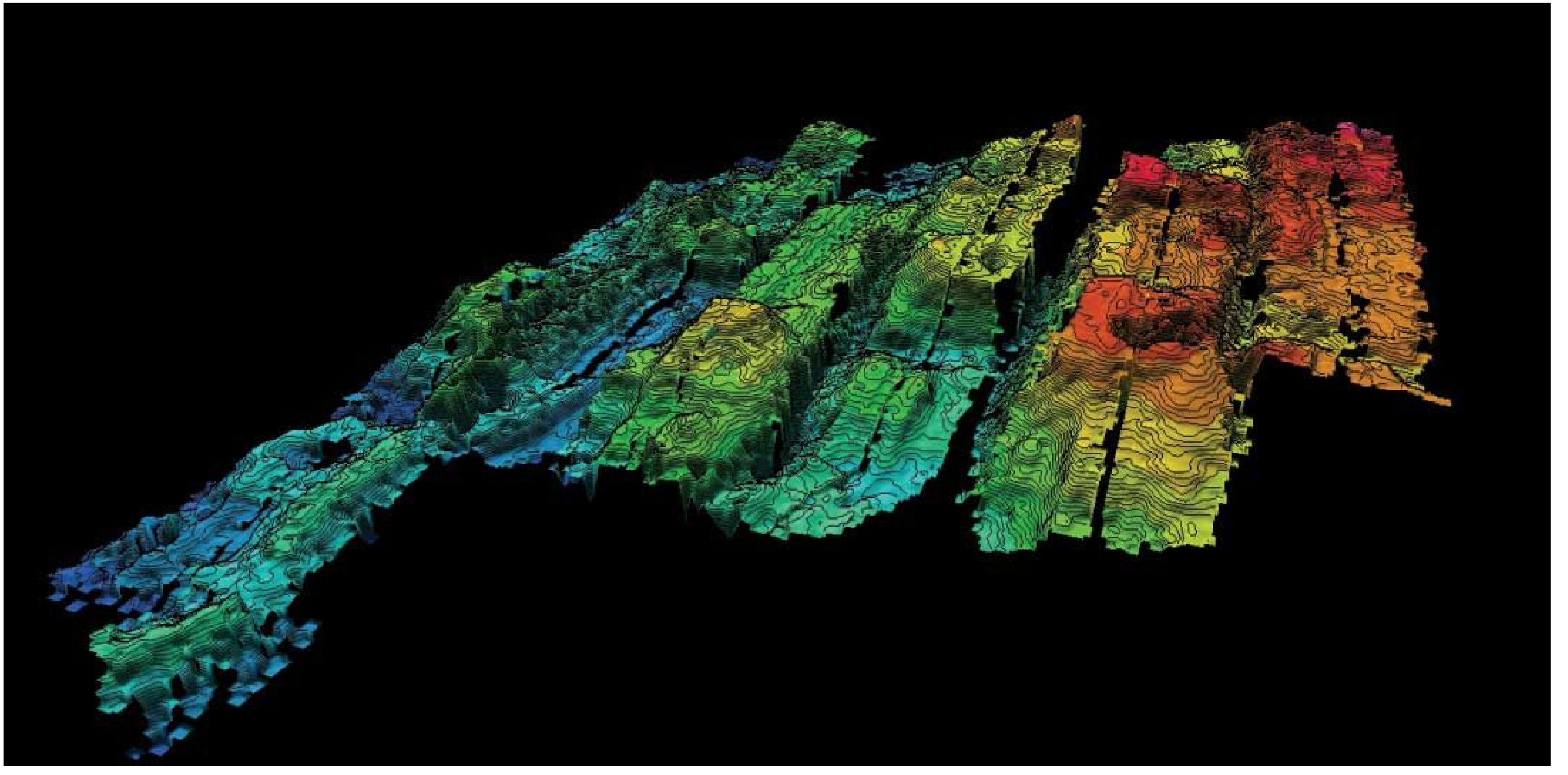
Side-Scan Sonar



- Overall topography of Hawaiian Islands

Detail in next slide

Side-Scan Sonar



- Data acquired in strips, as side scan sonar towed behind ship

Side-Scan Sonar and Air France 447 Search: Remus 6000

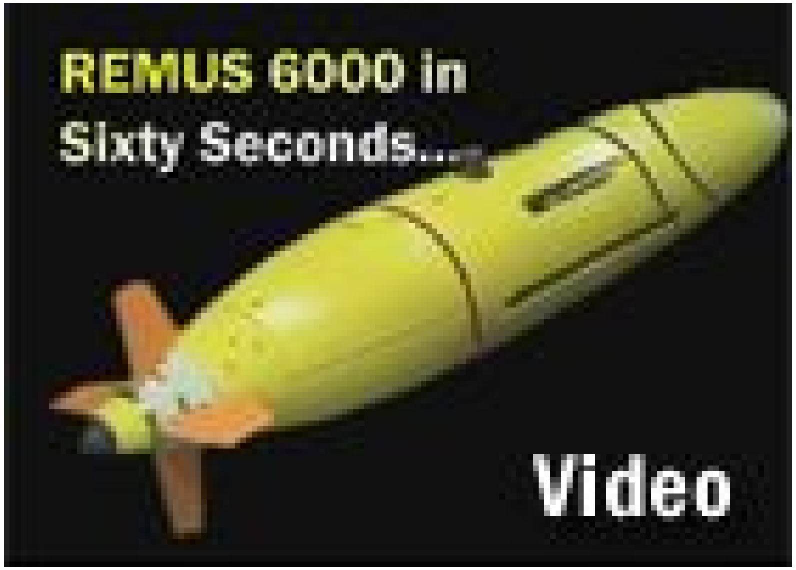
•Results from last spring:
Woods Hole Oceanographic Institution REMUS 6000 ROV's

•Side-Scan Sonar search system

•Can operate to 6000 m (~20,000 ft)   Crash side depth is 10,000 ft

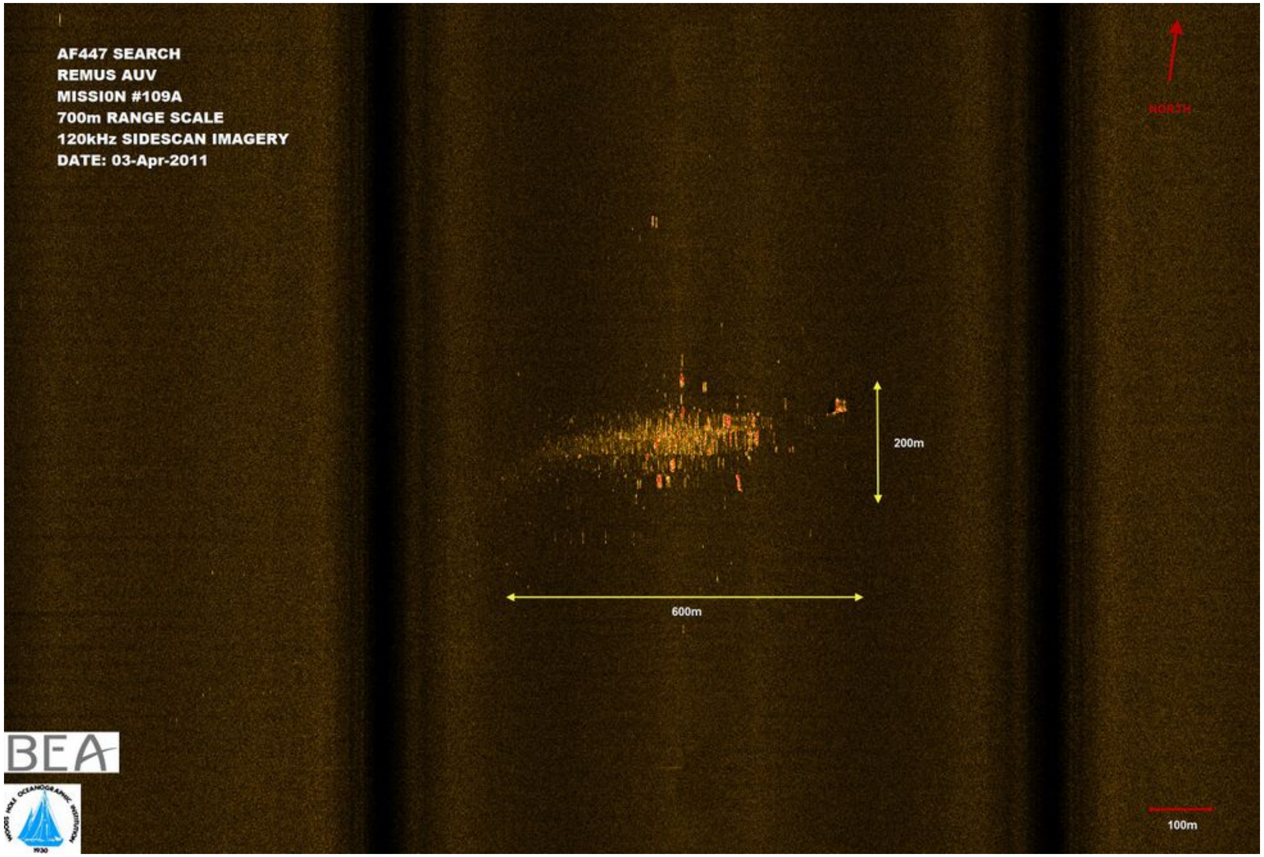
•5 knot speed

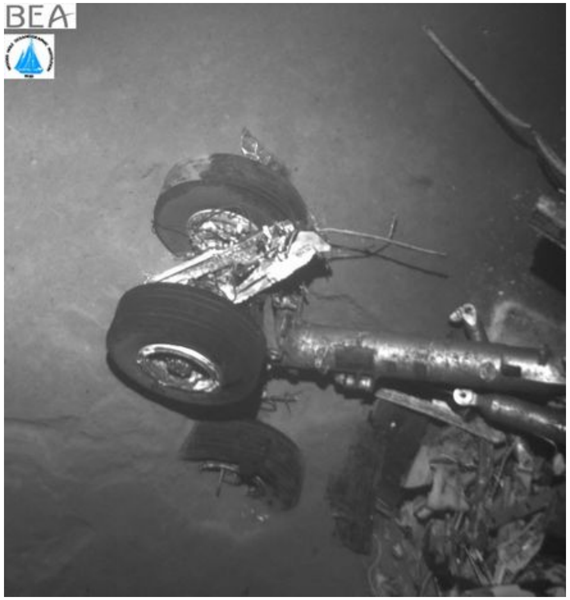
•22 hour mission duration (Li-ion batteries)



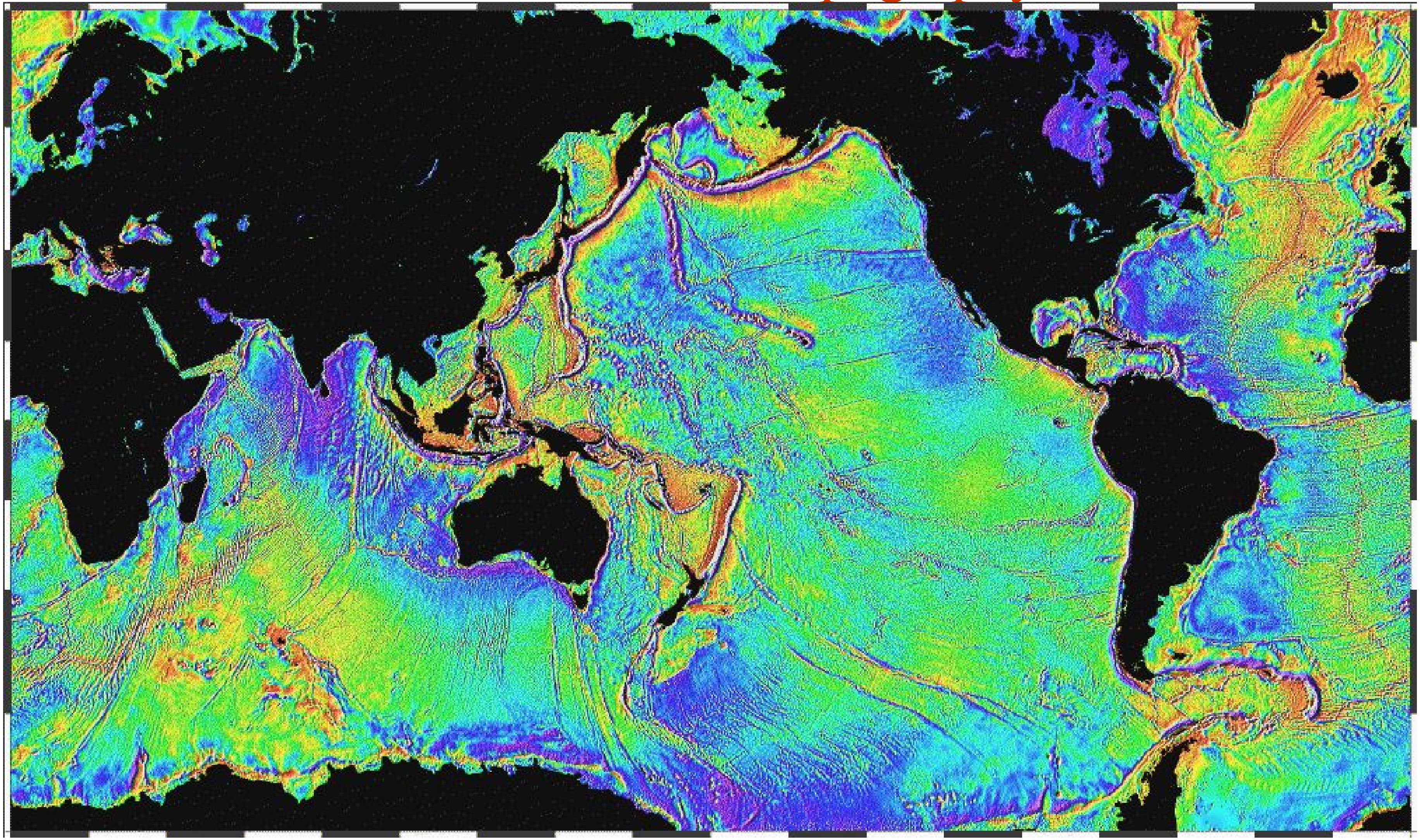
Air France 447 Search: Sonar and Photos

- Debris field formed as material settles to depth (Arrows are 600 m x 200 m)



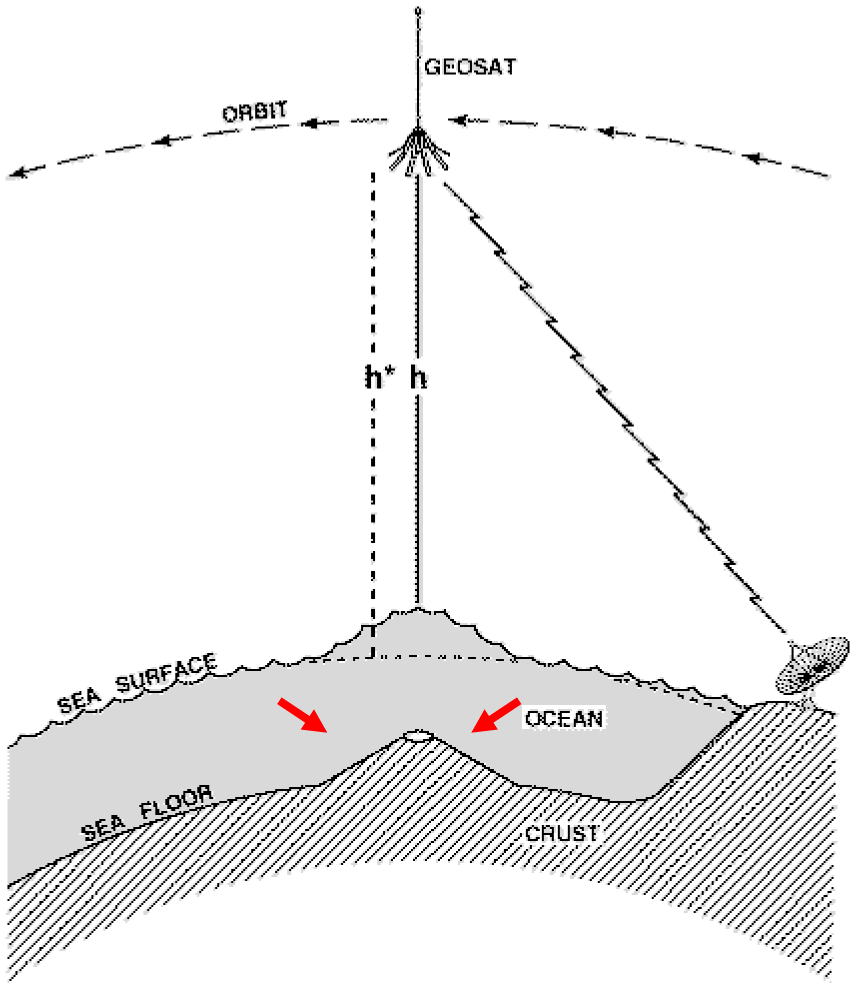


Ocean Floor Topography



- Data from European ERS-1 altimeter and Navy Geosat

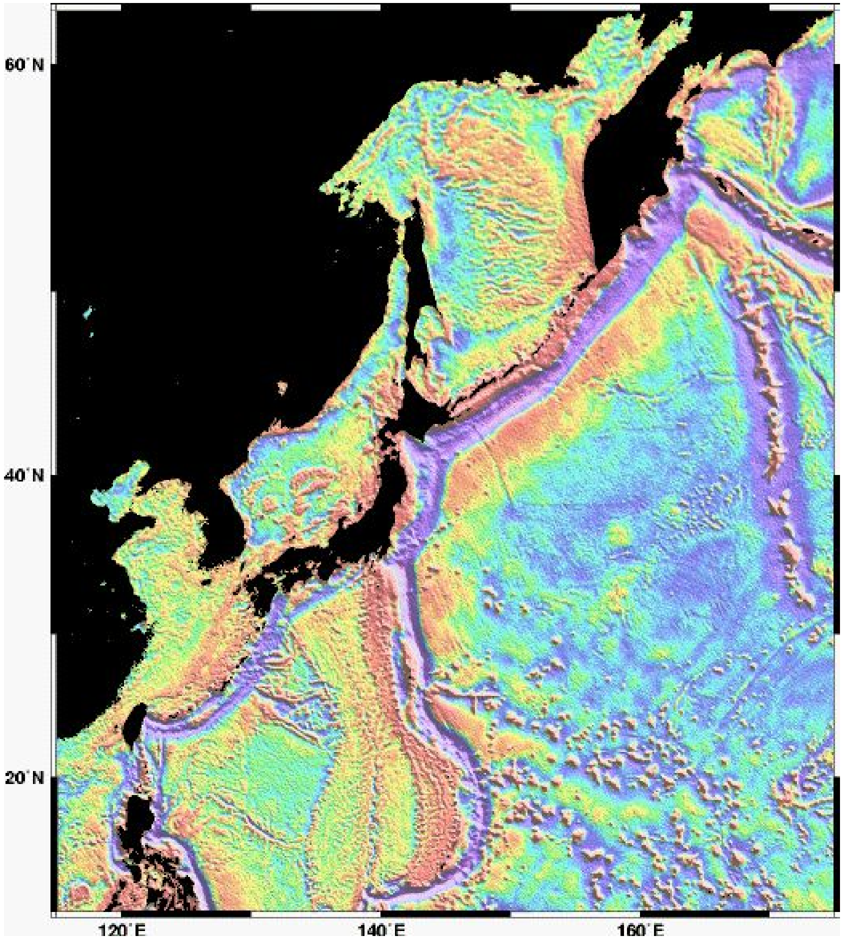
Ocean Floor Topography

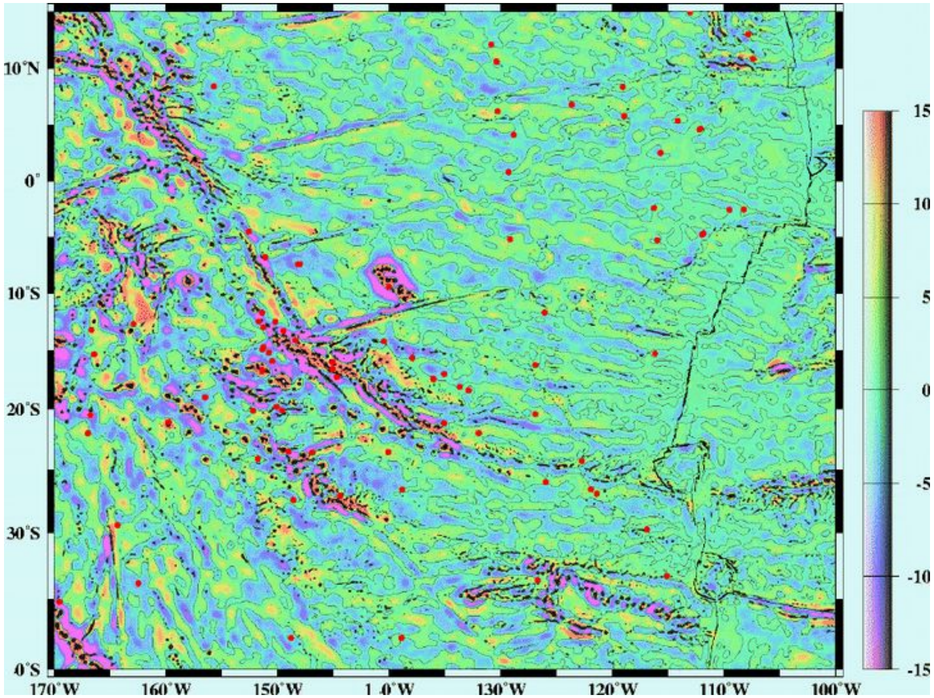


- Data from European ERS-1 altimeter and Navy Geosat
- Measure height of satellite above ocean using 13 GHz radar
- Accurate to 3 cm
- Track orbit of satellite with GPS and laser systems

Extra gravity from mountain pulls water in from the sides, raising sea level slightly

Ocean Floor Topography

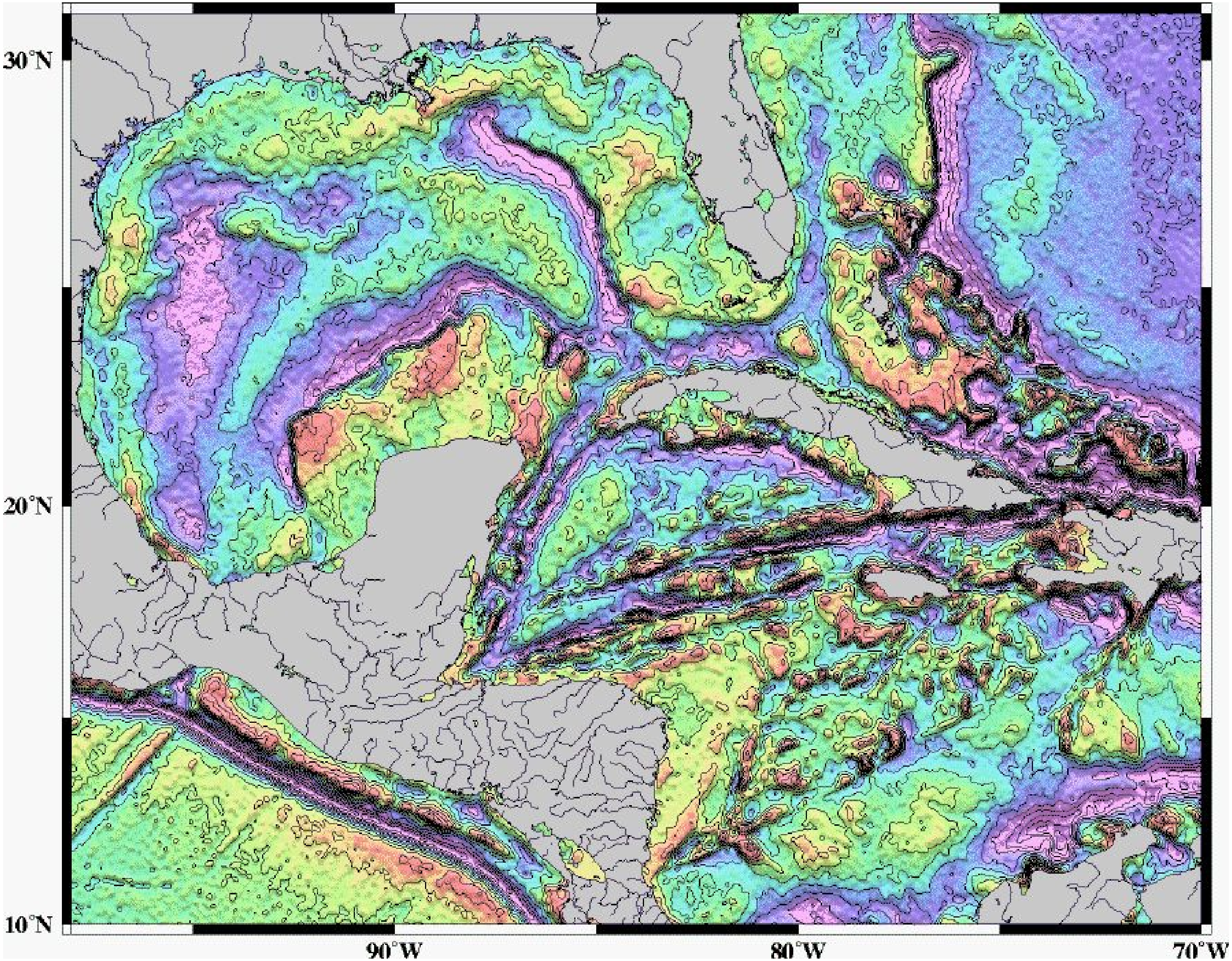




- West pacific subduction zones

Chains of volcanoes

Ocean Floor Topography – Gulf of Mexico



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