



Today: maps! navigation! history!

- ♦ **Maps:** Map projections, types, meanings, etc.
- ♦ **Navigation:** Piloting, dead reckoning, sailing by the stars, finding latitude/longitude, modern navigation
- ♦ **History:** Brief history of ocean exploration and study



Navigation by Piloting & Dead Reckoning

- ♦ **Piloting**, earliest method of navigation, judging location by landmarks
within sight of coastline – Egyptians, 4000 B.C.
- ♦ Later mariners also used direction and speed of travel to determine approximate position: **Dead Reckoning**
had to rely on visibility, instincts, luck



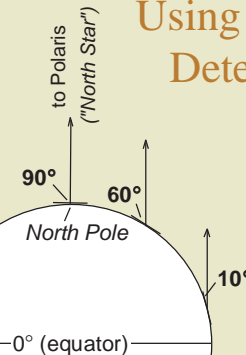
Celestial Navigation

- ♦ In 325 B.C., Pytheas (Greek astronomer-geographer), worked out simple method for determining latitude:

determine the angle between the horizon and the North Star (Polaris)



Using the North Star to Determine Latitude

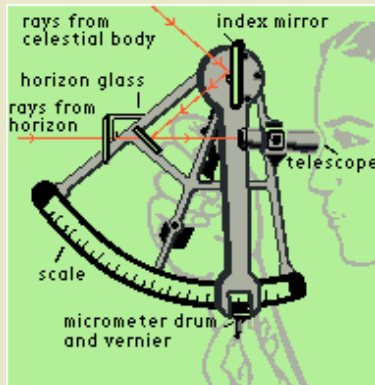


Here in Noho
the angle is
42°19'

altitude of Polaris
relative to the horizon = latitude

note: can only determine North-South position

Sextant – for measuring angles



The Longitude Problem

- ♦ Prior to the late 18th century, explorers had problem locating East-West position (longitude)
- ♦ Solution: invention of the **chronometer**
John Harrison (read Dava Sobel's Longitude)
- ♦ Need to **measure time accurately at sea**

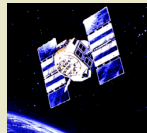
Earth rotates from West to East (counter-clockwise when looking down on N. Pole)
 $360^\circ/24 \text{ hours} = 15^\circ/\text{hour}$
record time at noon (Sun at highest point)
compare ship time with Greenwich time (how many hours ahead or behind Greenwich time?)

Navigation Today

Method	Accuracy
1. Celestial navigation <i>position of sun, moon, stars</i>	2-10 km
2. Radio navigation systems <i>land-based signals: Omega, Loran C</i>	0.3-1.0 km
3. Satellite navigation <i>GPS - Global Positioning System</i>	0.1-200m



GPS receiver & satellite



History of Oceanography *ancient explorers*

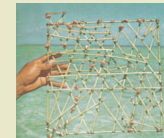
Polynesians



2000 B.C. – 500 B.C.
settled Pacific islands
covering an ocean
area the size of a
continent.



Used crude but
amazing navigation
tools, simple canoes.
No written language!




History of Oceanography

ancient explorers

Phoenicians
1000 B.C. - 600 B.C.

Explored the Mediterranean Sea

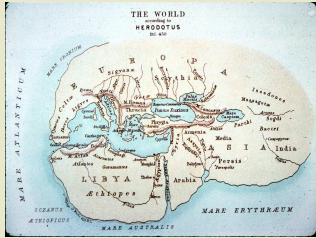


Ancient anchor, Sicily

Navigated by piloting and celestial bodies

Greeks and Romans
450 B.C. – 150 A.D.

Herodotus – mapped the Mediterranean



Pytheas – sailed to England, Norway, maybe Iceland

History of Oceanography

Viking discoveries

Erik the Red
982 A.D.

Discovered Greenland, Baffin Island in Canada



Major routes of longship expeditions

Leif Erikson
995 A.D.

Established settlement of Vinland, now part of Newfoundland




History of Oceanography

Viking discoveries



History of Oceanography

The “Age of Discovery”

Christopher Columbus
1492 A.D.

Italian but sailed for Spain

Discovered the West Indies, founded Santo Domingo

Went to his grave thinking he had sailed to Asia



Columbus statue, Santo Domingo, DR

Vasco Nunez de Balboa
1513 A.D.

Spanish and sailed for Spain

“Discovered” the Pacific Ocean (though Polynesians had been there for thousands of years)

Crossed the isthmus of Panama



Balboa statue - Panama City, Panama

History of Oceanography

The "Age of Discovery"

Ferdinand Magellan

1519-1522 A.D.



First circumnavigation of the globe

Started out with 5 ships, about 250 officers and crew

Returned with 1 ship, grand total of 18 crewmen, Magellan not among them

Sebastian del Cano completed voyage

History of Oceanography

early scientific expeditions

Captain James Cook

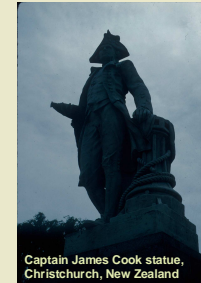
1768, 1772, 1778 A.D.

Sailed for England, 3 voyages to the Pacific Ocean

Took a natural scientist on board; laid groundwork for future scientific expeditions

Discovered Australia, New Zealand, Hawaii

Killed in Hawaii while attempting to recover a large boat



Captain James Cook statue, Christchurch, New Zealand

History of Oceanography

early scientific expeditions

Charles Darwin

1831-1836 on HMS Beagle



Original mission was to chart coast of South America

Conducted groundbreaking research on the biology of the Galapagos Islands

Led to the theory of evolution and natural selection

Published *On the Origin of Species* in 1859

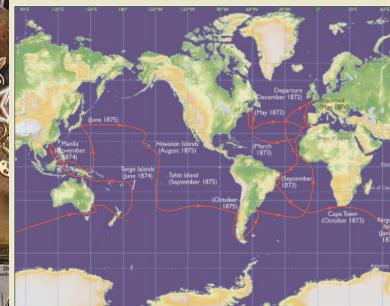
History of Oceanography

beginnings of modern oceanography

C. Wyville Thomson

1868, 1869 on HMS Porcupine and HMS Lightning

1872-1876 on HMS Challenger



First major cruises specific to scientific ocean research, commissioned through British Navy

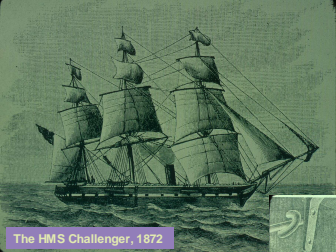
Disproved Forbes's hypothesis that ocean is lifeless (azoic) below 550 m depth

Also found deepest water colder than 4°C

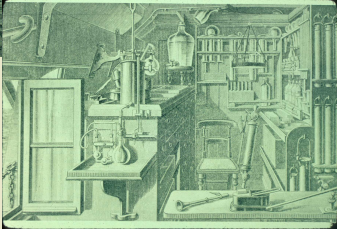
Challenger expedition a resounding success

History of Oceanography

beginnings of modern oceanography




The HMS Challenger, 1872



History of Oceanography

beginnings of modern oceanography

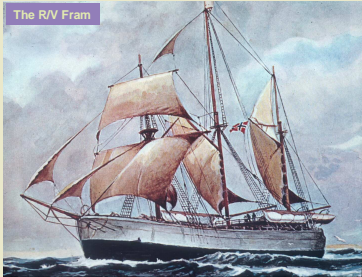
Fridtjof Nansen
1893-1897 on R/V Fram




Designed research vessel (R/V Fram) to withstand pressure of polar sea ice
 Deliberately froze the Fram in Arctic ice in an effort to attain North Pole
 Confirmed circulation patterns in Arctic Ocean and absence of polar continent
 Farthest North latitude achieved was 86°14'

History of Oceanography

beginnings of modern oceanography



The R/V Fram



Fridtjof Nansen

History of Oceanography

beginnings of modern oceanography

