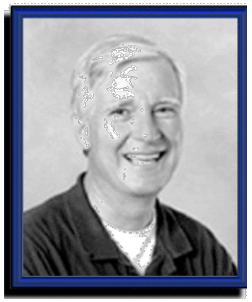
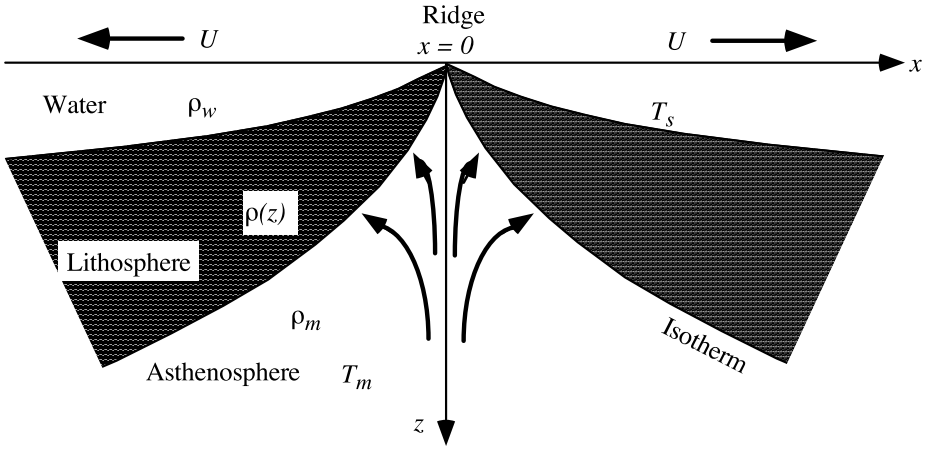
Age-Depth

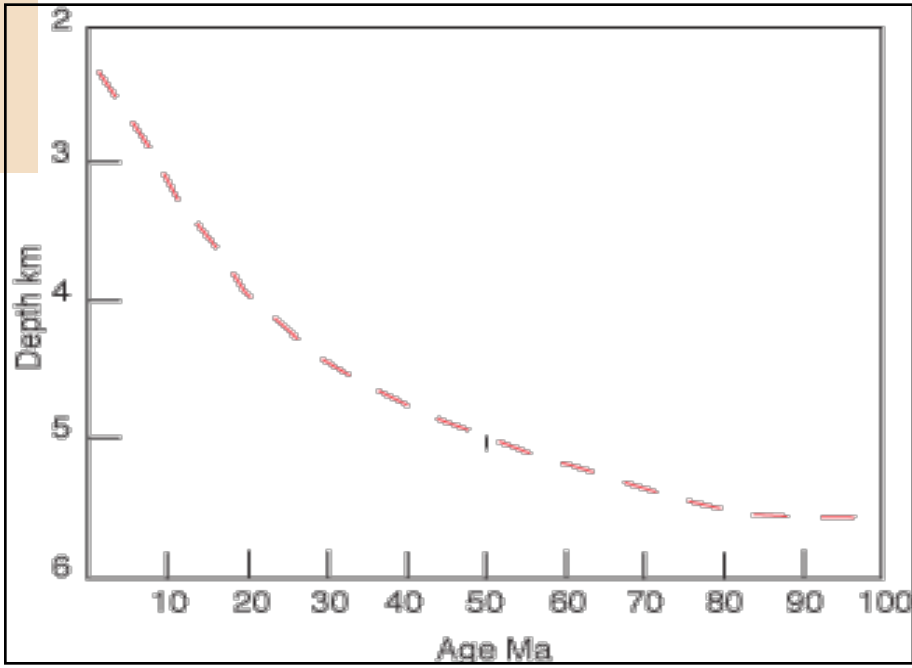
- Near ridge: Young, hot, thin, buoyant.
- Away from ridge: Old, cold, thick, dense
- Thickened by cooling and underplating



"Sclater curve - half-space thermal cooling model" Sclater et al. (1971)

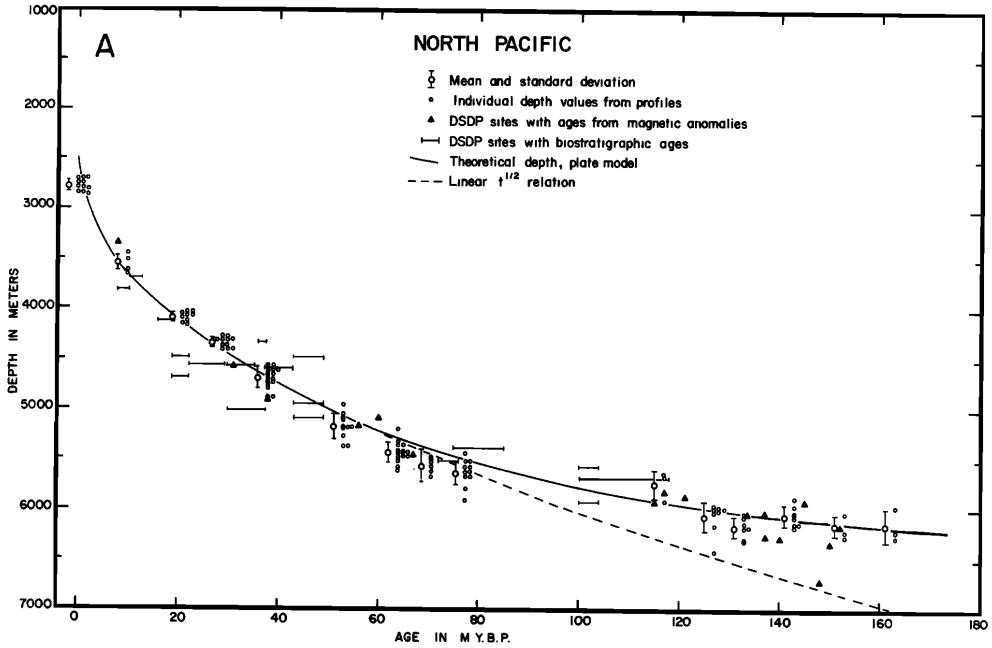
$$d \text{ (meters)} = 2500 + 350\, t^{(1/2)}$$

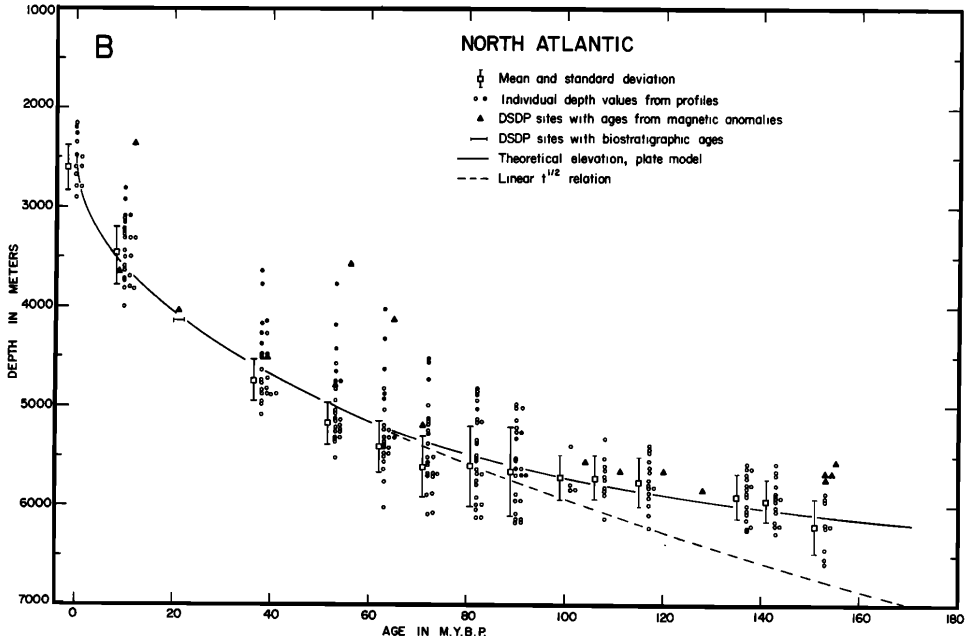




Problems

- In general, the half-space cooling model of Sclater et al. (1971) is a good match with actual depths of the oceanic floor.
- Parsons and Sclater (1977) show that the half-space cooling model doesn't always provide a good match for oceanic crust older than ~80 Ma


A
NORTH PACIFIC
Mean and standard deviation
Individual depth values from profiles
DSDP sites with ages from magnetic anomalies
DSDP sites with biostratigraphic ages
Theoretical depth, plate model
Linear $t^{1/2}$ relation
DEPTH IN METERS
AGE IN M.Y.B.P.


B
NORTH ATLANTIC
Mean and standard deviation
Individual depth values from profiles
DSDP sites with ages from magnetic anomalies
DSDP sites with biostratigraphic ages
Theoretical elevation, plate model
Linear $t^{1/2}$ relation
DEPTH IN METERS
AGE IN M.Y.B.P.

Not only age

- Seafloor depth is not only affected by age.
- Can be affected by
  - oceanic crustal thickness
  - sediment cover (this can be removed fairly easily)
  - Mantle temperature
  - Mantle convection patterns

Since Parsons and Sclater 1977

- There have been lots of other authors who have come up with age-depth relationships
  - Parsons&Sclater(1977) - limited topographic dataset Pacific and N Atlantic
  - Stein & Stein (1992) used global satellite data
  - Smith&Sandwell (1997) used global satellite data with plateaus and seamounts excluded
  - DeLaughter et al. (1999) used low res models to try to exclude dynamic topography effects
  - Crosby et al. (2006) exclude thickened crust and long-wavelength dynamic topography
  - Adam & Vidal (2010) also account for mantle flow - and get no flattening

References

- Sclater, J.G., Anderson, R.N. & Bell, M.L., 1971. Elevation of ridges and evolution of the central eastern Pacific, J. Geophys. Res., 76, 7888–7915.
- Parsons, B. & Sclater, J.G., 1977. An analysis of the variation of ocean floor bathymetry and heat flow with age, J. Geophys. Res., 82, 803– 827.
- Stein, C.A. & Stein, S., 1992. A model for the global variation in oceanic depth and heat flow with age, Nature, 359, 123–129.
- Smith, W.H.F. & Sandwell, D.T., 1997. Global sea floor topography from satellite altimetry and ship depth soundings, Science, 277, 1956–1962.
- DeLaughter, J., Stein, S. & Stein, C.A., 1999. Extraction of a lithospheric cooling signal from oceanwide geoid data, Earth planet. Sci. Lett., 174, 173–181.
- Crosby, A.G., McKenzie, D. & Sclater, J.G., 2006. The relationship between depth, age and gravity in the oceans, Geophys. J. Int., 166, 553–573
- Adam, C. & Vidal V. (2010) Mantle Flow Drives the Subsidence of Oceanic Plates, Science, 328, 83–85

Assignment

- You are going to investigate the age-depth half-space cooling model
- Instructions on handout (due 5 May)