The Thermal Structure of the Oceanic Lithosphere

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Cambridge University

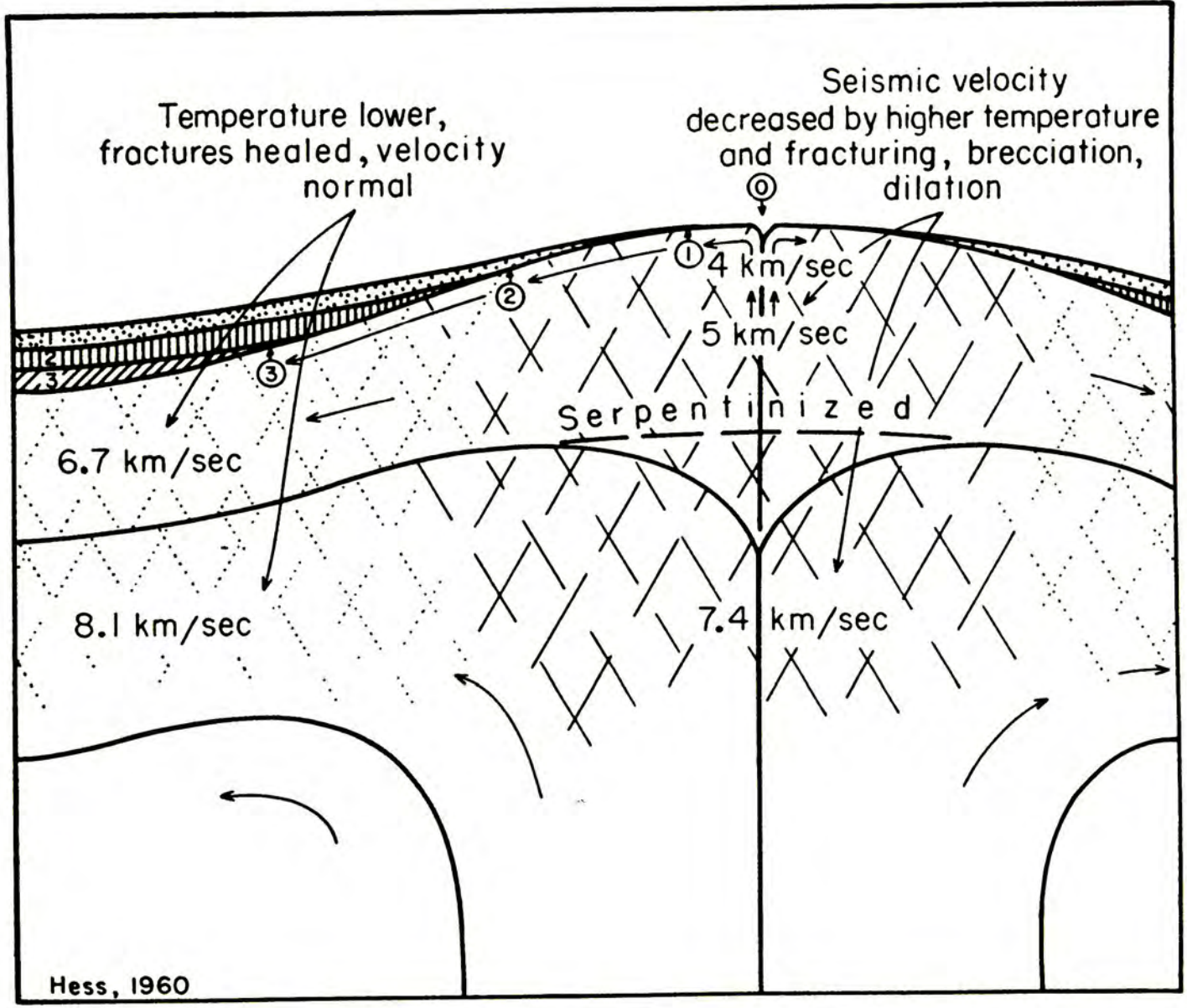
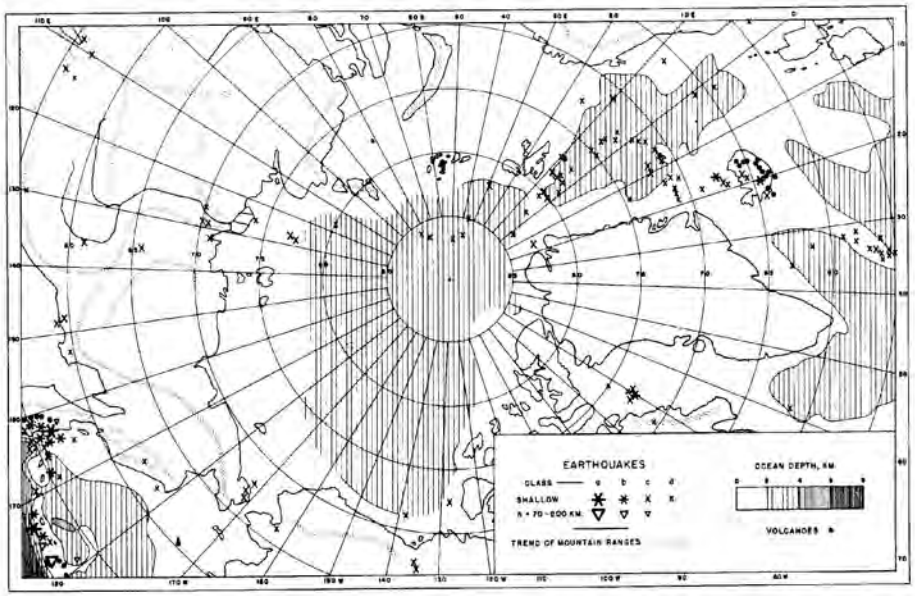


Figure 7. Diagram to represent (1) apparent progressive overlap of ocean sediments on a mid-ocean ridge which would actually be the effect of the mantle moving laterally away from ridge crest, and (2) the postulated fracturing where convective flow changes direction from vertical to horizontal. Fracturing and higher temperature could account for the lower seismic velocities on ridge crests, and cooling and healing of the fractures with time, the return to normal velocities on the flanks.

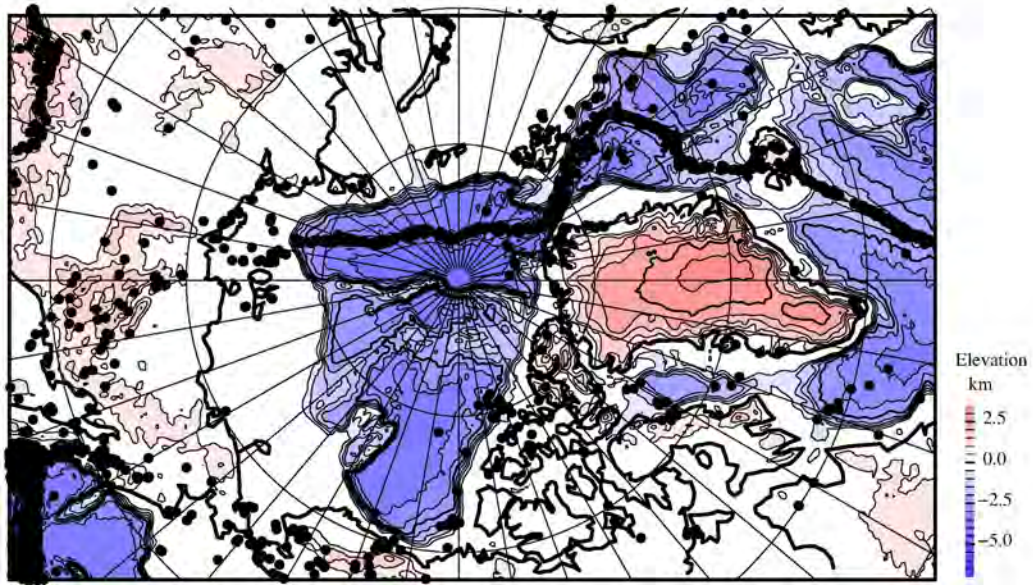
1954

Gutenberg and Richter

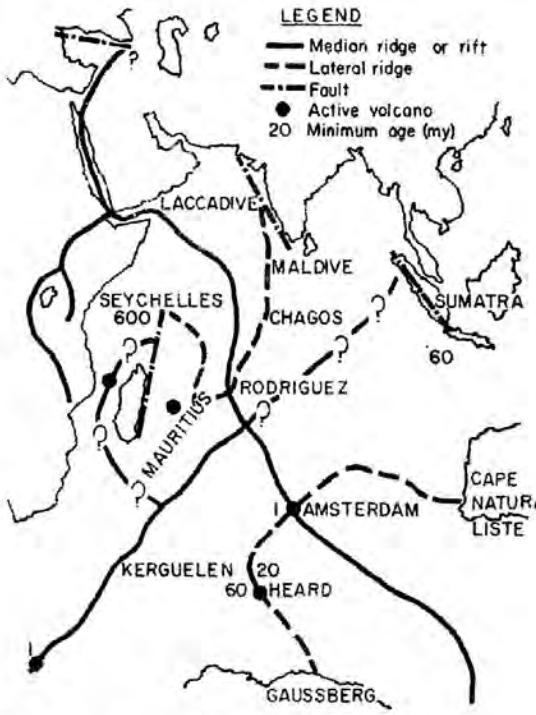


2017

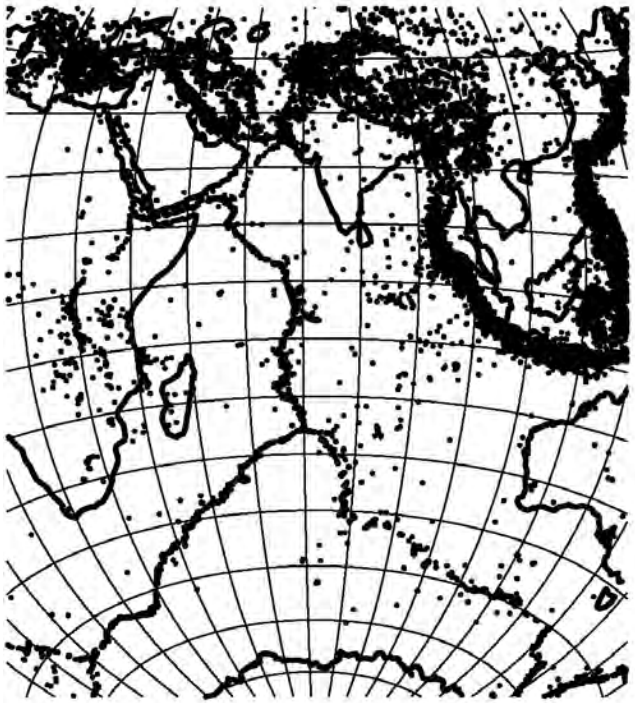
Elevation and earthquakes shallower than 50 km

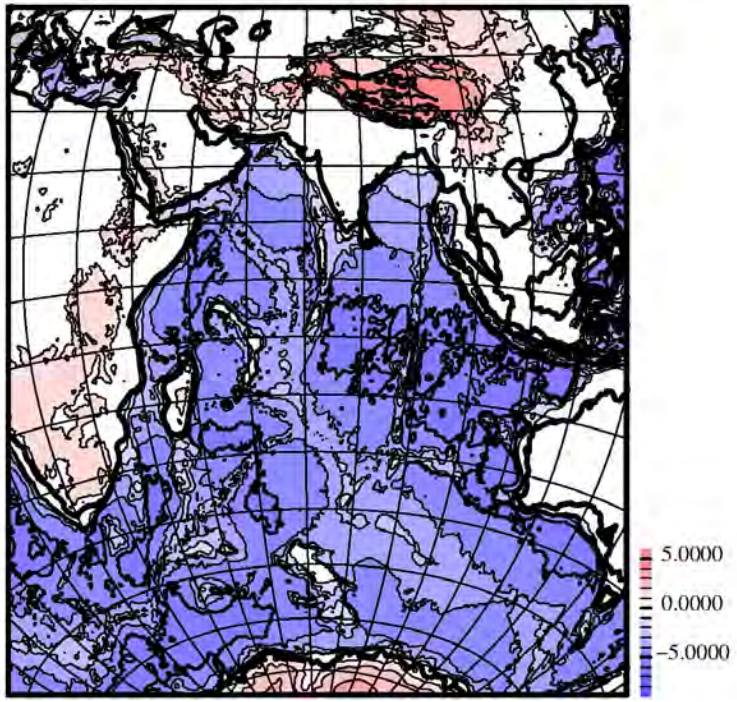


1963 Wilson



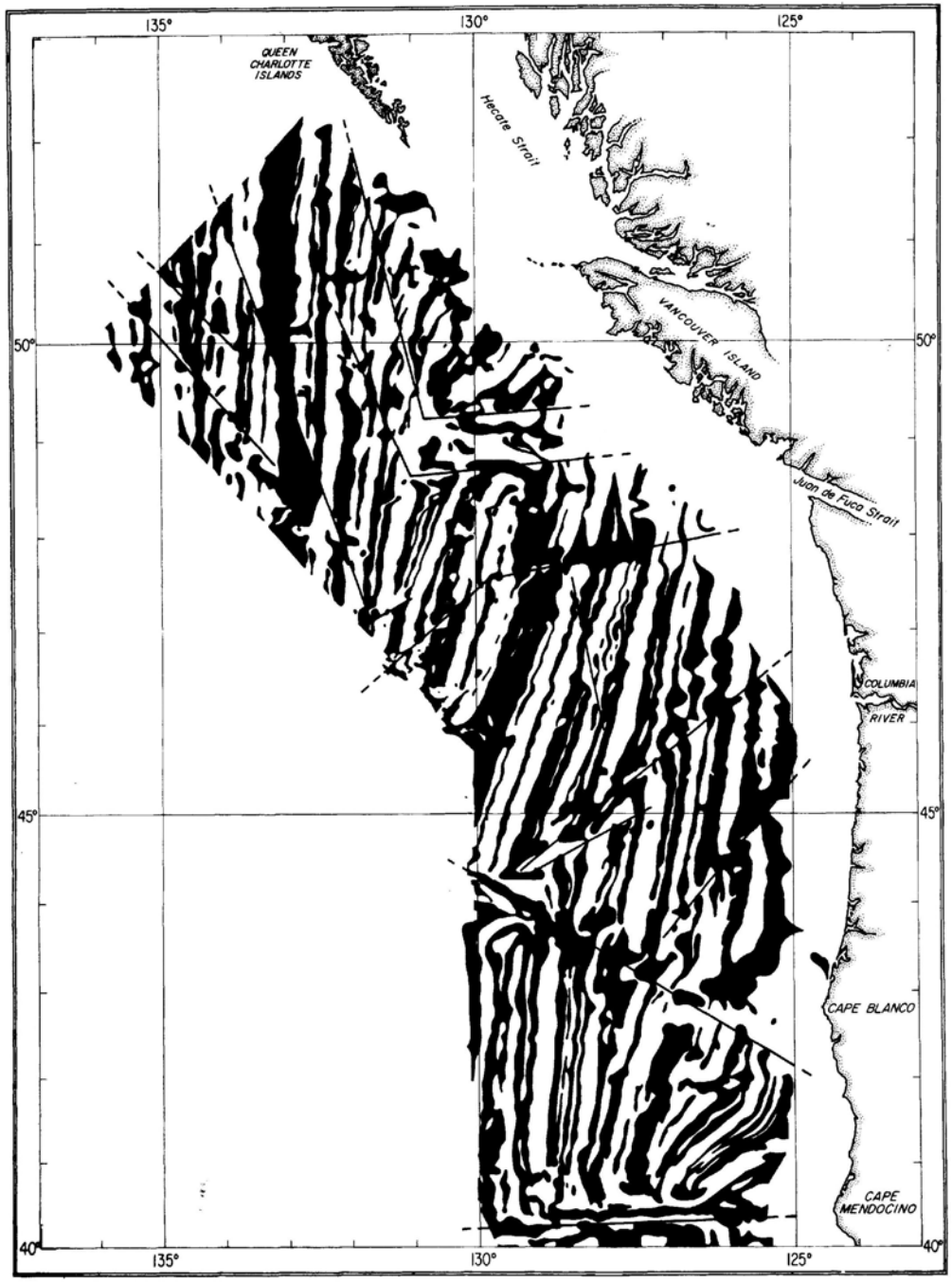
Shallow earthquakes 2017 Topography



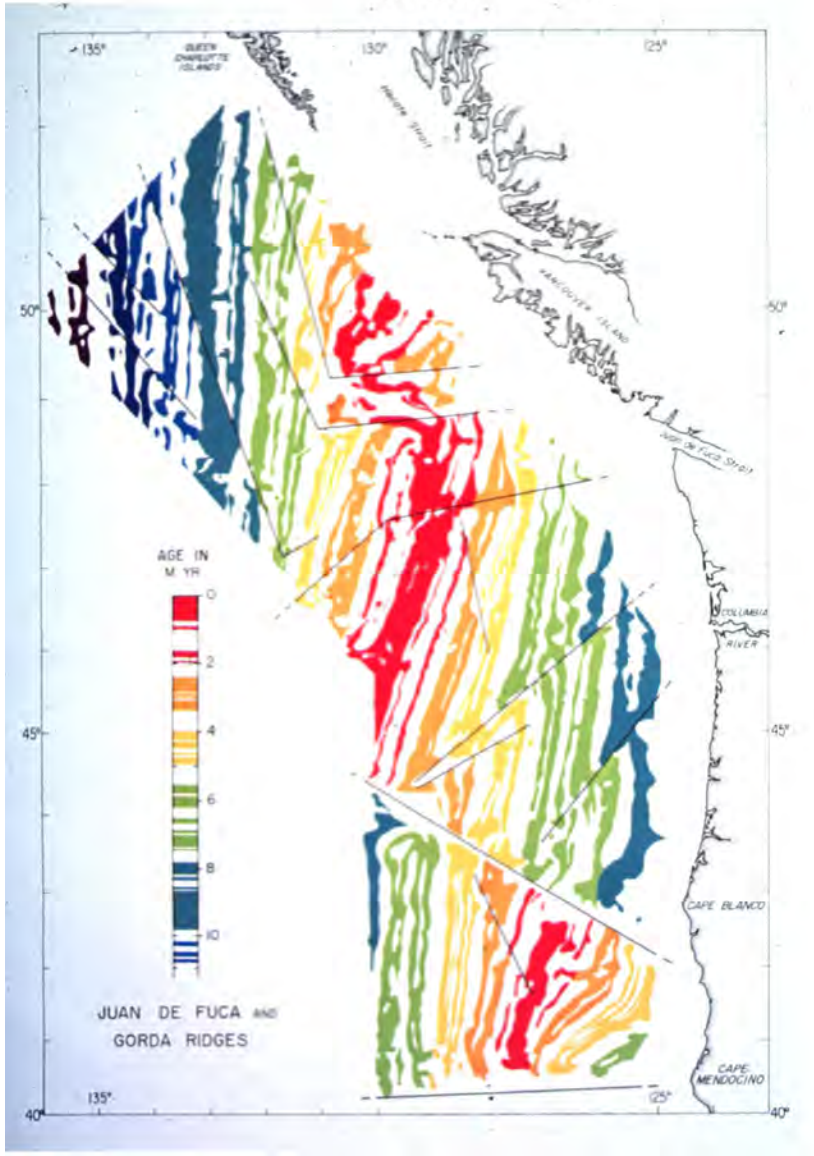


1961

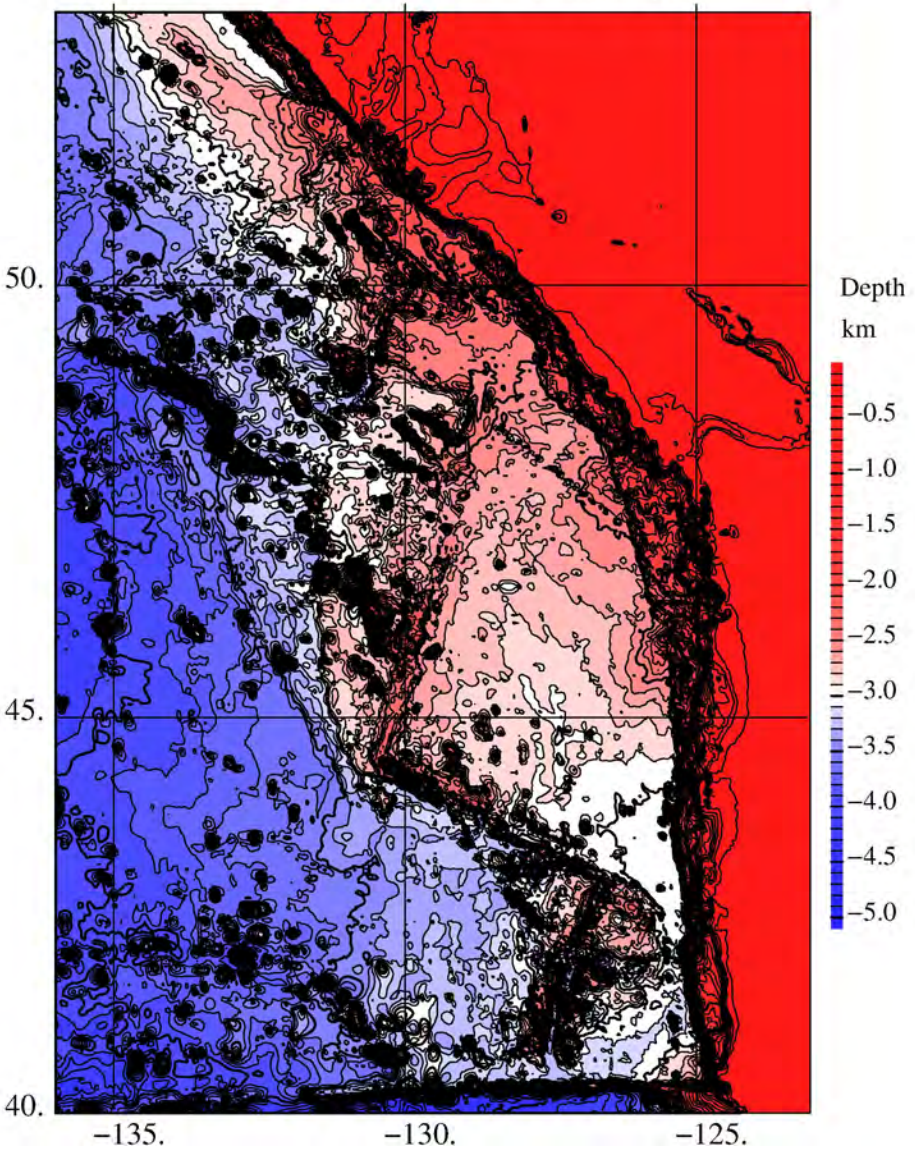
Raff and Mason



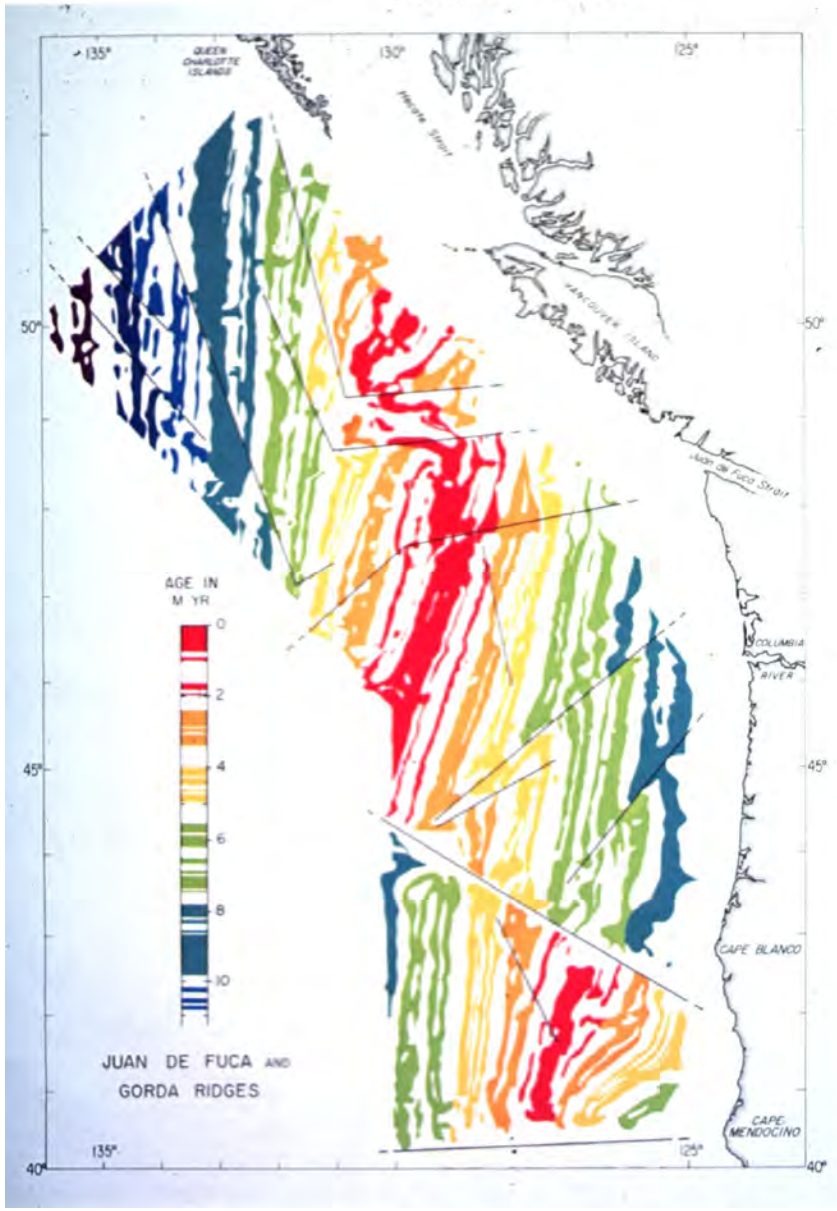
1966 Vine



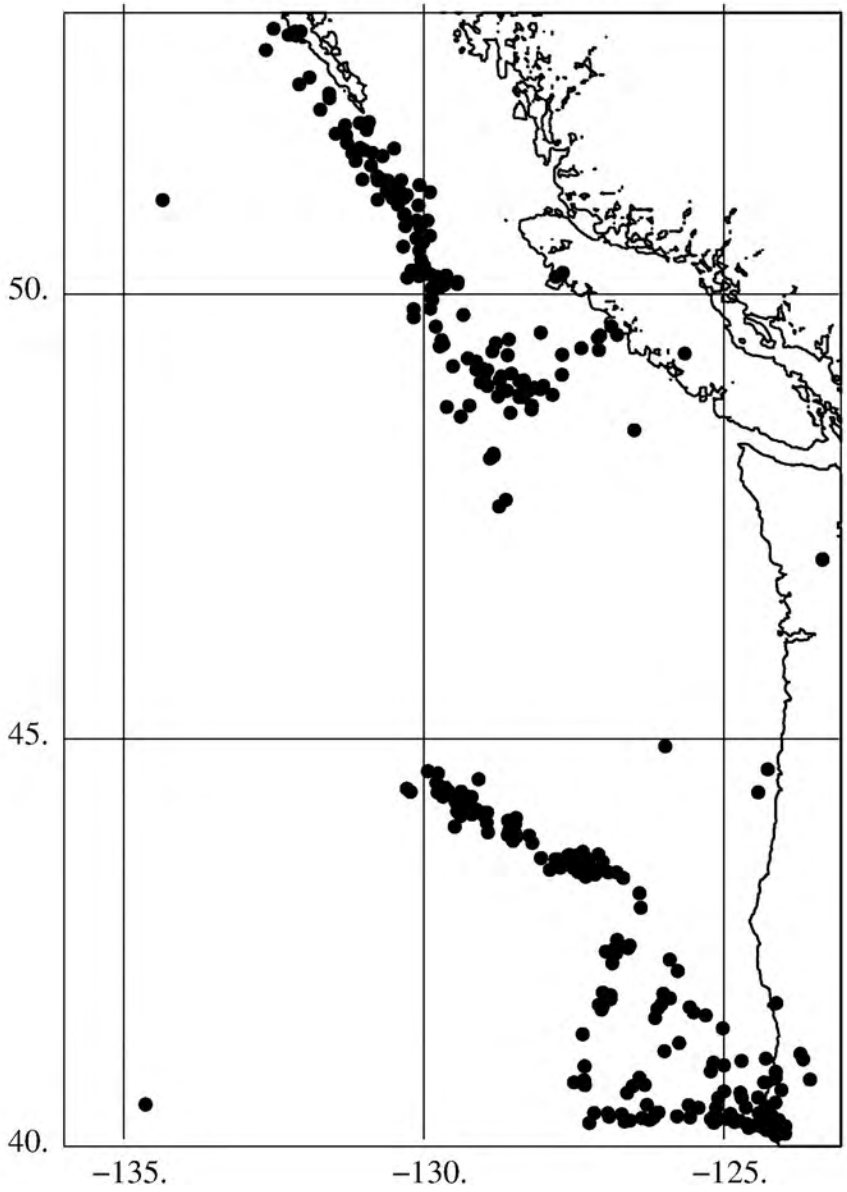
Bathymety of NE Pacific Ocean Sandwell 2017



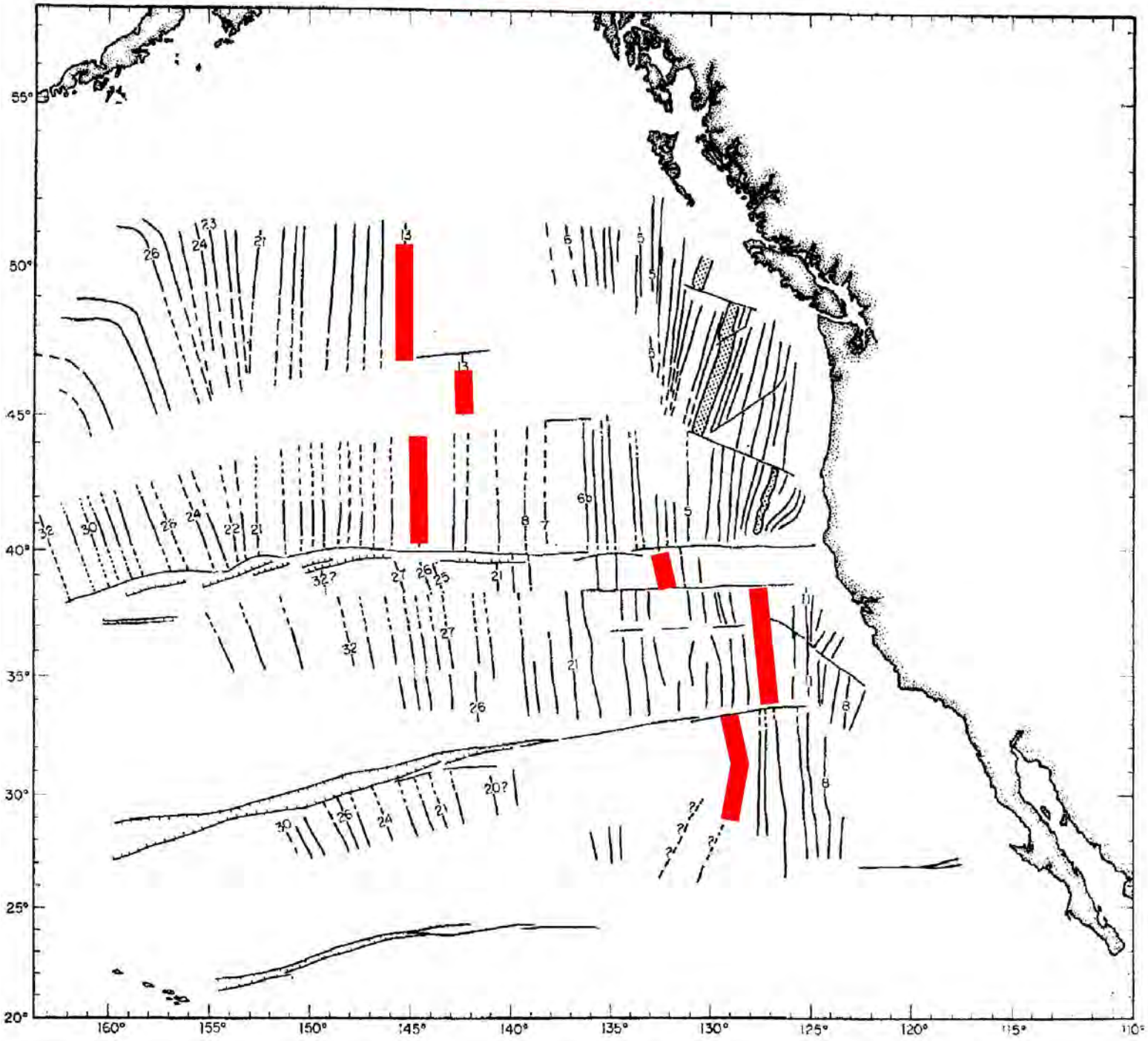
1966 Vine



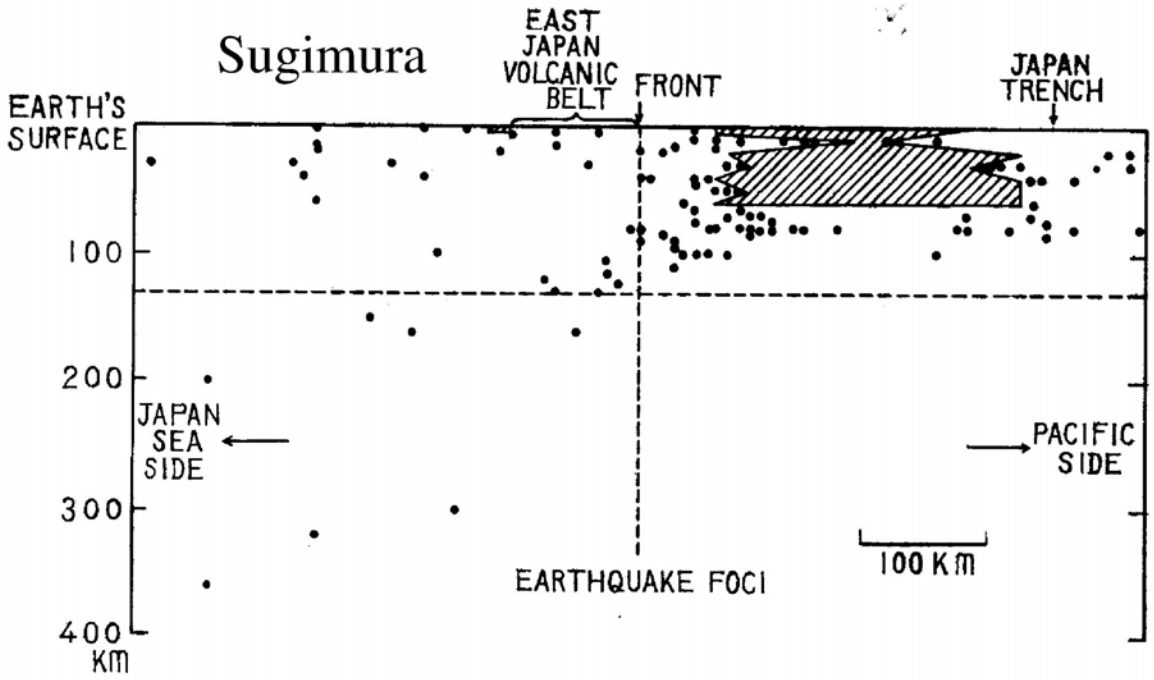
Epicentres of NE Pacific Ocean



anomaly 13

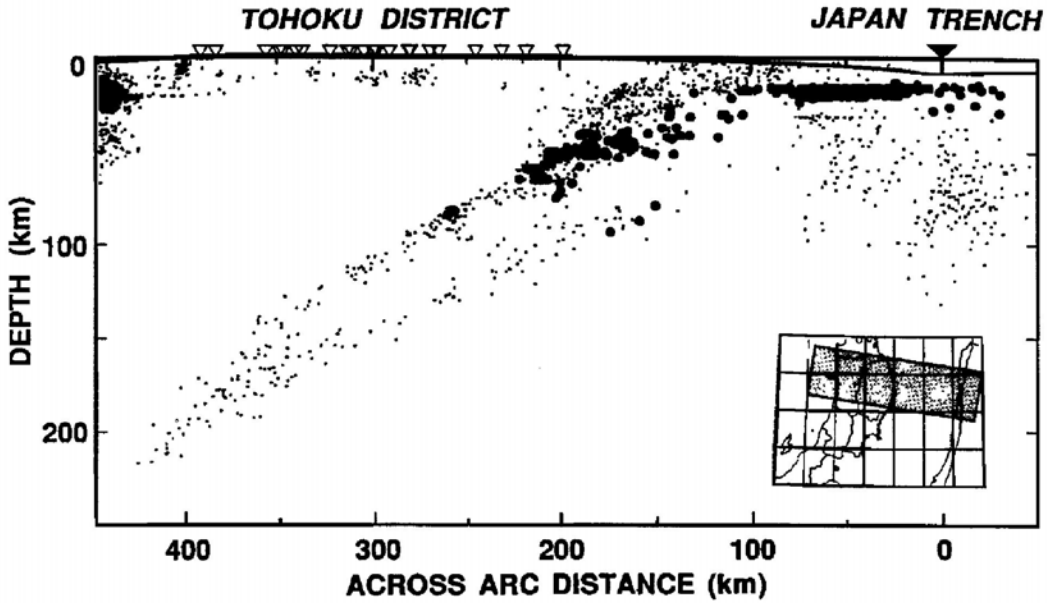


1965



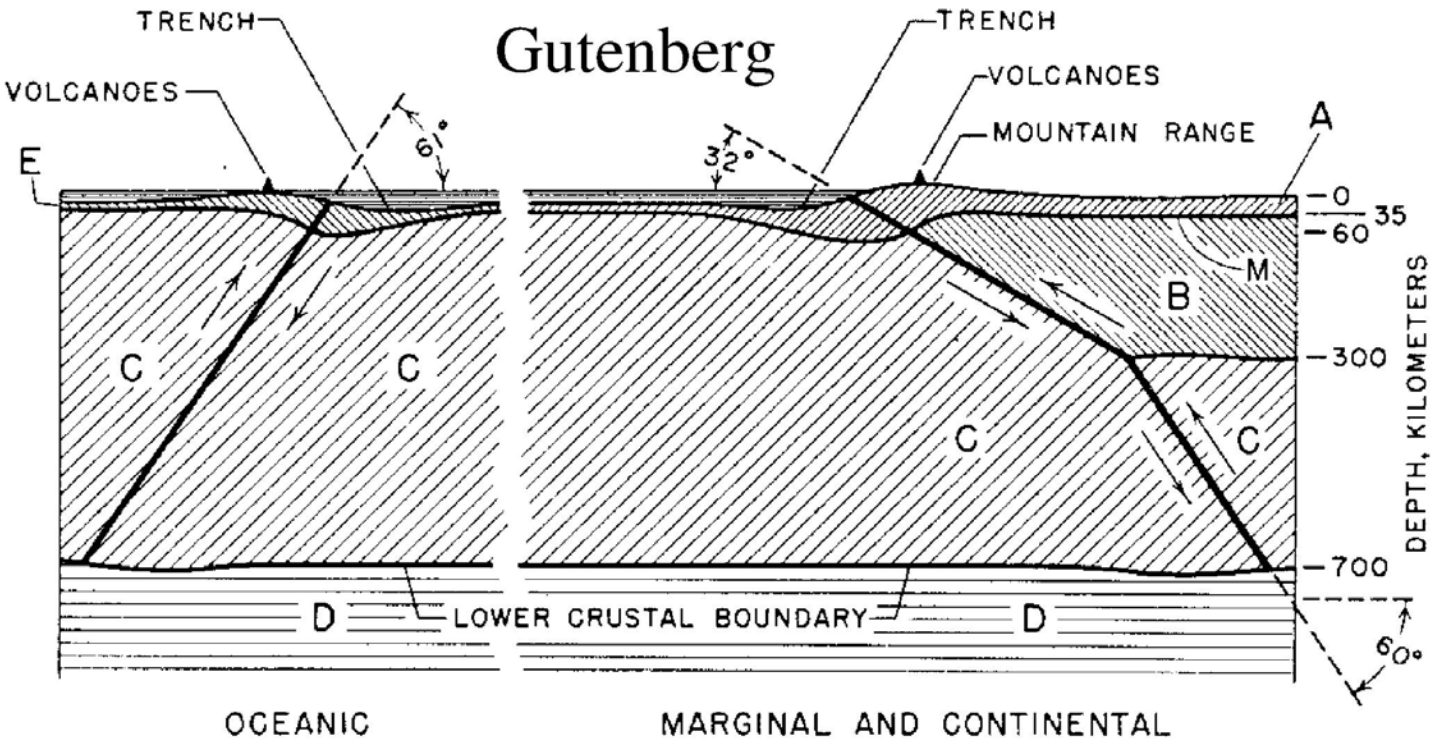
1994

HASEGAWA ET AL.: SEISMIC STRUCTURE OF NORTHEAST JAPAN



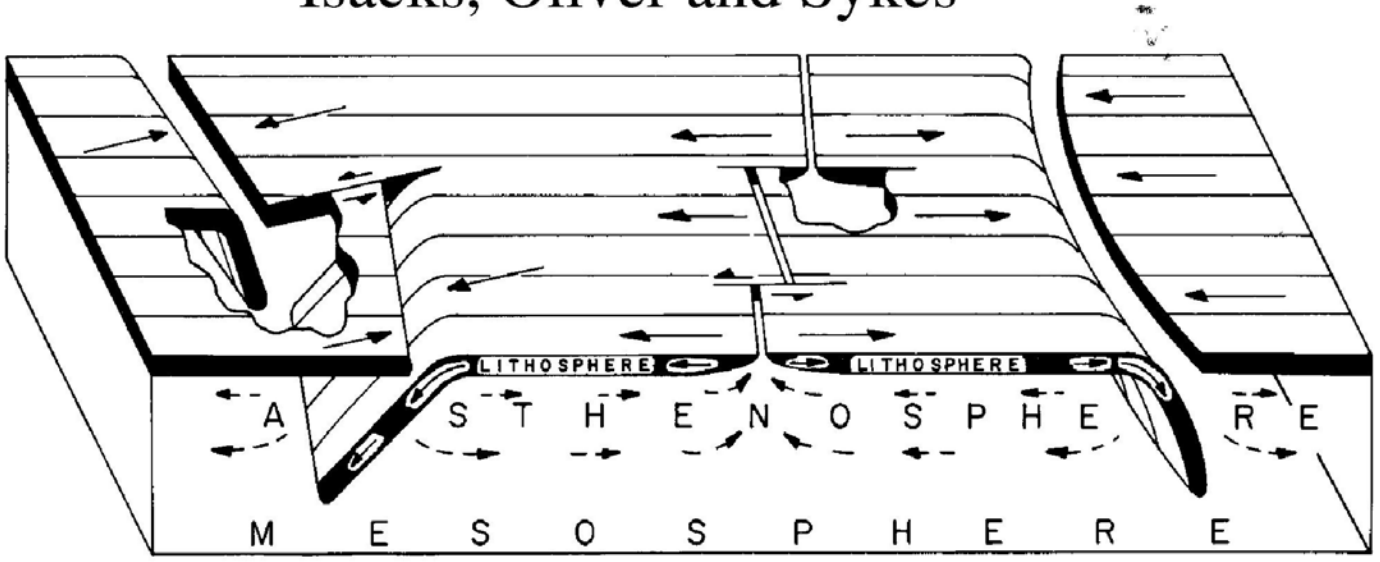
1959

Gutenberg



1968

Isacks, Oliver and Sykes



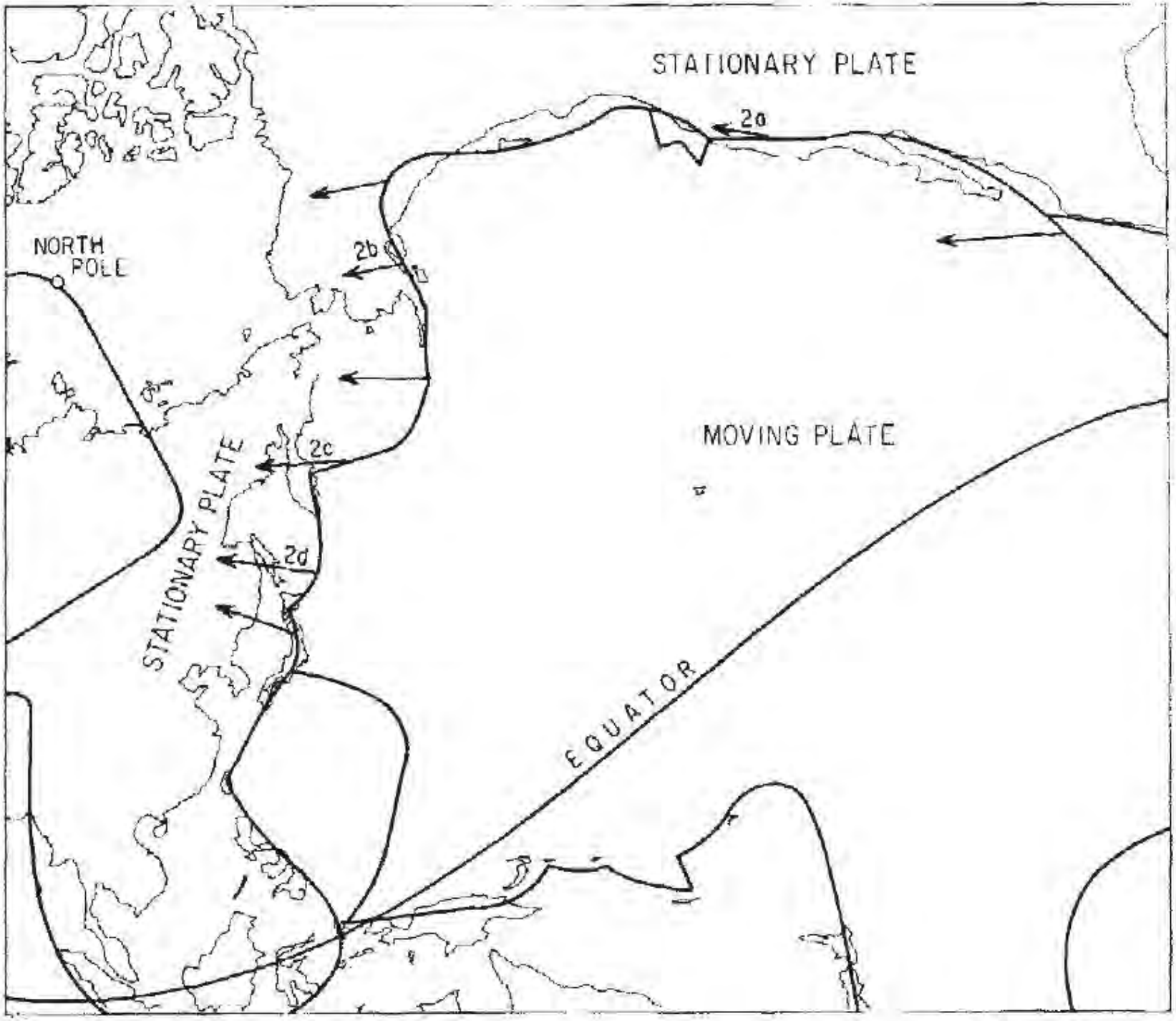
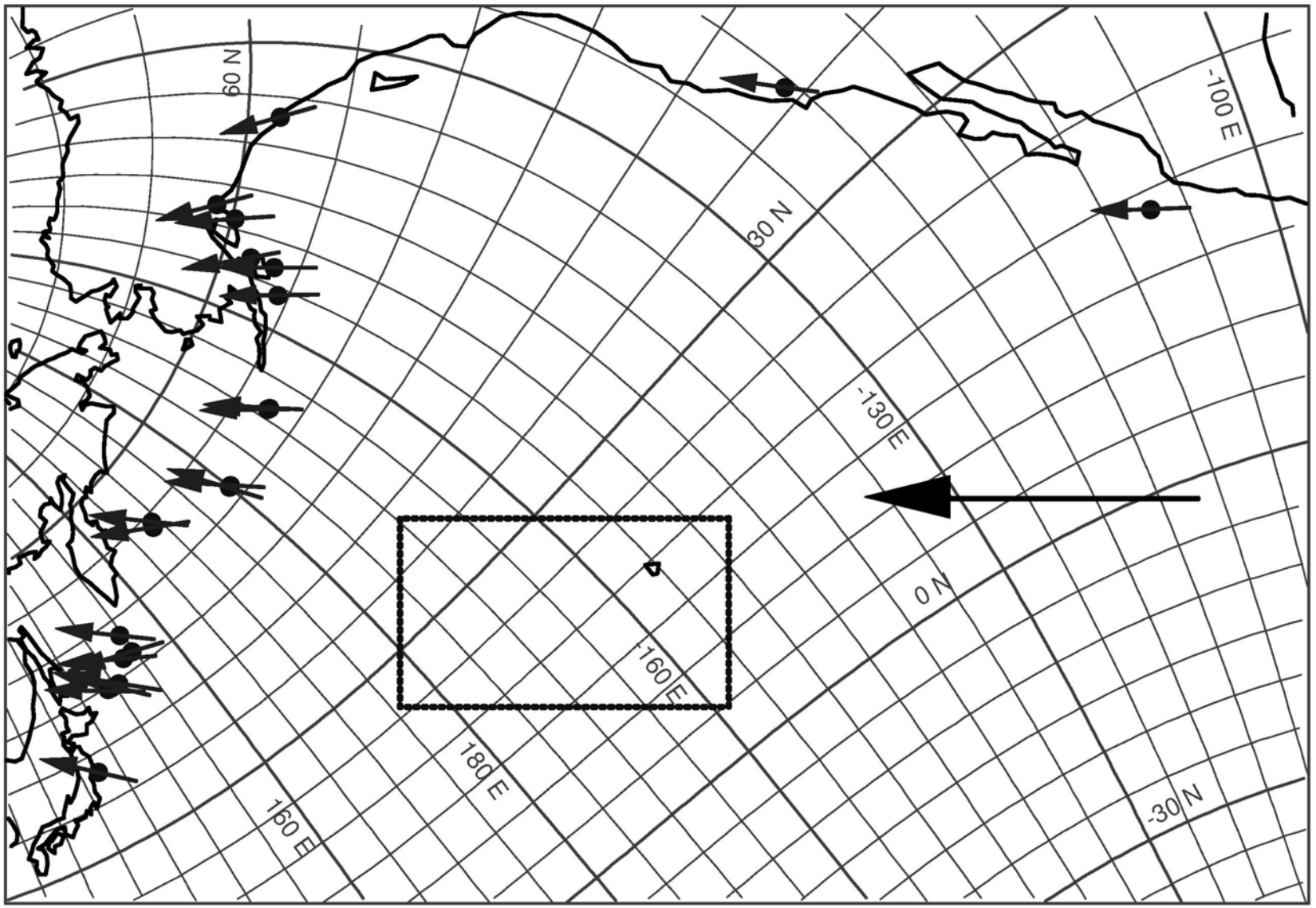


Fig. 3. A Mercator projection of the Pacific with a pole at 50° N., 85° W. The arrows show the direction of motion of the Pacific plate relative to that containing North America and Kamchatka. If both plates are rigid all slip vectors must be parallel with each other and with the upper and lower boundaries of the figure. Possible boundaries of other

(a)



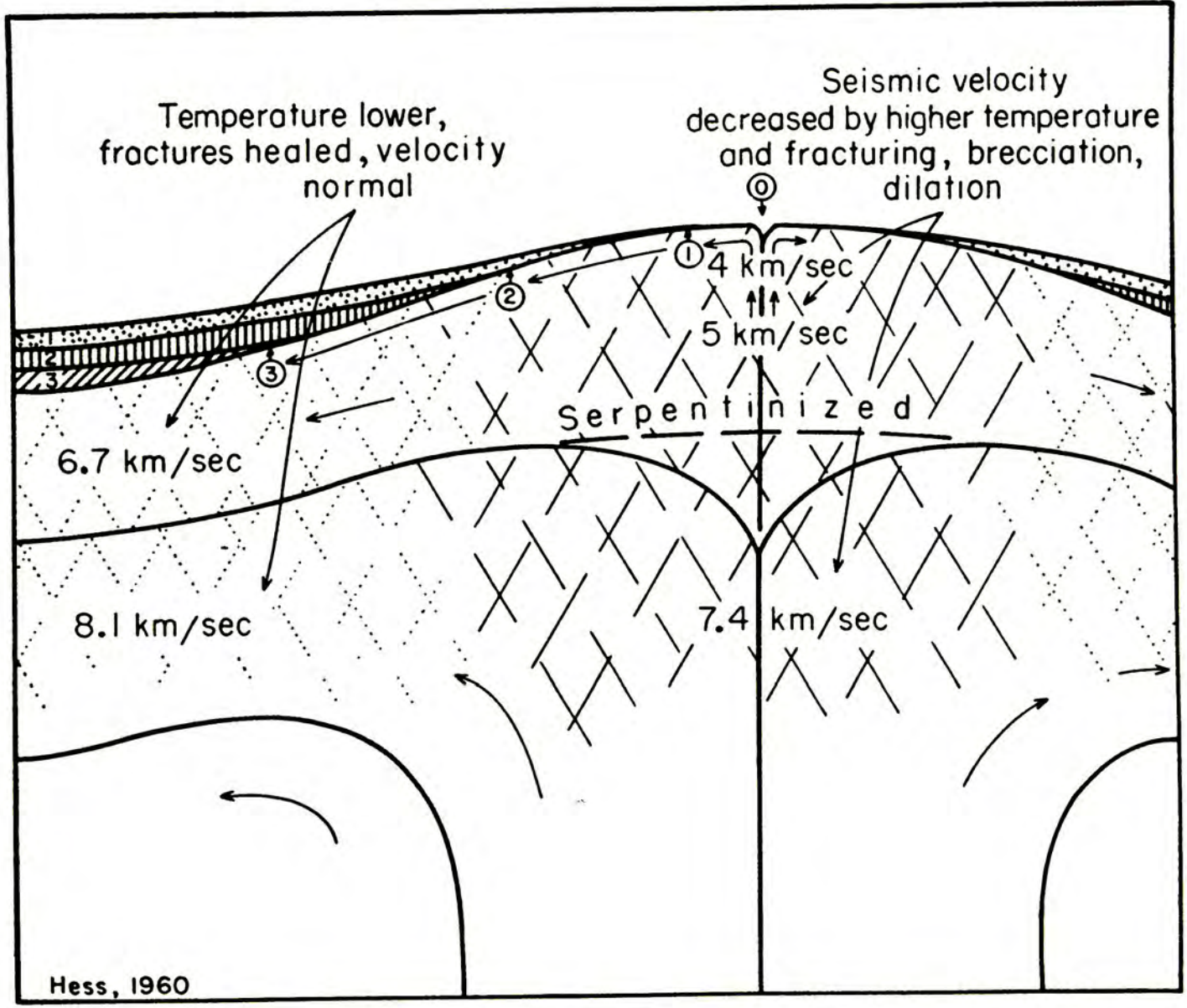
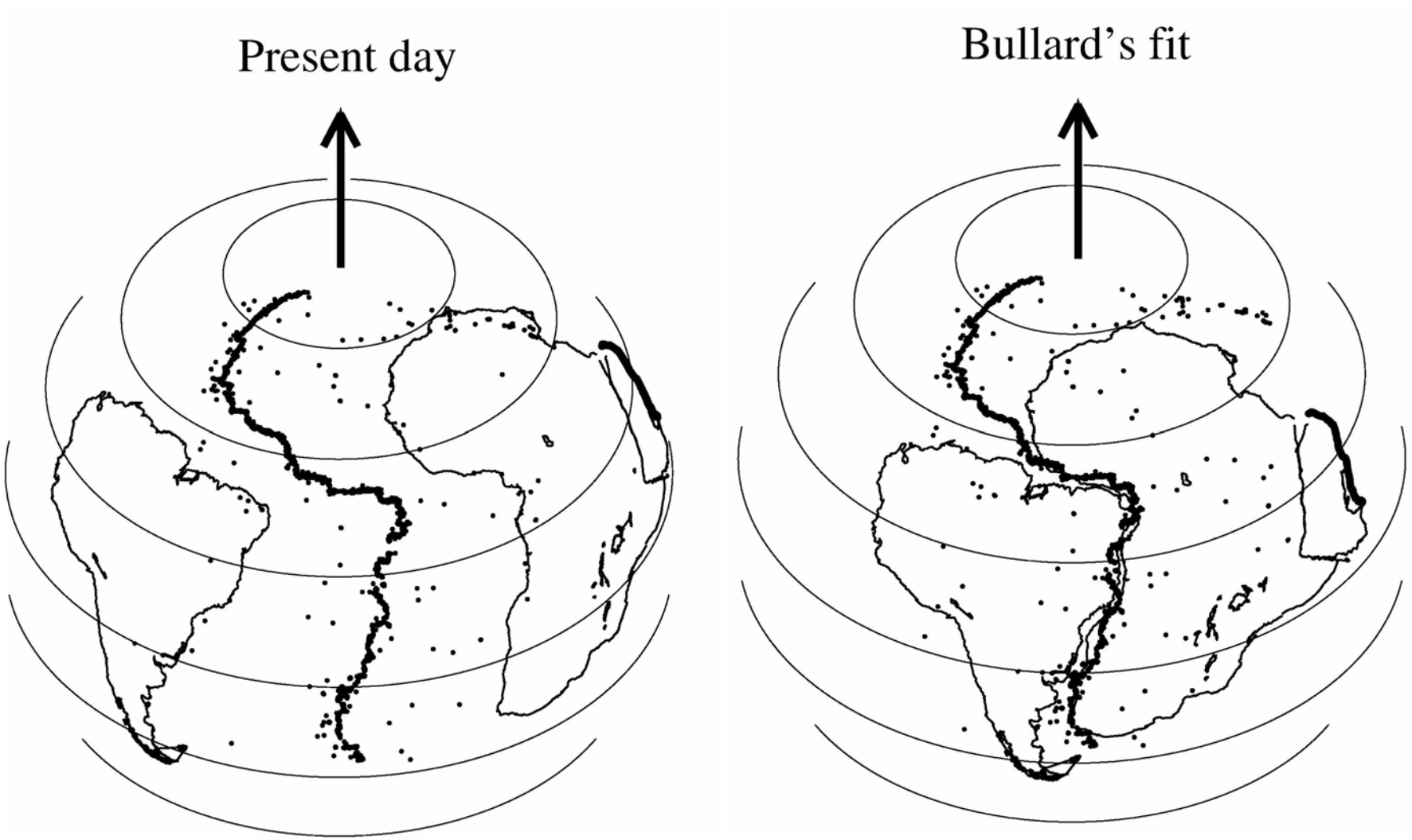
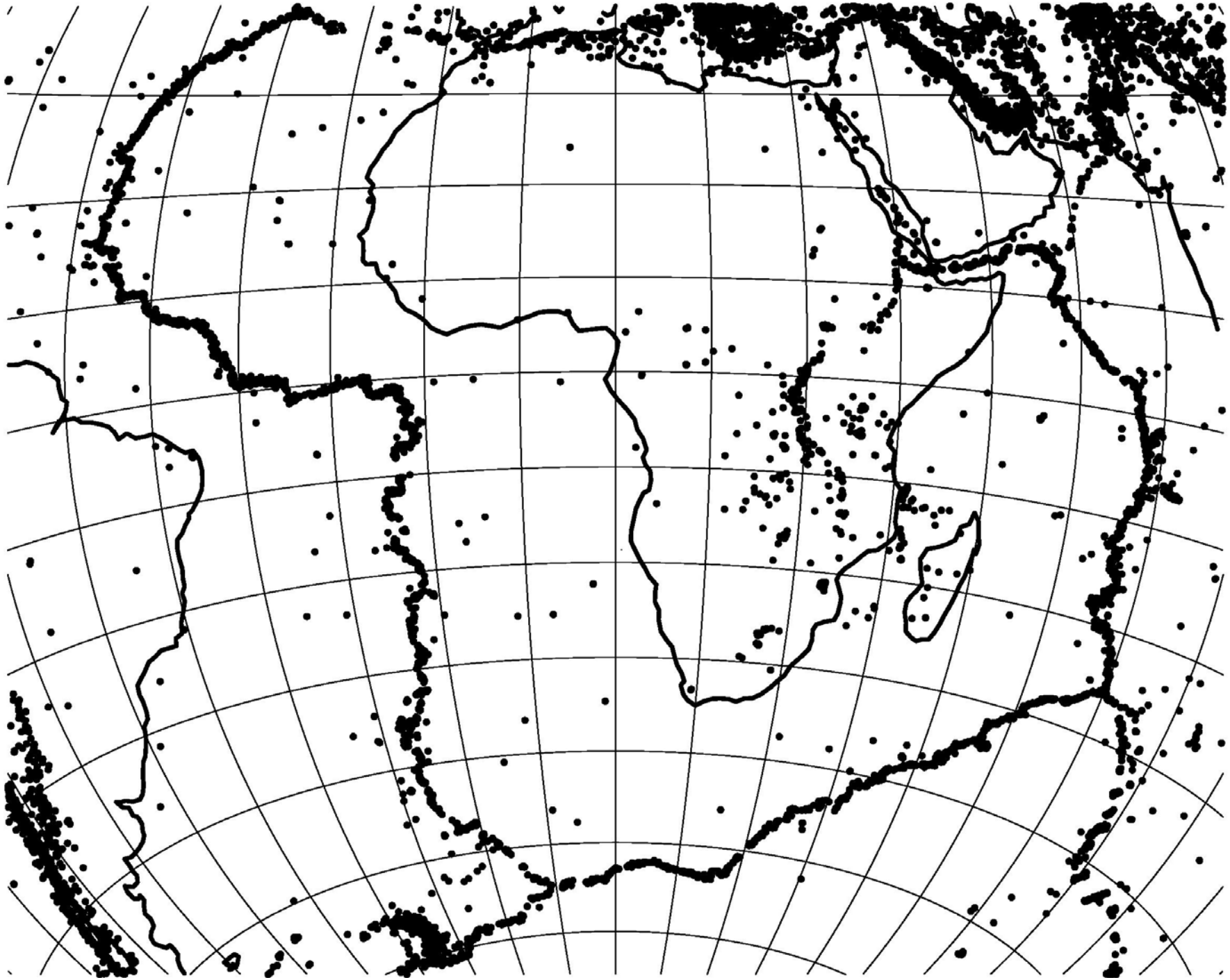
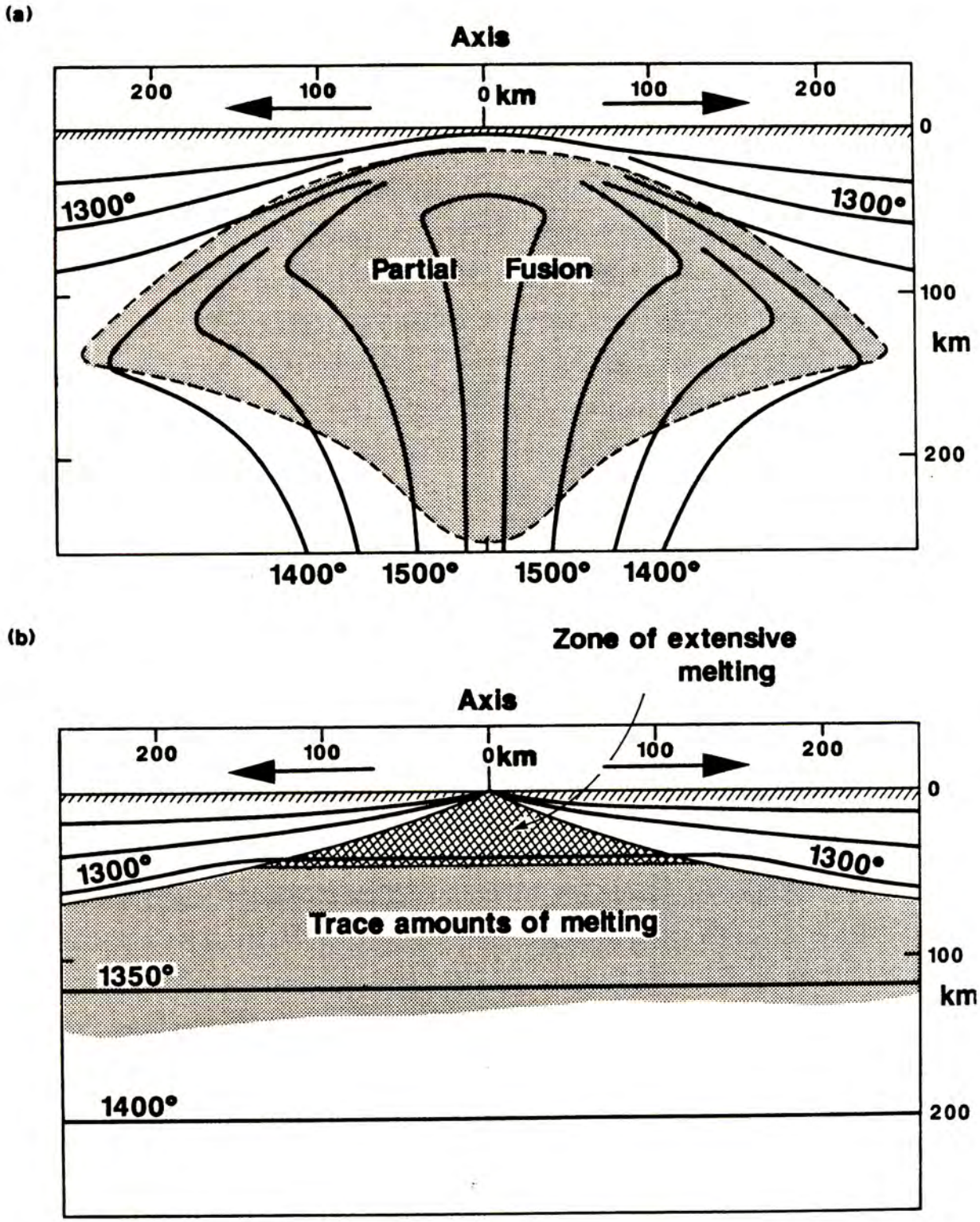


Figure 7. Diagram to represent (1) apparent progressive overlap of ocean sediments on a mid-ocean ridge which would actually be the effect of the mantle moving laterally away from ridge crest, and (2) the postulated fracturing where convective flow changes direction from vertical to horizontal. Fracturing and higher temperature could account for the lower seismic velocities on ridge crests, and cooling and healing of the fractures with time, the return to normal velocities on the flanks.

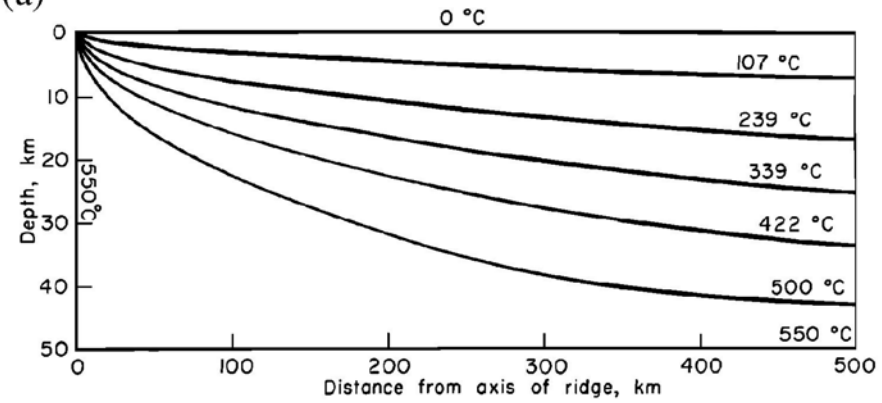

Present day
Bullard's fit




(a)
Axis
200
100
0 km
100
200
0
1300°
1300°
Partial
Fusion
100
km
200
1400°
1500°
1500°
1400°
(b)
Zone of extensive melting
Axis
200
100
0km
100
200
0
1300°
1300°
Trace amounts of melting
100
km
1350°
1400°
200

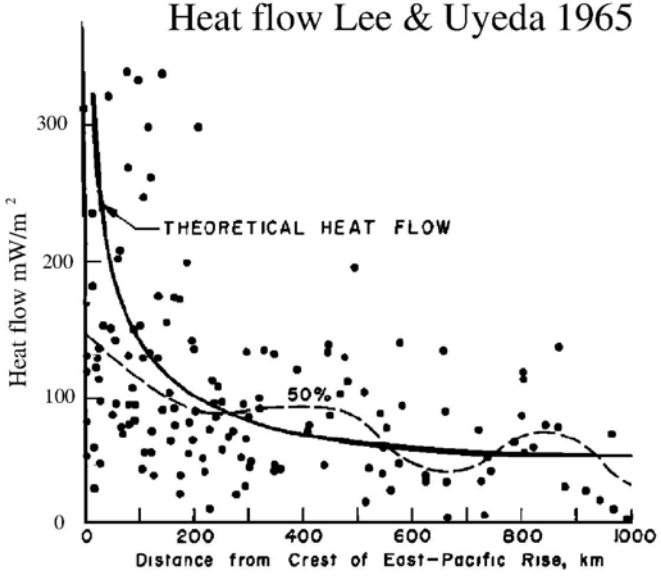
Isotherms, McKenzie 1967

(a)



Heat flow Lee & Uyeda 1965

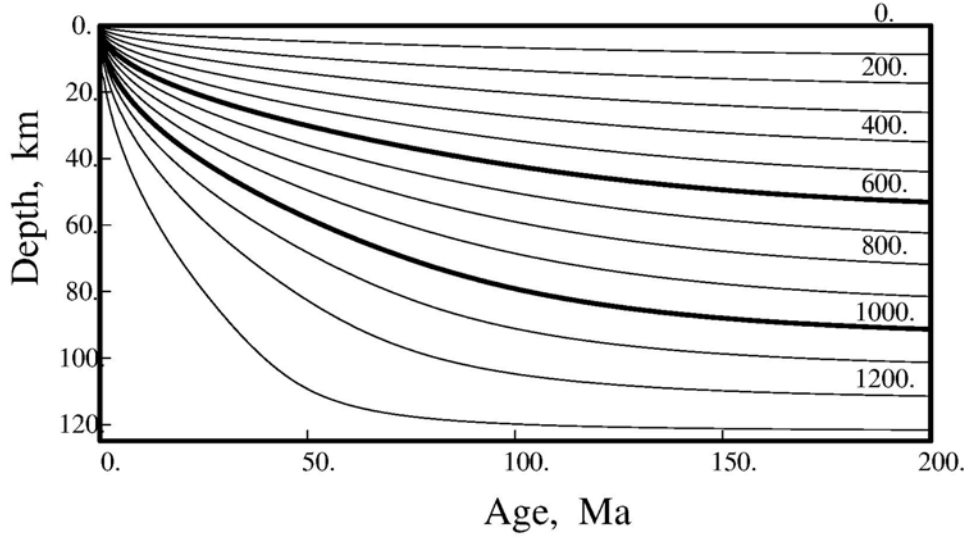
(b)



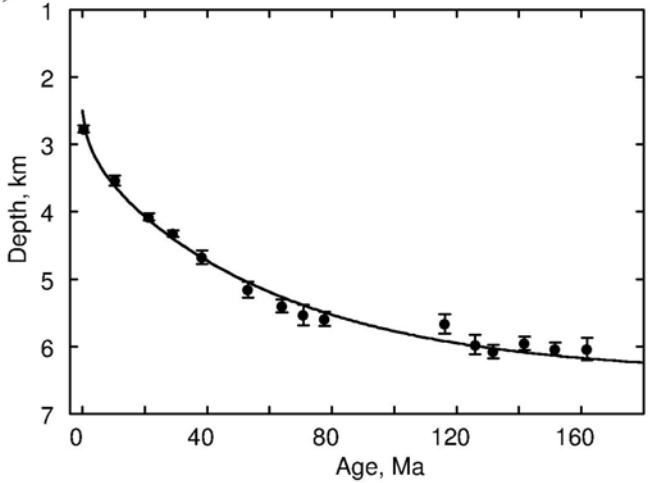
Heat flow in the Pacific Ocean.

(c)

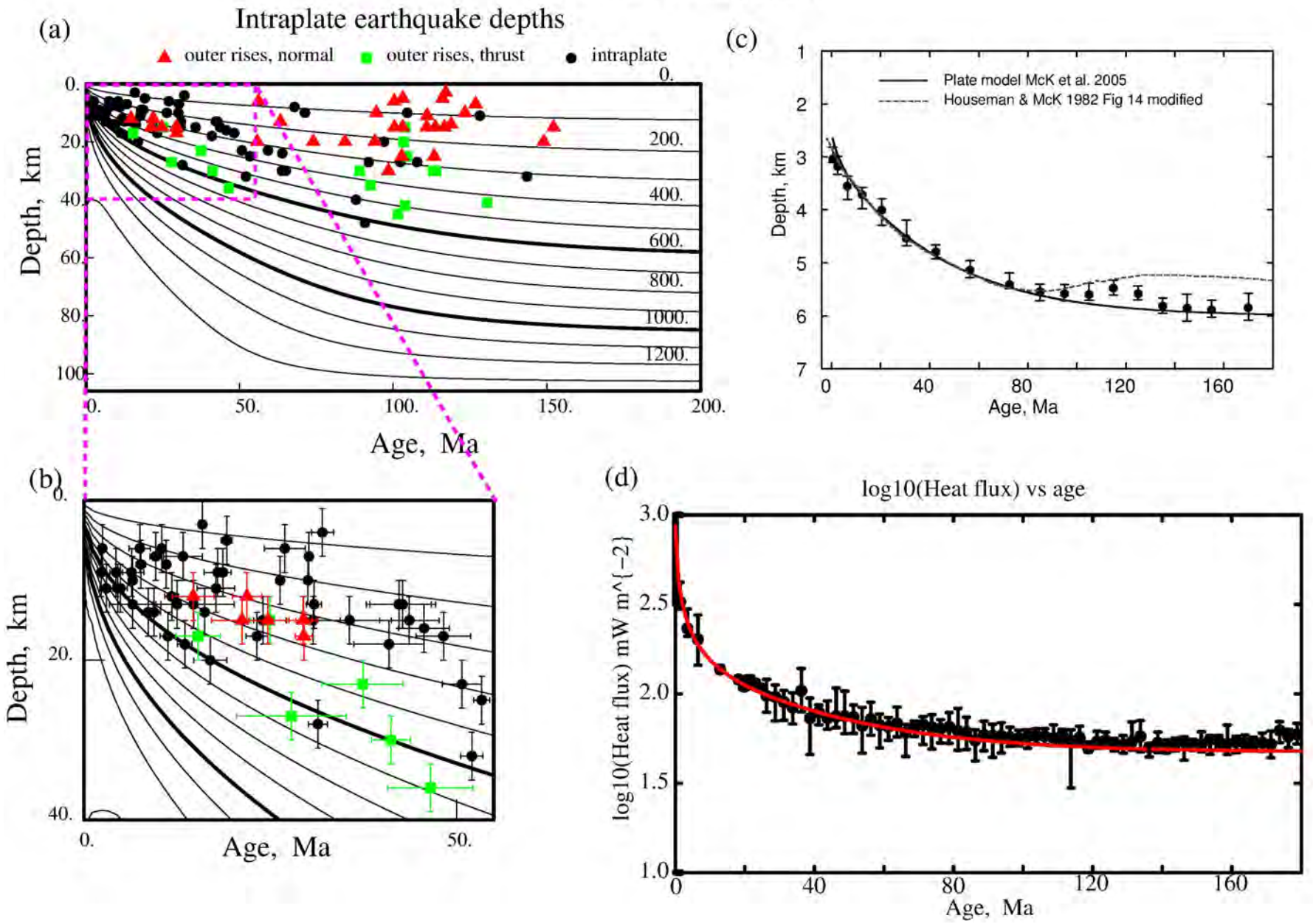
Isotherms, Parsons and Sclater 1977



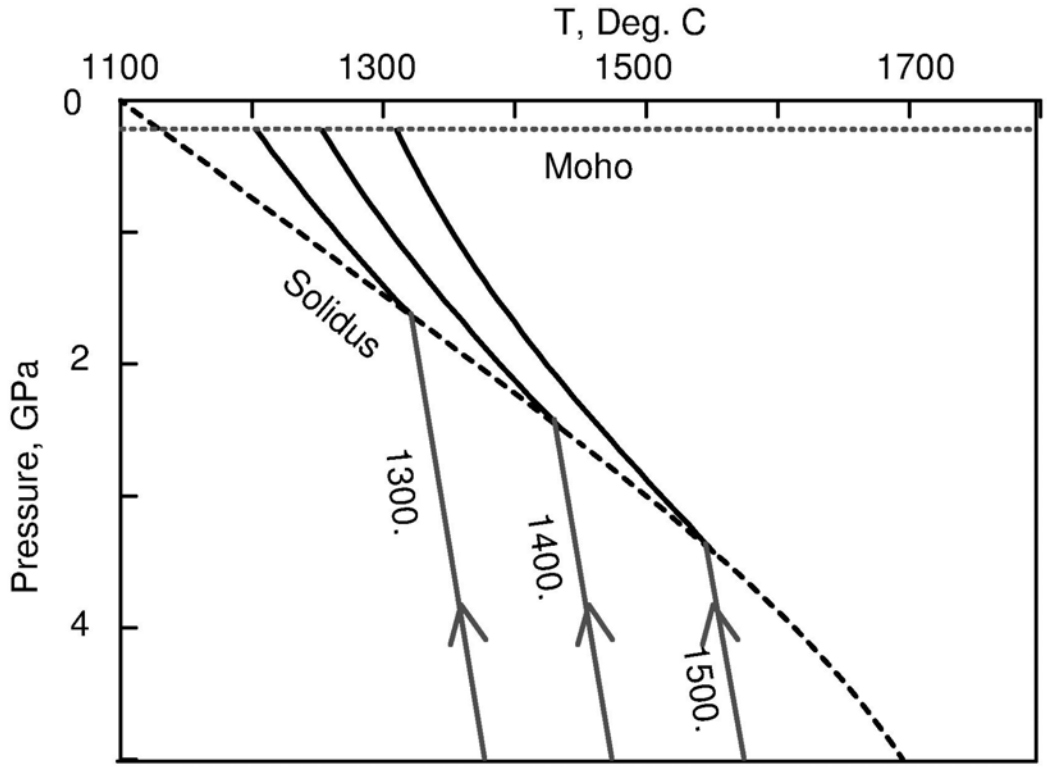
(d)

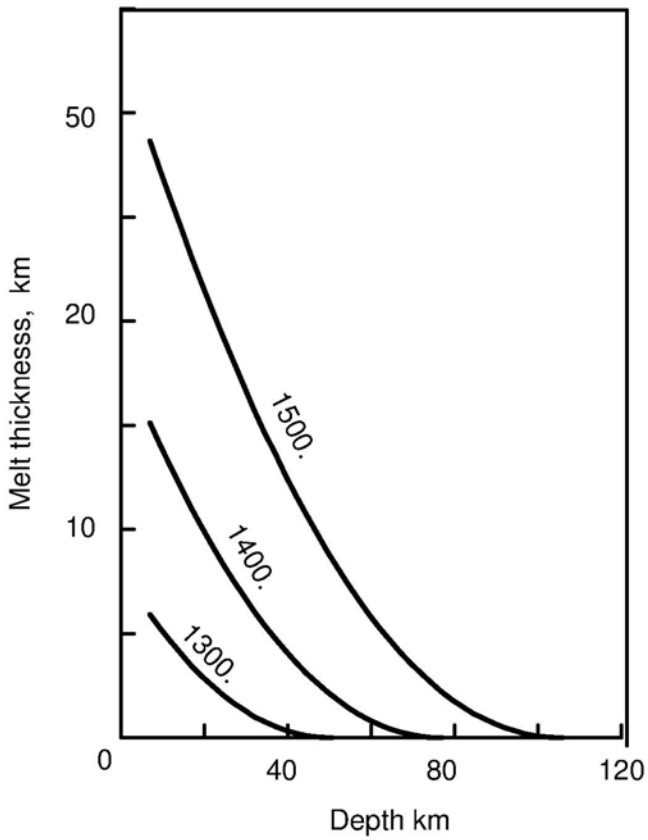


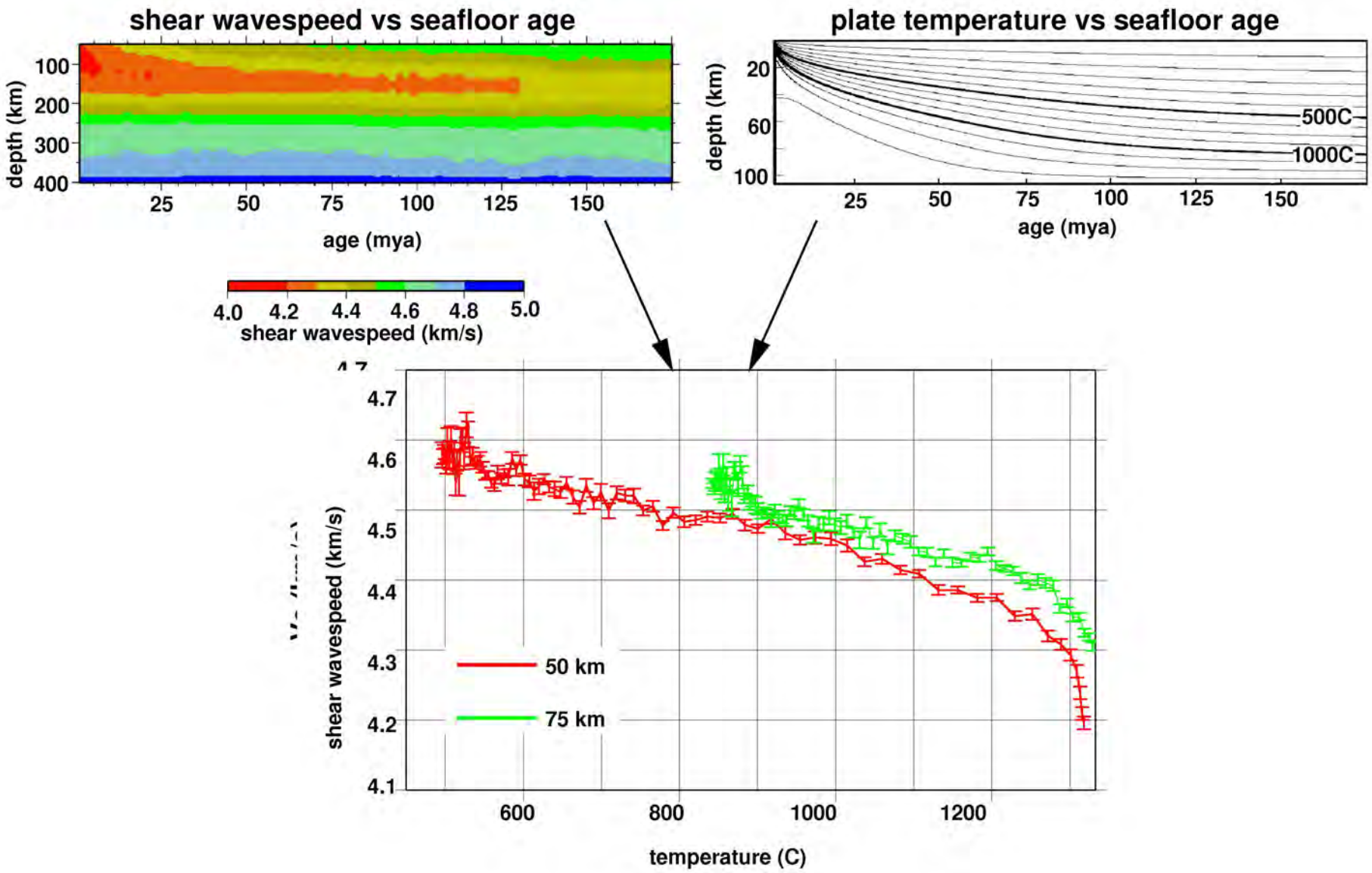
McKenzie et al. (2005)



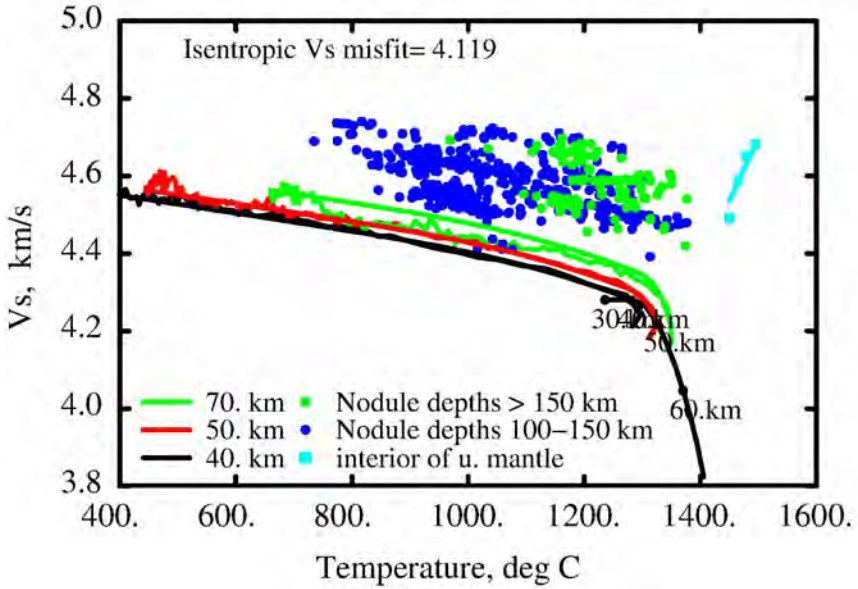
Kojitani and Akaogi DS=400 J/K kg

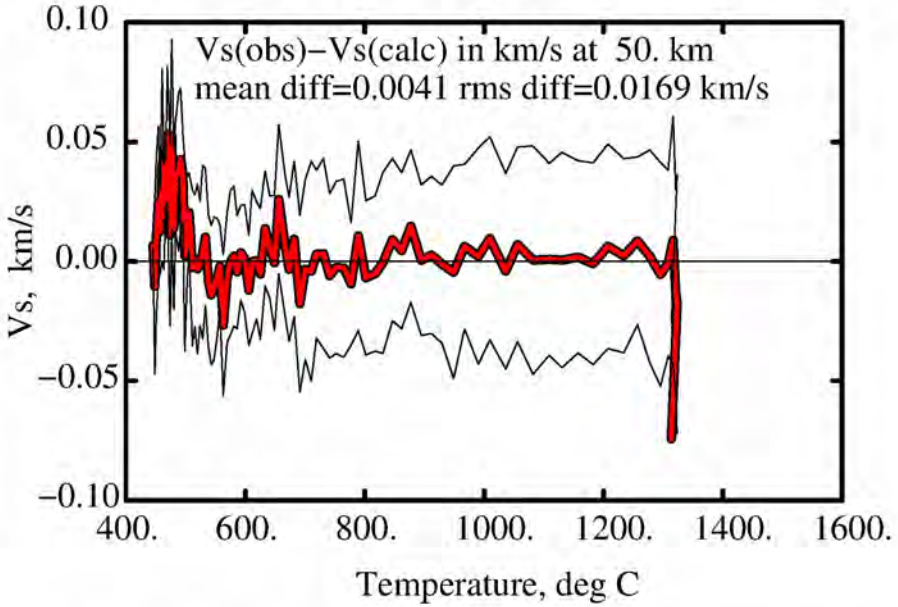


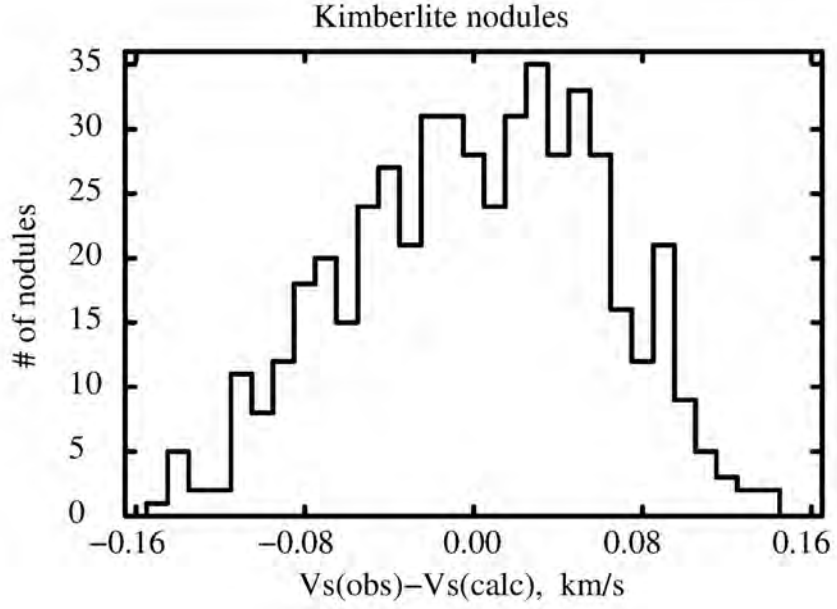


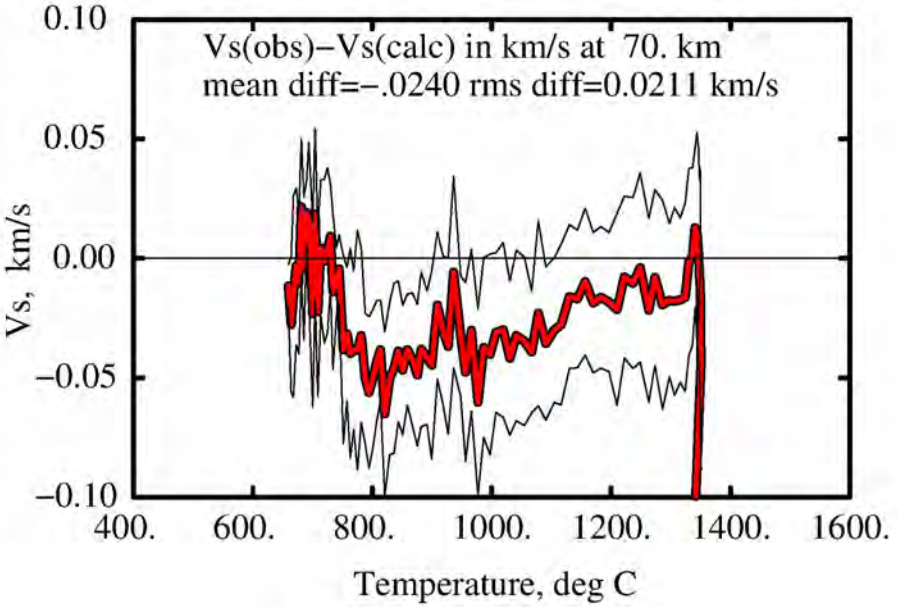

shear wavespeed vs seafloor age
depth (km)
100
200
300
400
25
50
75
100
125
150
age (mya)
4.0
4.2
4.4
4.6
4.8
5.0
shear wavespeed (km/s)
plate temperature vs seafloor age
depth (km)
20
60
100
500C
1000C
age (mya)
4.7
4.6
4.5
4.4
4.3
4.2
4.1
shear wavespeed (km/s)
50 km
75 km
600
800
1000
1200
temperature (C)

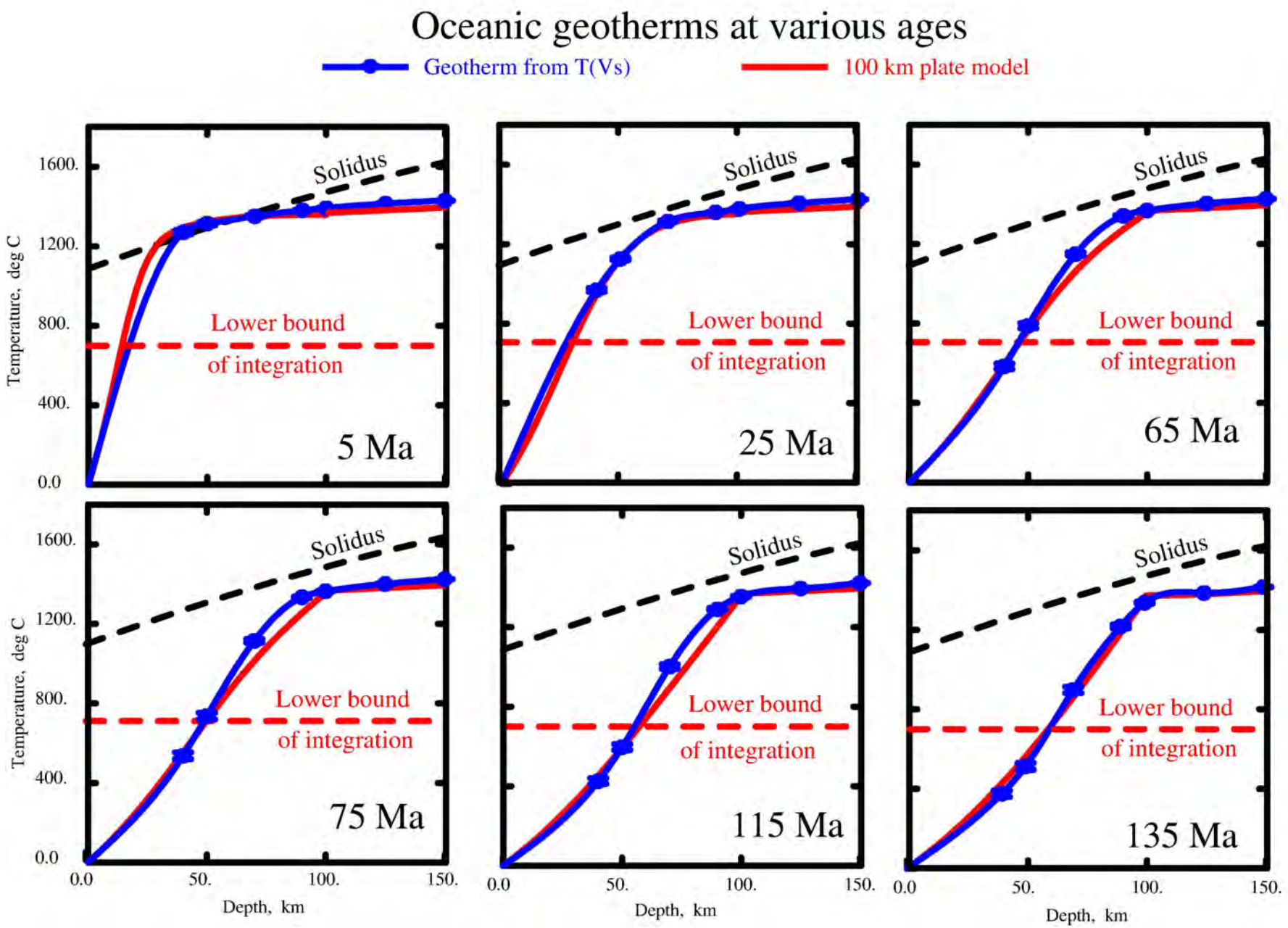
T(Vs) parameterisation using the 1/2 space model



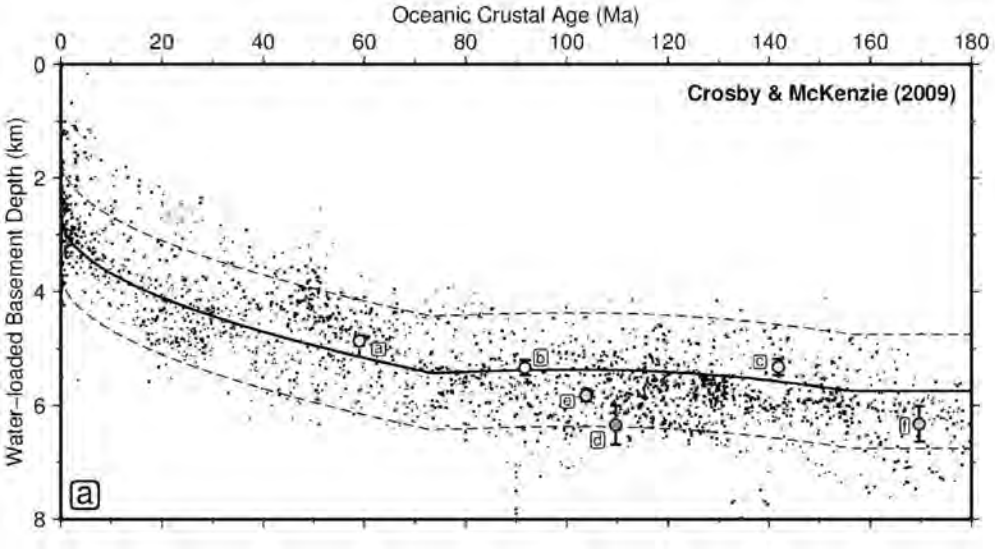


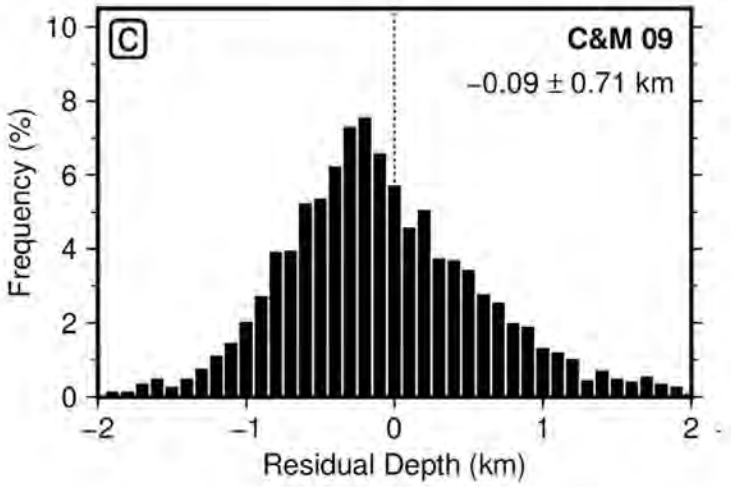




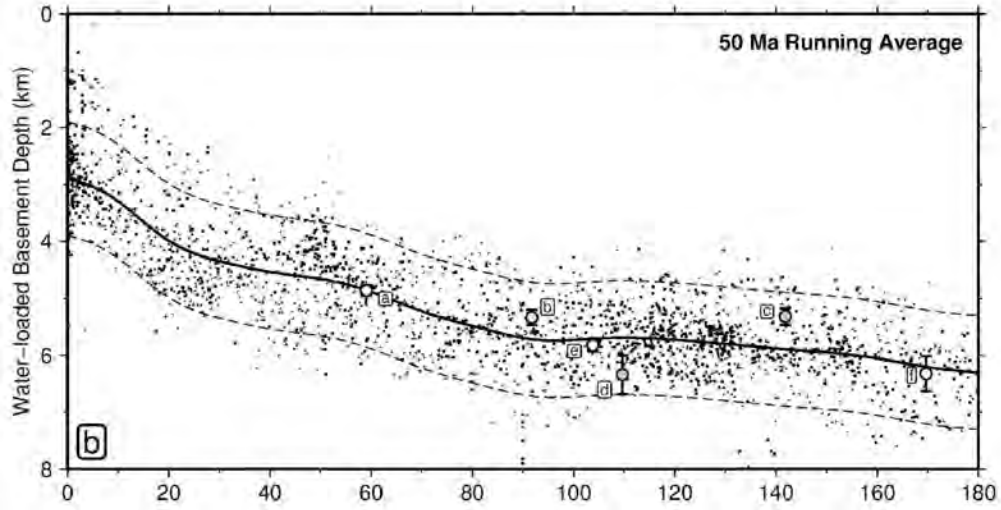

Oceanic geotherms at various ages
Geotherm from T(Vs)
100 km plate model
Solidus
Lower bound
of integration
5 Ma
25 Ma
65 Ma
75 Ma
115 Ma
135 Ma
Temperature, deg C
1600.
1200.
800.
400.
0.0
0.0
50.
100.
150.
Depth, km

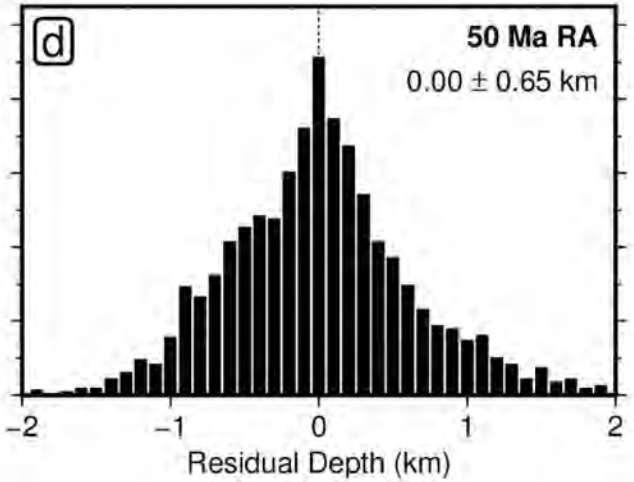
Crosby and McKenzie 2009

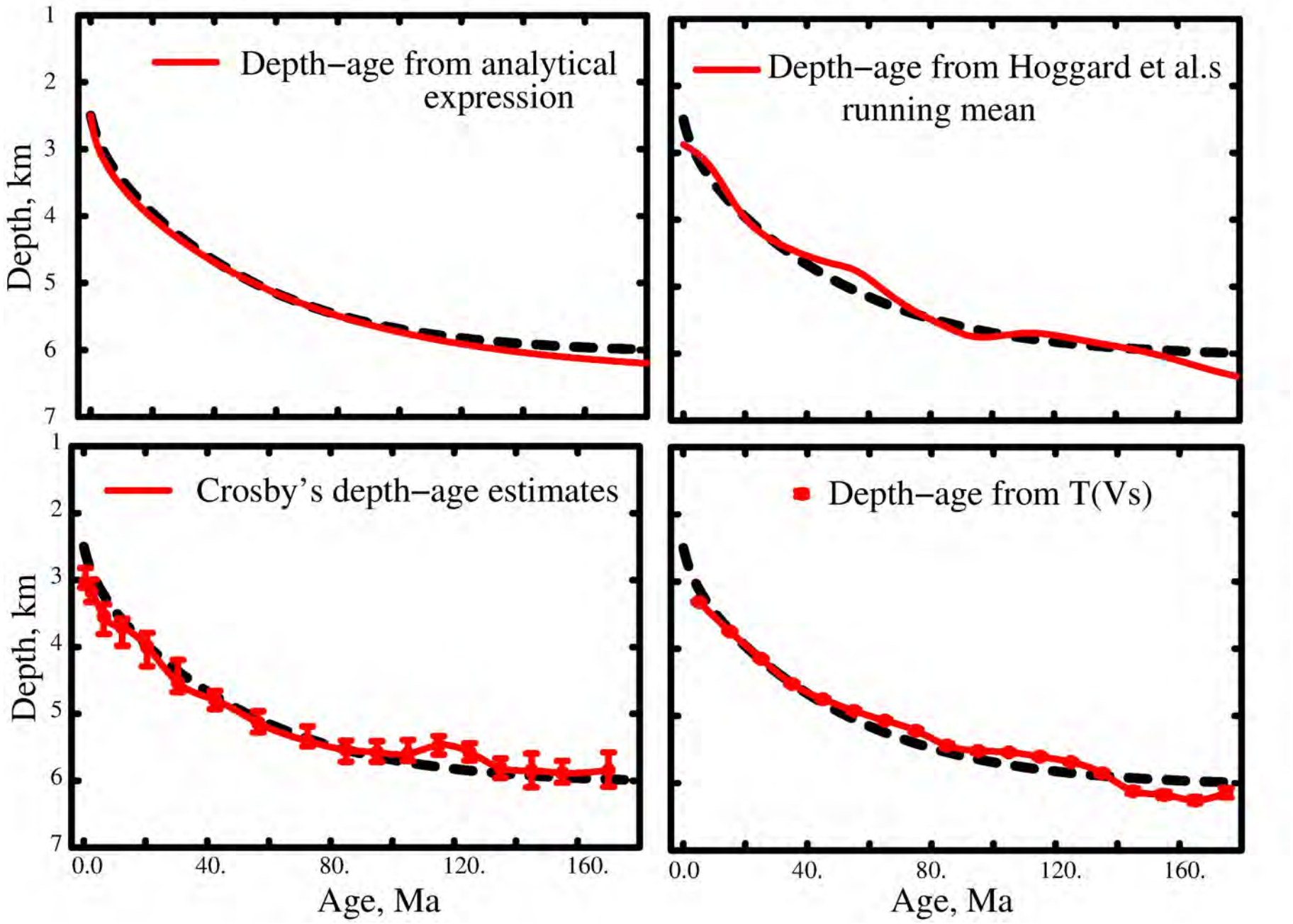




Hoggard et al. 2017






Numerical solution, 100 km thick lithosphere k=k(T), isentropic decompression
Depth–age from analytical expression
Depth–age from Hoggard et al.s running mean
Crosby's depth–age estimates
Depth–age from T(Vs)
Depth, km
Age, Ma
1
2
3
4
5
6
7
0.0
40.
80.
120.
160.

Collaborators

Seismology

Keith Priestley

Plate Tectonics

Bob Parker

Marine Geology and Geophysics ,

John Sclater

Barry Parsons

Alistair Crosby

Gravity

Reiner Rummel

Mantle Convection

Nigel Weiss

Frank Richter

Greg Houseman

John Rudge

Venus

Francis Nimmo