Q1) what's the lithosphere? how are its boundaries defined ? On what evidence is its existence based?

Answer)

Definition :

- The lithosphere is the solid outermost shell of a rocky planet. On the earth , the lithosphere includes the crust and the uppermost mantle .

There are two types of lithosphere :

- oceanic lithosphere , which is associated with oceanic crust (basaltic , derived directly from mantle , thin , dense , young <200My).

-continental lithosphere , which associated with continental crust (granitic, residue of long continued partial melting , thick and light , ancient > 2.5 bY) .

its boundaries

- oceanic lithosphere is typically about 50-100km (but beneath the mid-ocean ridges is no thicker than the crust) , while continental lithosphere is about (150-200km) thick , consisting (70km) of crust and 100km or more of uppermost mantle .

The concept of its existence :

- the concept of the lithosphere as earth's strong outer layer was developed by Barrell (1914) , the concept was based on the presence of significant gravity anomalies over continental crust , from which he inferred that there must exist a strong upper layer (which he called lithosphere) above a weaker layer which could flow (asthenosphere) . This idea accepted by geologists and geophysicists (this idea is the basic concept of plate tectonics which developed in the 1960's).

Q2)- how is sea floor topography inferred from studies of gravity over the ocean ?

Answer)

- gravity measurements have shown that free air anomalies are broadly zero over ridges , indicating that they are in a state of Isostatic equilibrium, although small scale topographic features are uncompensated and cause positive and negative free air anomalies . the small long wavelength , positive and negative free air anomalies over the crests and flanks , respectively , of ridges are a consequence of the compensation , with the positives being caused by the greater elevation of the ridge and the negatives from the compensation mass deficiency .

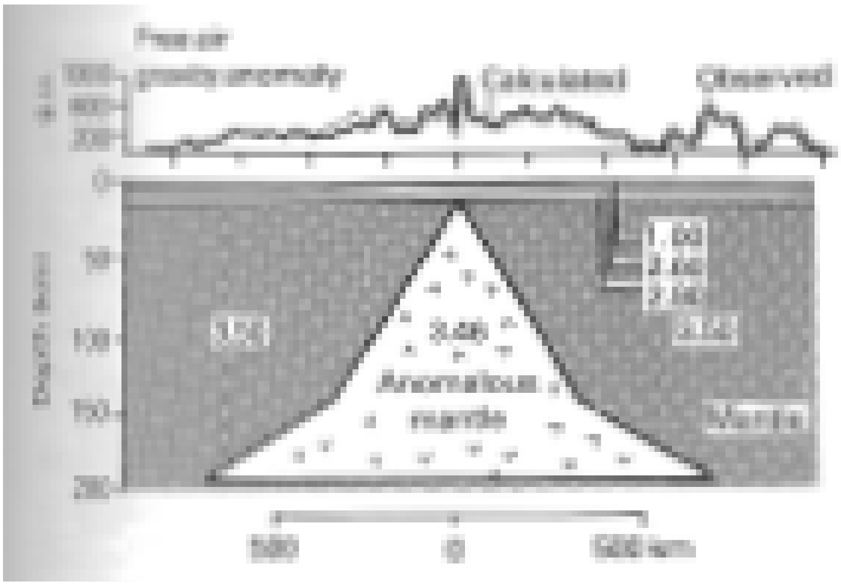


Figure above explain an alternative model of the structure beneath the Mid-Atlantic Ridge from gravity modeling (Keen & Tramontini ,1970)

Q3)- Is the earth's mantle beneath the plates liquid or solid ? Explain.

Answer)

The earth's mantle beneath the plates is liquid this is explained by the fact that the deeper you go inside the earth the hotter it gets, and the fact of the plate movements (theory of plate tectonics) which assumed that the lithosphere which is made up of dozen plates is underlain by asthenosphere (the weaker, hotter and deeper part of the upper mantle)

Q4)-how deep are the deepest earthquakes at mid-ocean ridges? At transform faults? At subduction zones?

Answer)

- The deepest earthquake in subduction zones is about 700km
- The deepest earthquake in mid-ocean ridges is about 250 km.
- The deepest earthquake in transform faults is shallower than 7-9 km.

Q5)- How is the asthenosphere different from the lithosphere ?

Answer)

Asthenosphere	Lithosphere
-it's not sharp but stretches from a depth of about 100 km to 250 km below the surface . weak and hot - it's a low velocities zone- -both P and S wave velocities are sharply reduced within the asthenosphere. -thought to be party molten (1-10 % liquid), which accounts for its low -velocities and make it very weak. - most basalt magma have their origin in asthenosphere	It's thin , depth from 0 to 200 km - Rigid and cool - - both P and S wave velocities are increased within the lithosphere - lithosphere is solid

Q6)- What's the relation among lithosphere, asthenosphere, oceanic crust , oceanic mantle ?

Answer)

- The relation between lithosphere and asthenosphere is that the lithosphere movements are controlled by the liquid movements in the asthenosphere.

- The oceanic crust is part of the lithosphere.

- The oceanic mantle transfer heat and elements through the oceanic crust.

- Lithosphere plates are created at oceanic ridges as two plates move apart with a few tens of mm/year, hot mantle rocks flow upward to fill the gap

Q7)- How much does temperature increase across a 100km thick lithosphere ? How much across a 100km thick boundary layer at the base of the mantle? How much across the rest of the mantle?

Answer)

The lower boundary of the lithosphere is defined as an isotherm (equal surface of constant temperature) this isotherm is about 1600K (1300□ C) across 100 km depth.

- in the upper mantle , we have an adiabatic gradient which give the temperature vary from 1600 k to about 2000 k .

- in the lower mantle we have super adiabatic gradient , which give the temperature vary from 2500 k to 4000 k .

Q8) – What're the average thickness of the oceanic crust , continental crust , mantle , and lithosphere ?

Answer)

1- The oceanic crust (7-8 km)
2- The continental crust (35 km).
3- The mantle (begin with an average of 35 km to 2900km depth) an average of 2850 km.
4- Lithosphere (100 km thick beneath the ocean basins and about 200 km beneath continent).

Q9) – what's the average water depth above old oceanic crust?

Answer)

- The average water depth above the old oceanic crust is 3.8 km.

Q10)- what are the slowest and fastest well-documented rates of the present seafloor spreading ? Where do they occur?

Answer)

- The fastest spreading ridge today is that portion of the East Pacific Rise between Nazca and Pacific plate, its rate is almost 10 cm yr^{-1}.
- The slowest spreading ridges are the southwest Indian Ridge and the Arctic ridges (half-rates < 1 cm yr^{-1}) .

Q11)- What's the depth of a typical mid-ocean ridge crest in the Atlantic ?

The depth of a mid-ocean ridge crest in the Atlantic is (1-2 km).

Q12) – Describe the relationship between heat flow and age of oceanic lithosphere .

Answer)

–Heat flow of Sea floor (see Figure 1) is highest at mid-ocean ridge, and decreases with the age of the lithosphere; this variation is one of the key features in the models of the plate tectonics.
- Where the oceanic lithosphere cools as it spreads away from mid-ocean ridge and reheats upon returning to the mantle at subduction zones.
-Average heat flow (Figure 1) is greater that about **100mWm^{-2}** *for the youngest lithosphere (<10Ma) .*

- The mean values rapidly decrease from about 0 to 30 Ma. The standard deviations are large for young lithosphere, but decrease with increasing lithosphere age.

Table 3. Oceanic Heat Flow Predicted from a Plate Model and Observed with Given Uncertaintics due only to Data Scatter

Age (Ma)	Average Heat Flow ($mW\ m^{-2}$) Predicted (GDH1 Model)	Observed	No. Data
0-1	1020	131 ± 93	79
0-2	721	136 ± 99	195
0-4	510	128 ± 98	338
4-9	204	103 ± 80	382
9-20	136	82 ± 52	658
20-35	98	64 ± 40	535
35-52	77	60 ± 34	277
52-65	66	62 ± 26	247
65-80	60	61 ± 27	398
80-95	56	59 ± 43	443
95-110	53	57 ± 20	230
110-125	51	53 ± 13	417
125-140	50	52 ± 20	224
140-160	49	51 ± 14	242
160-180	48	52 ± 10	67

from Stein and Stein [107]

- Two different sets of parameters for the plate model have been used by Parsons and Sclater (hereafter termed PSM) and Stein and Stein (termed GDH1) .

- GDH1, provides better fit to the average depth –age and heat flow data using a hotter, thinner lithosphere (figure1) .

The heat flow $Q(mWm^{-2})$ is related to the age t(Ma) by : -

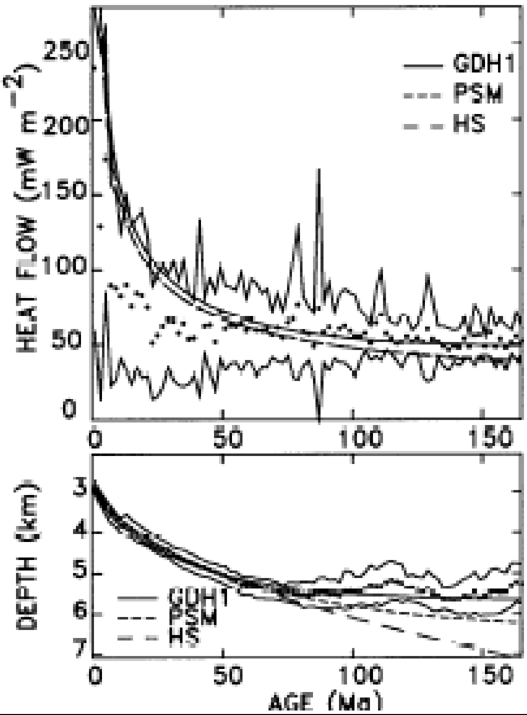
a) $Q = 510.t^{-1/2}$

(This relation used for ages ≤ 55 Ma) in this case, heat flow decreases linearly with inverse square root of age.

b) $Q = 48+ 96\exp(-t/36)$

(This relation used for ages >55Ma) in this case, heat flow deceases more slowly with increasing age, and follows a negative exponential.

Table 3, shows the oceanic heat flow predicted from a plate model and observed with given uncertainties due to data scatter.



HEAT FLOW (mW m^{-2})
250
200
150
100
50
0
GDH1
PSM
HS
0
50
100
150
DEPTH (km)
3
4
5
6
7
GDH1
PSM
HS
0
50
100
150
AGE (Ma)

Figure 1