INTERNAL STRUCTURE OF THE EARTH
ACCORDING TO E. SUESS

NAME	THICKNESS	MATERIALS	DENSITY	REMARKS
SIAL	50-300 Km	Silica & Aluminium, Potassium and sodium	2.9	Continents are formed by this layer.
SIMA	1000-2000Km	Silica, Magnesium and calcium , iron mainly basic materials	2.9 -4.7	Oceanic crust are formed and source of lava and magma
NIFE	6880Km	Nickel(NI)+ Ferrium(FE), Heavy metal with very high density	11	This layer indicates the magnetic property and rigidity of earth

ACCORDING TO DALY

NAME	THICKNESS	MATERIALS	DENSITY
OUTER ZONE	1600 Km	Mainly silicates materials	3.0
INTERMEDIATE ZONE	1280 Km	Mixer of Iron & Silicates	4.5 - 9
CENTRAL ZONE	7040 Km	Iron and in solid state	11.6

ACCORDING TO VAN DER GRACHT

LAYER	THICKNESS	DENSITY
OUTER SIALIC CRUST	60 Km under continents, 20Km under Atlantic Ocean and Absent under Pacific Ocean	2.75 – 2.9
INNER SILICATE MANTLE	60-1140 Km	3.1 – 4.75
ZONE OF MIXED METALS AND SILICATES	1140 -2900 Km	4.75 – 5.0
METALLIC NUCLEUS	2900 - 6371	11.0

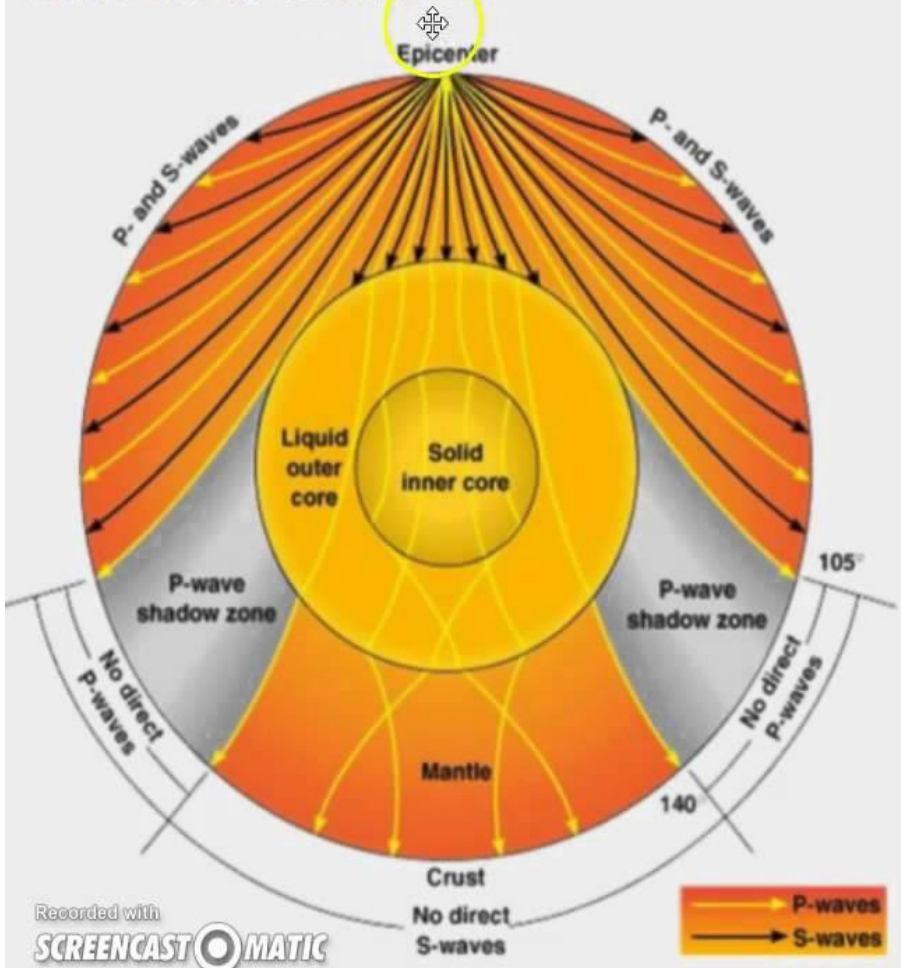
According to Harold Jeffreys:

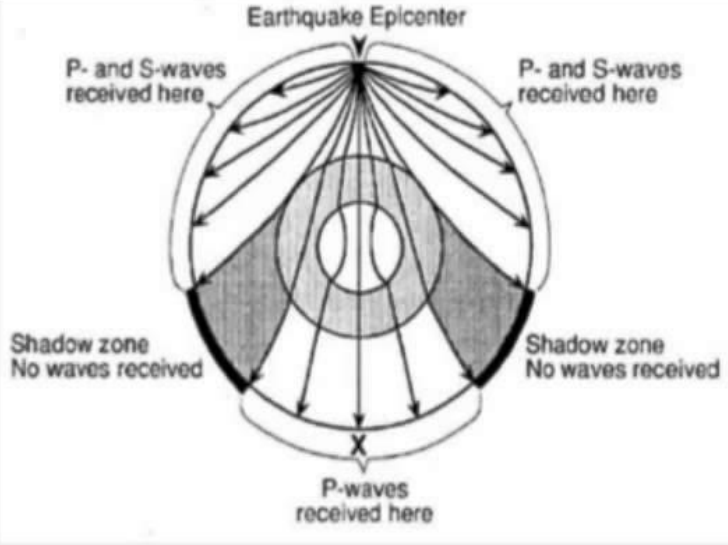
1. **Outer layer of sedimentary rocks**
2. **Second layer of granites**
3. **Third layer of diorite**
4. **Fourth layer of dunite**

Generalized Classification

- Lithosphere: 100Km thickness, composed of granites, silica and aluminium are dominant elements, average density is 3.5.
- Pyrosphere: 2780 Km thickness, dominant rock is basalt and average density is 5.6.
- Barysphere: 2800 to nucleus of the core, mainly composed of iron and nickel and average density 8-11.

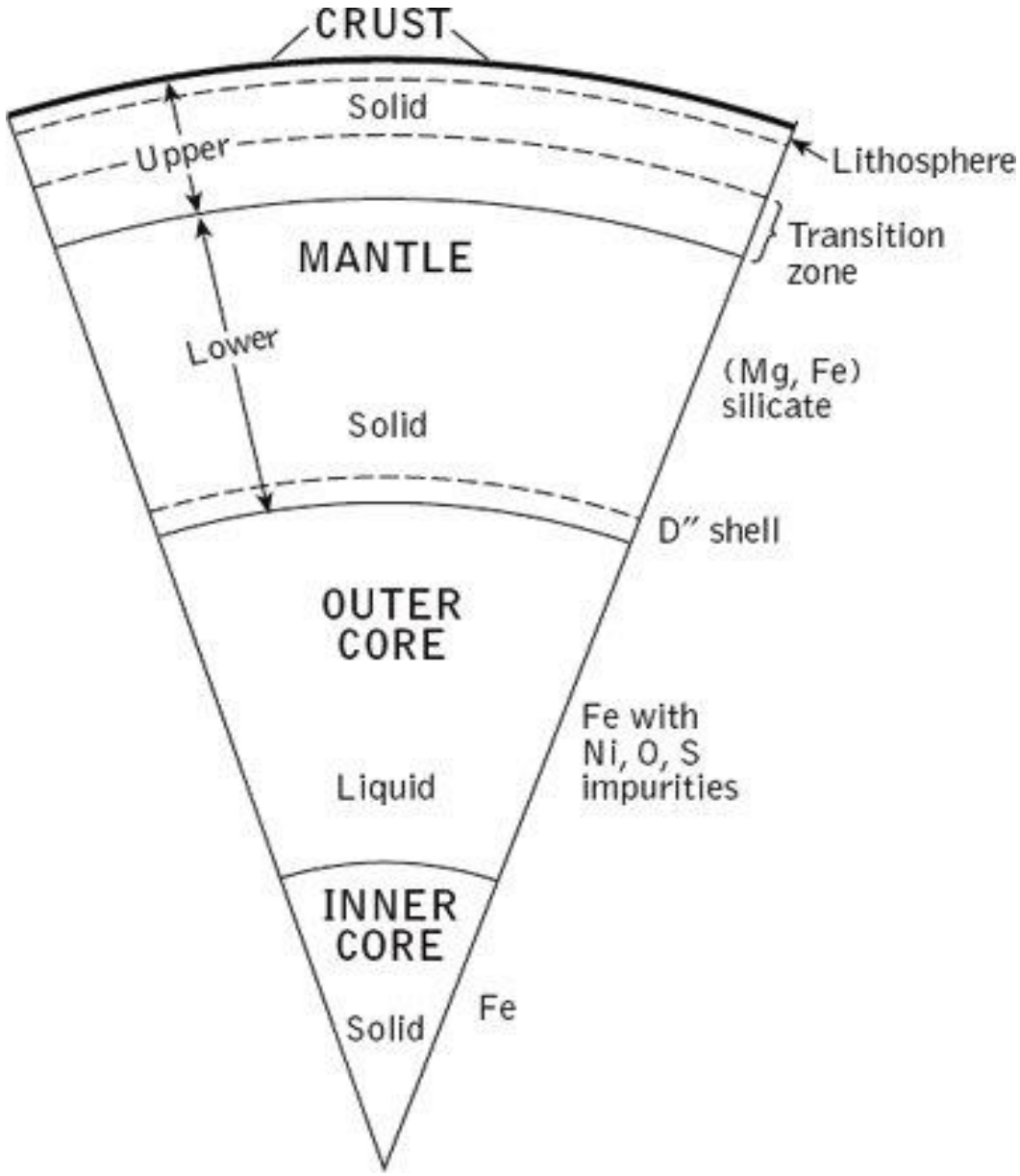
Shadow Zones

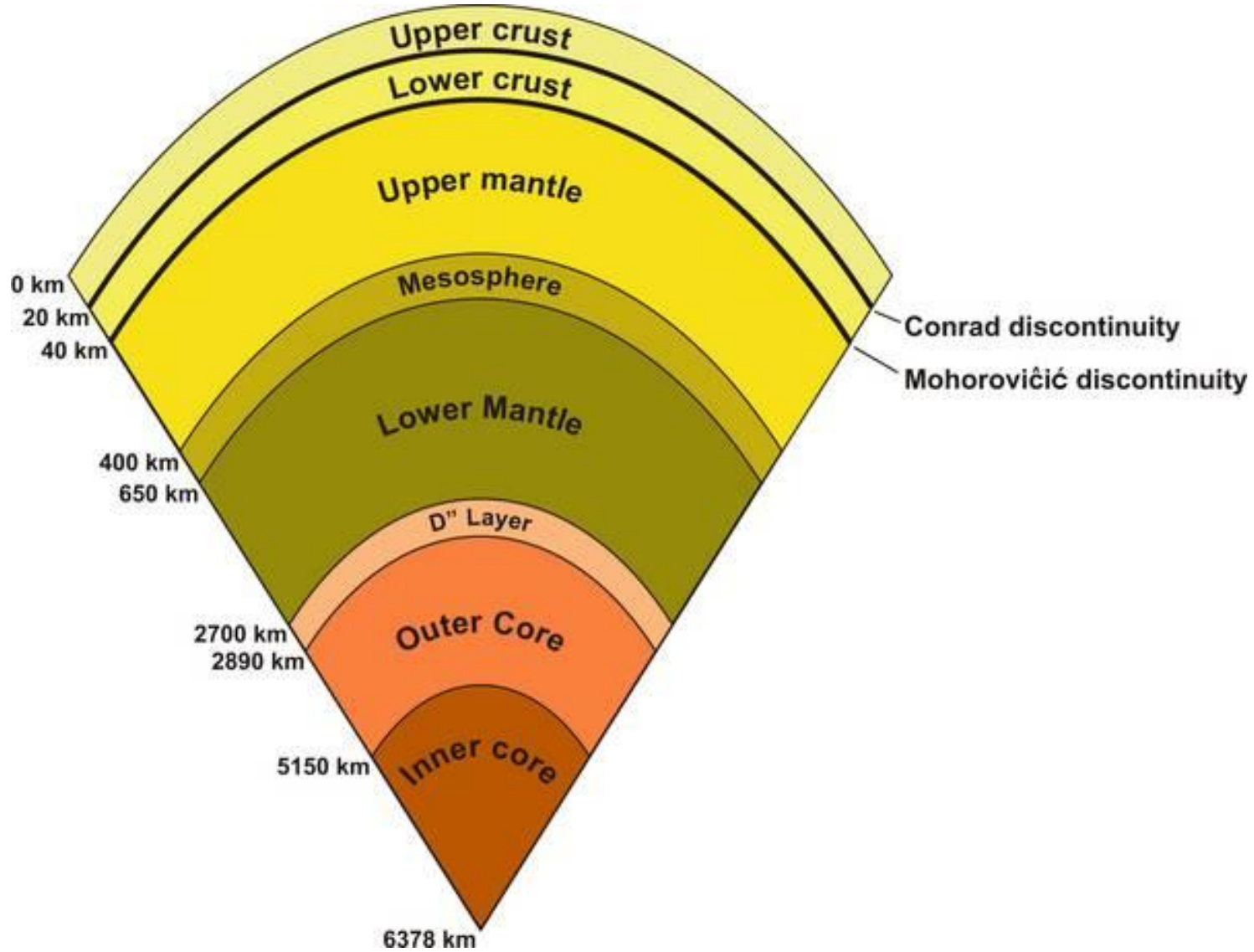


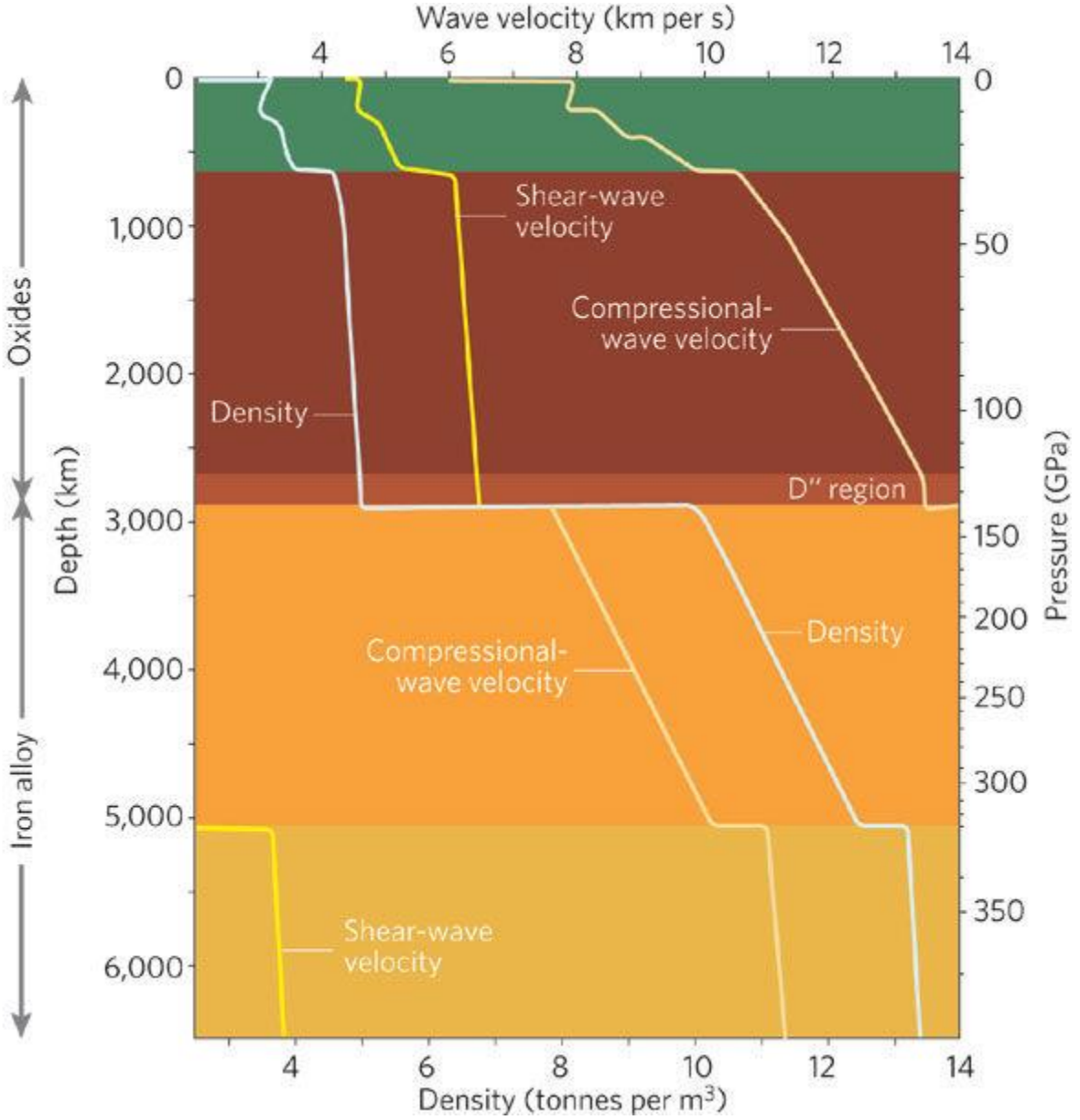


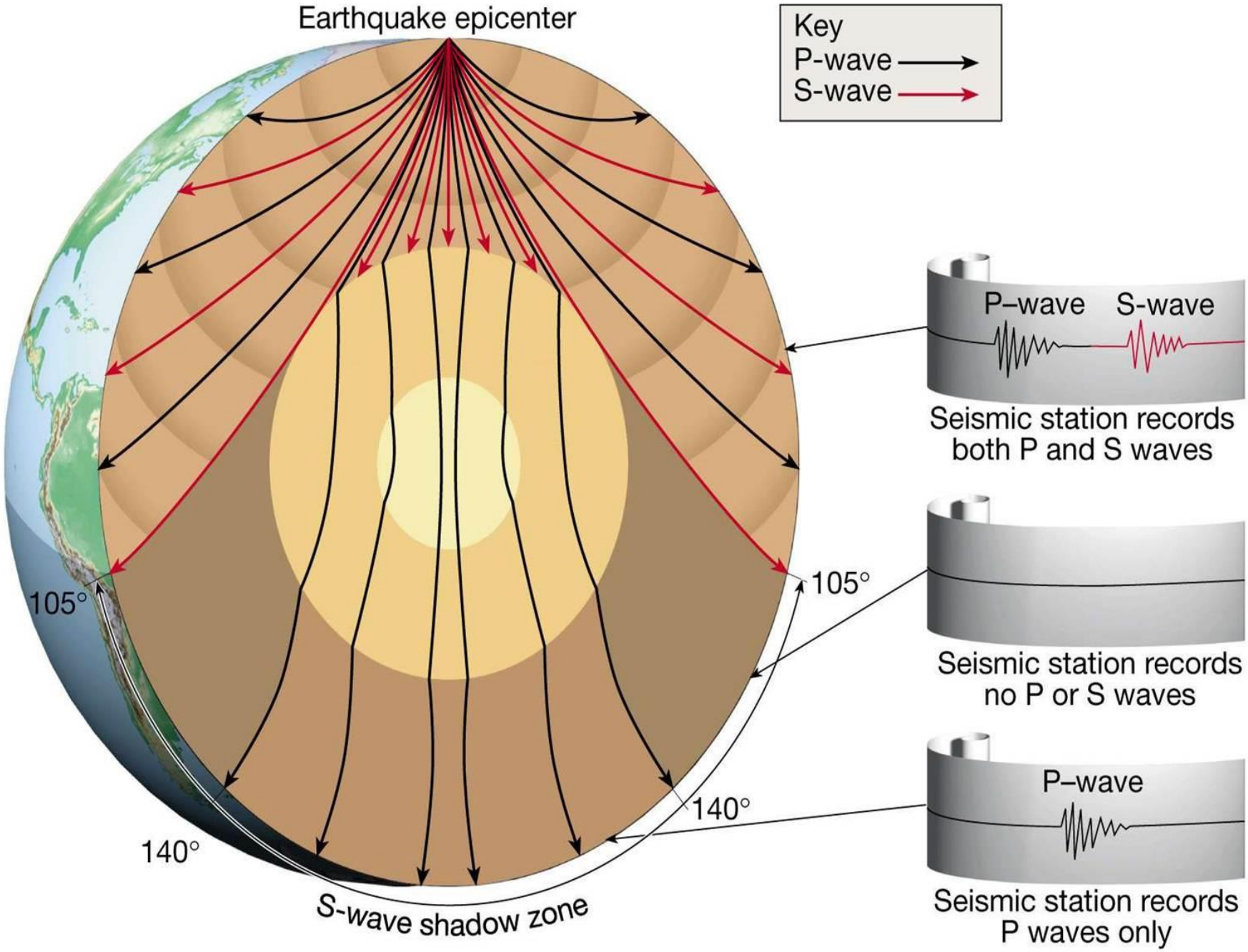
Due to REFRACTION, one can get a detailed 'visual' of the internal layers of the Earth, much like that of an ultrasound to see a baby!

The shadow zone of the S-wave and the P-wave provide the boundaries for calculating the size of the outer core. The time of the arrival of P-waves provide the density. The lack of S-waves provides the evidence the outer core is a liquid.

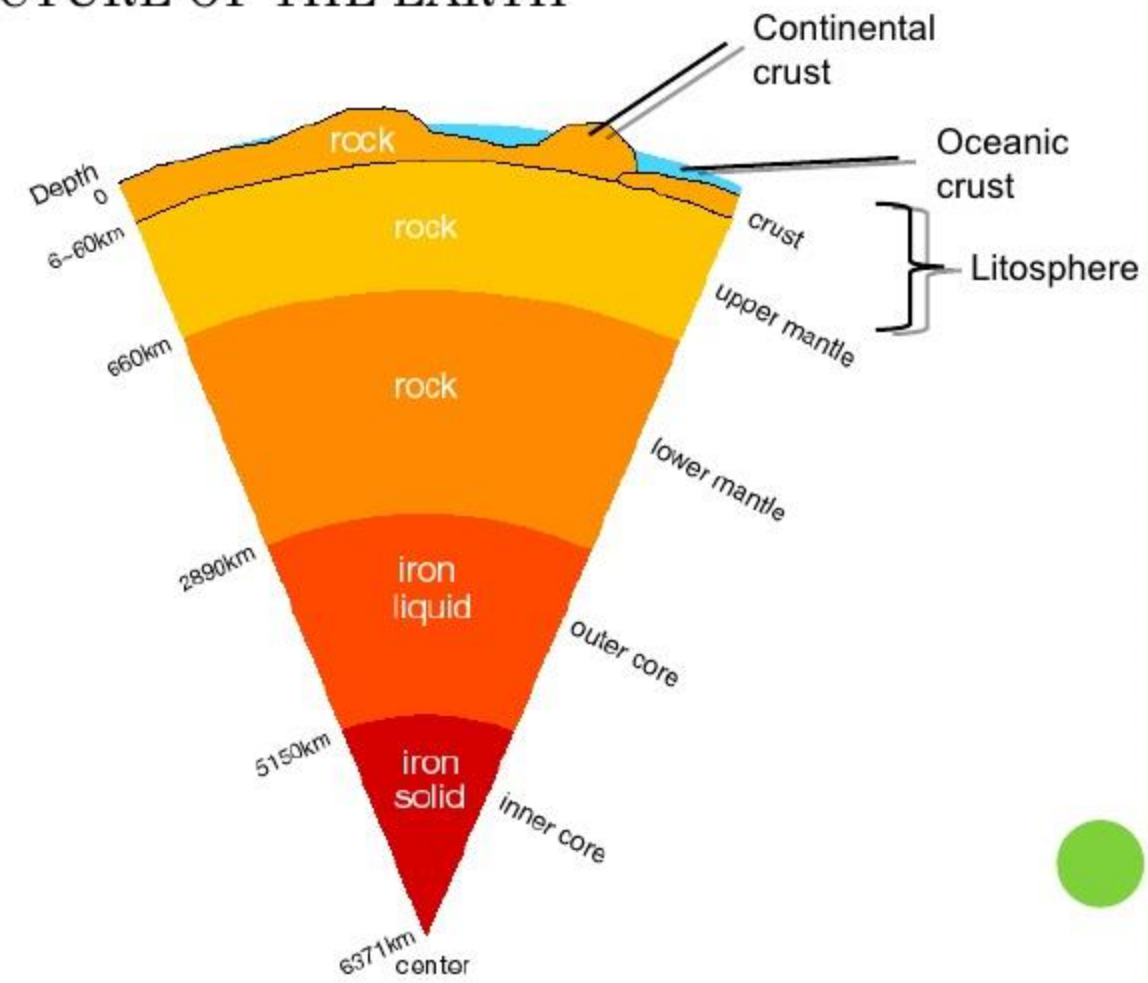

CRUST
Solid
Upper
Lithosphere
MANTLE
Transition zone
Lower
(Mg, Fe) silicate
Solid
D″ shell
OUTER CORE
Fe with Ni, O, S impurities
Liquid
INNER CORE
Solid
Fe


Upper crust
Lower crust
Upper mantle
Mesosphere
Lower Mantle
D" Layer
Outer Core
Inner core
0 km
20 km
40 km
400 km
650 km
2700 km
2890 km
5150 km
6378 km
Conrad discontinuity
Mohorovičić discontinuity


Wave velocity (km per s)
4
6
8
10
12
14
0
1,000
2,000
3,000
4,000
5,000
6,000
Depth (km)
Oxides
Iron alloy
Shear-wave velocity
Compressional-wave velocity
Density
D'' region
Density
Compressional-wave velocity
Shear-wave velocity
0
50
100
150
200
250
300
350
Pressure (GPa)
4
6
8
10
12
14
Density (tonnes per m3)



STRUCTURE OF THE EARTH



Seismic Waves			
Type (and names)	**Particle Motion**	**Typical Velocity**	**Other Characteristics**
P,Compressional, Primary, Longitudinal	Alternating compressions ("pushes") and dilations ("pulls") which are directed in the same direction as the wave is propagating (along the raypath); and therefore, perpendicular to the wavefront	$V_P \sim 5 - 7$ km/s in typical Earth's crust; $>\sim 8$ km/s in Earth's mantle and core; 1.5 km/s in water; 0.3 km/s in air	P motion travels fastest in materials, so the P-wave is the first-arriving energy on a seismogram. Generally smaller and higher frequency than the S and Surface-waves. P waves in a liquid or gas are pressure waves, including sound waves.
S, Shear, Secondary, Transverse	Alternating transverse motions (perpendicular to the direction of propagation, and the raypath); commonly polarized such that particle motion is in vertical or horizontal planes	$V_S \sim 3 - 4$ km/s in typical Earth's crust; $>\sim 4.5$ km/s in Earth's mantle; $\sim$ 2.5-3.0 km/s in (solid) inner core	S-waves do not travel through fluids, so do not exist in Earth's outer core (inferred to be primarily liquid iron) or in air or water or molten rock (magma). S waves travel slower than P waves in a solid and, therefore, arrive after the P wave.
L, Love, Surface waves, Long waves	Transverse horizontal motion, perpendicular to the direction of propagation and generally parallel to the Earth's surface	$V_L \sim$ 2.0 - 4.5 km/s in the Earth depending on frequency of the propagating wave	Love waves exist because of the Earth's surface. They are largest at the surface and decrease in amplitude with depth. Love waves are dispersive, that is, the wave velocity is dependent on frequency, with low frequencies normally propagating at higher velocity. Depth of penetration of the Love waves is also dependent on frequency, with lower frequencies penetrating to greater depth.
R, Rayleigh, Surface waves, Long waves, Ground roll	Motion is both in the direction of propagation and perpendicular (in a vertical plane), and "phased" so that the motion is generally elliptical – either prograde or retrograde	$V_R \sim$ 2.0 - 4.5 km/s in the Earth depending on frequency of the propagating wave	Rayleigh waves are also dispersive and the amplitudes generally decrease with depth in the Earth. Appearance and particle motion are similar to water waves.

LAYERING OF THE EARTHE INTERIROR

NAME	CHARACTERISTICS
CRUST	It is the outermost solid part of the earth, normally about 8-40 kms thick. It is brittle in nature. Nearly 1% of the earth's volume and 0.5% of earth's mass are made of the crust. The thickness of the crust under the oceanic and continental areas are different. Oceanic crust is thinner (about 5kms) as compared to the continental crust (about 30kms). Major constituent elements of crust are Silica (Si) and Aluminium (Al) and thus, it is often termed as **SIAL** (Sometimes SIAL is used to refer Lithosphere, which is the region comprising the crust and uppermost solid mantle, also). The mean density of the materials in the crust is 3g/cm3. The discontinuity between the **hydrosphere and crust** is termed as the **Conrad Discontinuity.**

NAME	CHARACTERISTICS
MANTLE	The portion of the interior beyond the crust is called as the mantle. The discontinuity between the **crust and mantle** is called as the **Mohorovich Discontinuity or Moho discontinuity.** The mantle is about 2900kms in thickness. Nearly 84% of the earth's volume and 67% of the earth's mass is occupied by the mantle. The major constituent elements of the mantle are Silicon and Magnesium and hence it is also termed as **SIMA**. The density of the layer is higher than the crust and varies from 3.3 – 5.4g/cm3. The uppermost solid part of the mantle and the entire crust constitute the **Lithosphere**. The **asthenosphere** (in between 80-200km) is a highly viscous, mechanically weak and ductile, deforming region of the upper mantle which lies just below the lithosphere. The asthenosphere is the main source of magma and it is the layer over which the lithospheric plates/ continental plates move (plate tectonics). The discontinuity between the **upper mantle and the lower mantle** is known as **Repetti Discontinuity**. The portion of the mantle which is just below the lithosphere and asthenosphere, but above the core is called as **Mesosphere**.

NAME	CHARACTERISTICS
CORE	It is the innermost layer surrounding the earth's centre. The **core is separated from the mantle by Guttenberg's Discontinuity**. It is composed mainly of iron (Fe) and nickel (Ni) and hence it is also called as **NIFE**. The core constitutes nearly 15% of earth's volume and 32.5% of earth's mass. The core is the densest layer of the earth with its density ranges between 9.5-14.5g/cm3. The Core consists of two sub-layers: the inner core and the outer core. The inner core is in solid state and the outer core is in the liquid state (or semi-liquid). The discontinuity between the upper core and the lower core is called as **Lehmann Discontinuity.** **Barysphere** is sometimes used to refer the core of the earth or sometimes the whole interior.

INNER Vs OUTER CORE

INNER

- Solid ball of iron , nickel and other materials
- Temperature: 5400 °C
- Density: 12.6-13g/cm3
- Pressure: High
- Radius:2890km

OUTER

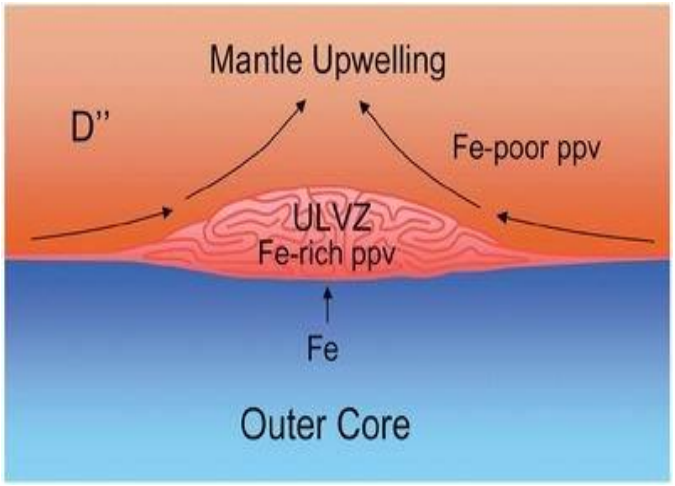
- Liquid metal composed of iron and nickel
- Temperature:3730-7730°C
- Density: 9.9-12.2g/cm3
- Pressure: Comparatively low
- Radius:2300km

P and S waves

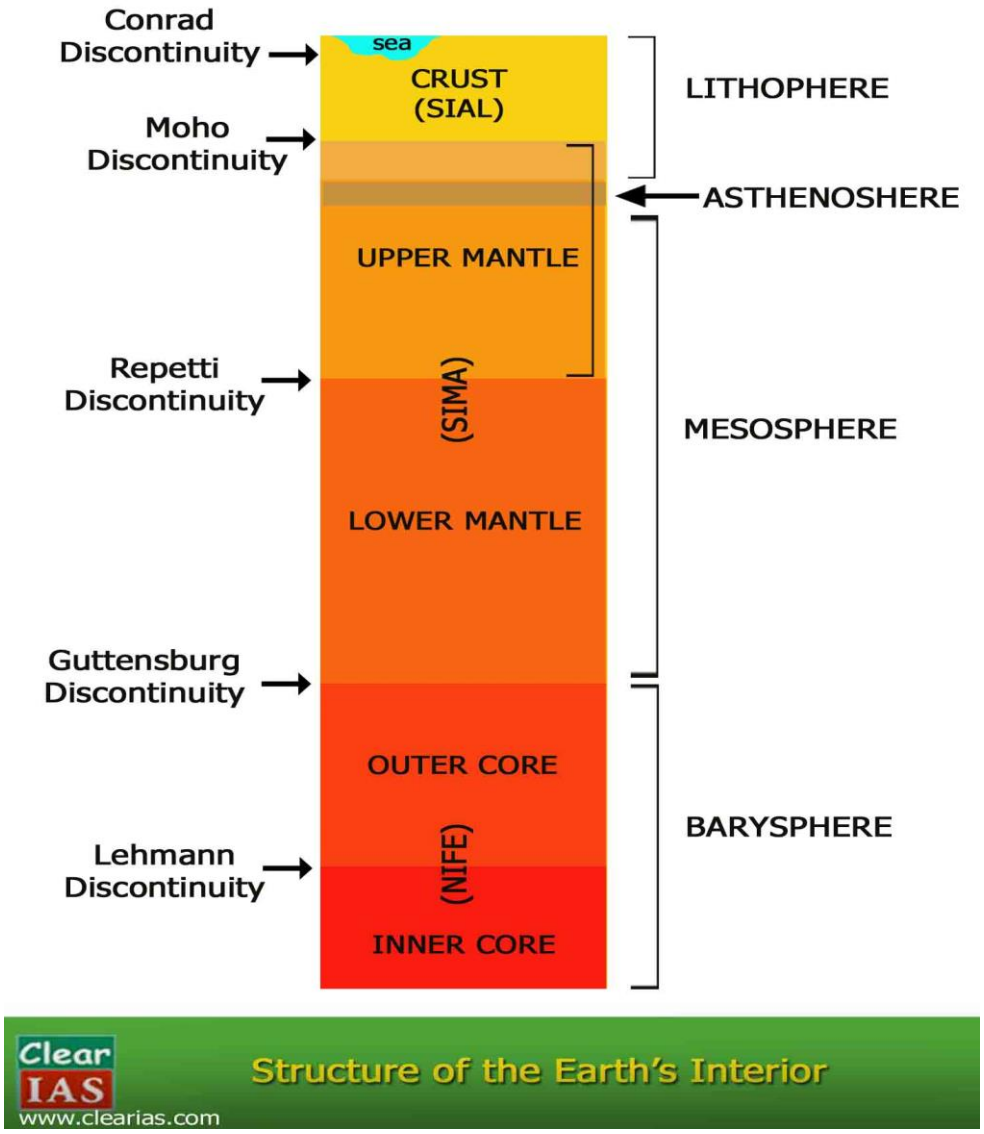
- First wave to hit seismograph
- Compression waves
- Shake the medium in the direction in which they area propagating
- Travel through solid, liquid and gases
- Speed greater than S waves

- Second wave to hit seismograph
- They are shear wave
- Shake the medium in the direction perpendicular to which they are moving
- Travel only through solid
- Slower than P waves

D-LAYER



The D" layer, the lowermost portion of the mantle, sits just above the molten iron-rich outer core. Seismic observations have revealed a region with an intriguingly complex signature. This relatively thin layer, varying around 250 km in thickness, may hold the key to understanding how the core and mantle interact. The D" layer may also be where deep mantle plumes originate and where subducting slabs terminate. Some of the most puzzling seismic features include the splitting of shear-waves travelling through this layer and the presence of ultralow-velocity zones (ULVZ). ULVZs are thin (5- 40 km thick) patches in which the compressional and shear wave velocities are depressed by 5-10% and 10-30%, respectively, relative to the neighboring region.


Conrad Discontinuity
sea
CRUST (SIAL)
LITHOPHERE
Moho Discontinuity
ASTHENOSHERE
UPPER MANTLE
Repetti Discontinuity
(SIMA)
MESOSPHERE
LOWER MANTLE
Guttensburg Discontinuity
OUTER CORE
BARYSPHERE
Lehmann Discontinuity
(NIFE)
INNER CORE
Clear IAS
www.clearias.com
Structure of the Earth's Interior