Lecture Notes – Week 4 Part 1

STRUCTURE OF THE EARTH: SEISMOLOGY

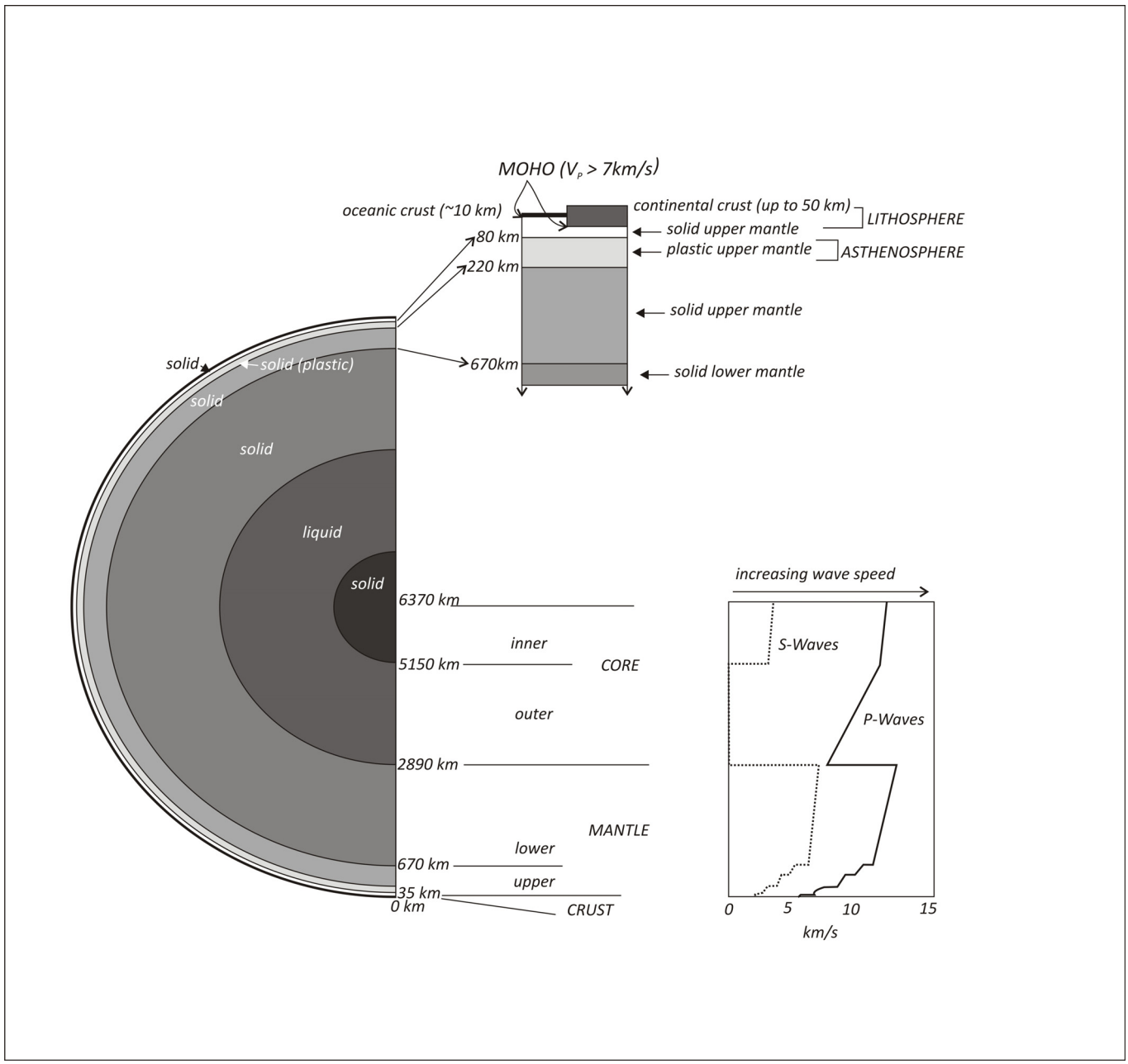
Applications to Earth Layering

Reading: Fowler, Chapter 8.1; Suggest reviewing relevant sections of supplementary text (e.g. Lowrie)

Objectives:

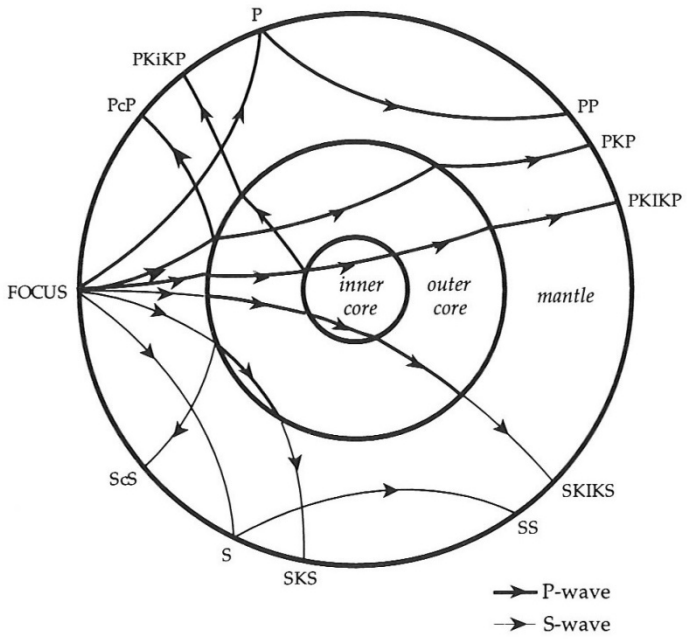
- **Review details of earth layering**
- Introduce some specific techniques and concepts used to describe/discuss wave interaction with earth layer
- Discuss specific evidence for properties of earth layering
- Introduce 'tomography'

Earth Layering:



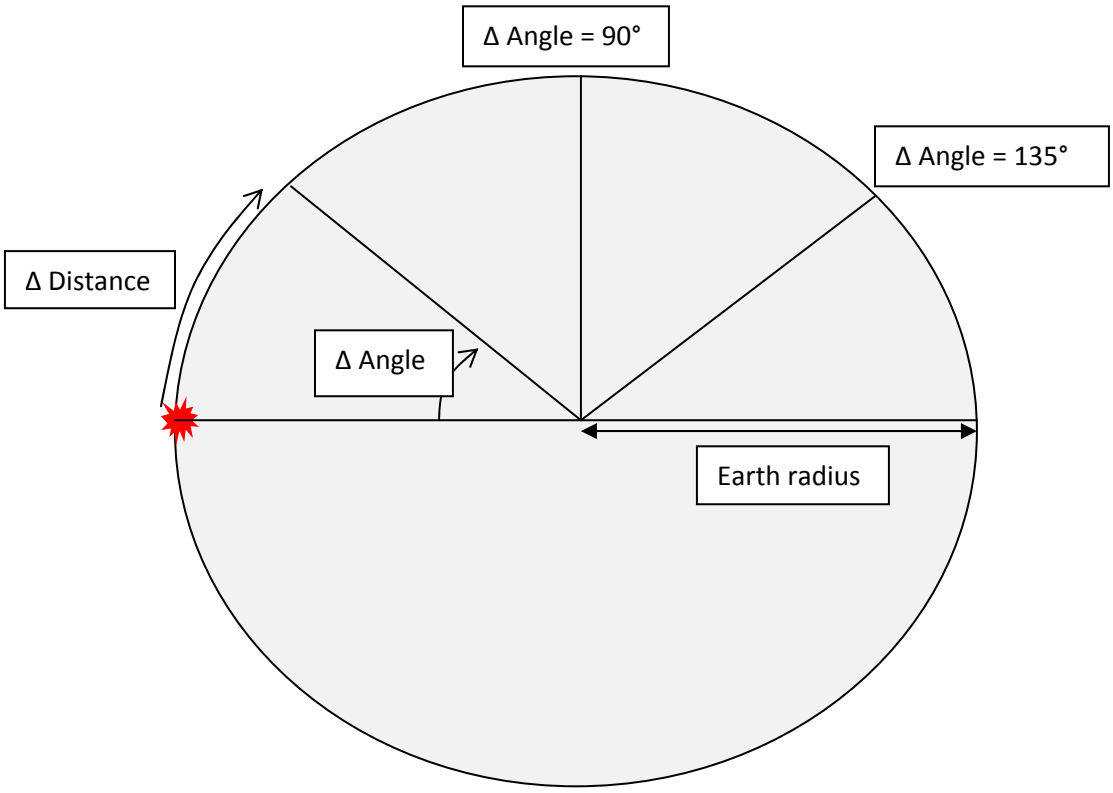
Wave Travel Notation:

- A short-hand notation is used to differentiate waves received at a surface station, based on the path of the ray, the layers it passed through and reflected from(Figure 3.70 from Lowrie, 1997: Fundamentals of Geophysics)

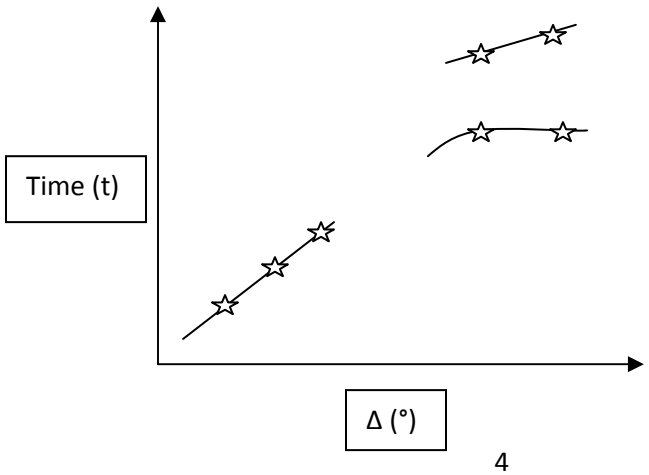


- '**P**' for P-wave; '**S**' for S-wave
- The term 'direct' wave often used to refer to the wave that starts as a P-wave or S-wave and arrives as a P-wave or S-wave, as opposed to the secondary waves that are generated by partitioning at interfaces
- Both the **P** and **S** waves follow identical curved paths through the crust and mantle (approximation), but diverge at the mantle-outer core boundary
- The Core is identified by the letter '**K**' ('kern' = core in German), so a P-wave that travels from the source, through the core, to the surface again is a **PKP**
- The SKS wave starts as a shear wave and arrives at the surface as a shear wave, but of course it propagates through the outer core as a P-wave
- The inner core is designated with the letter '**I**', so a P-wave that travels from the source, through the inner and outer core, and back to the surface is a '**PKIKP**'
- Likewise the S-wave that travels through the inner and outer core (partly as a P-wave) and to the surface is an **SKIKS**
- **Reflections** often given a lower-case letter 'c' or 'i' for reflections from outer and inner core (e.g. PKiKP)
- **Note that the outer core is liquid so is a 'low velocity zone', so wave refraction is *toward* the normal plane ($r_P < i_P$)**

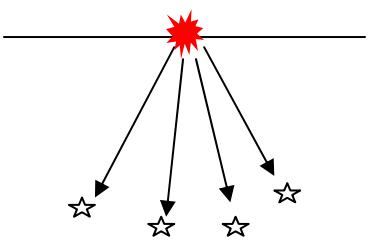
Epicentral distance (Δ): Sometimes refers to distance along earth's surface from source to sensor. *Usually refers to the radial angle between the source and the sensor (Δ°) or location on the surface where a given wave was received.*



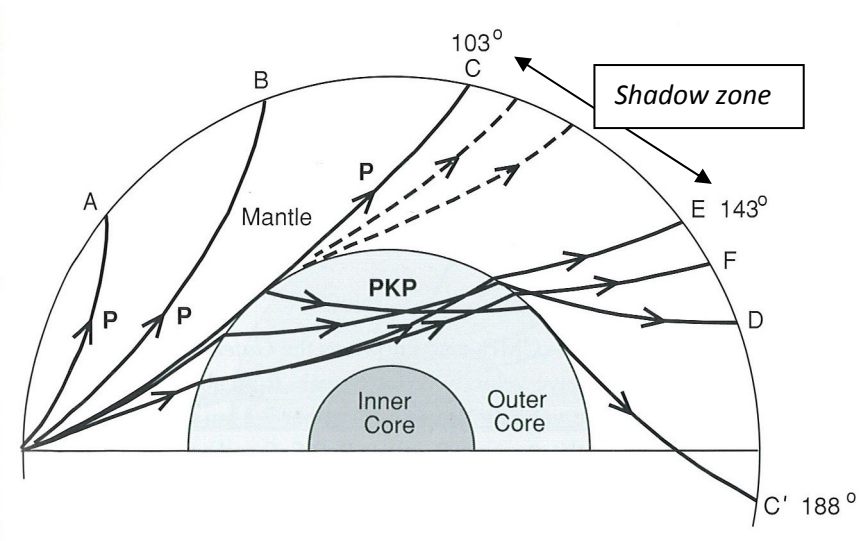
To solve whole-earth layering problems, use time/epicentral distance curves with arrival of different waves plotted (see figure 8.2 in Fowler):



Each point represents a different 'ray' propagating from the source in a different direction (e.g. different i_P)



Wave Shadows: The original evidence for modeling the earth's interior comes from the lack of waves arriving at certain epicentral distances (Figure 8.3 from Fowler, 2004. The Solid Earth):



- Note the curved ray-paths, and the refraction at the outer core *toward* the normal, followed by a refraction *away* from the normal back into the mantle
- This leads to a divergence of ray paths that do not interact with the core, those that glance it, and those that are refracted through it
- Between Δ 103° and 143° a weak 'diffracted' P-wave can be heard (dashed ray)