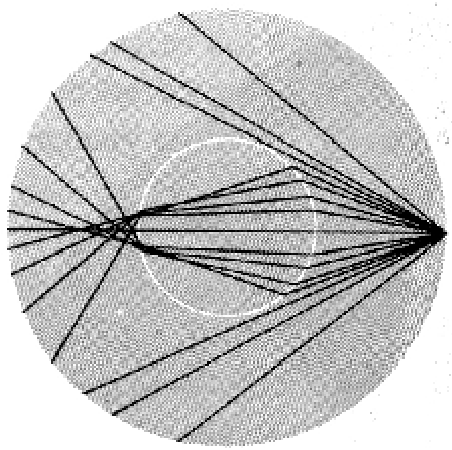
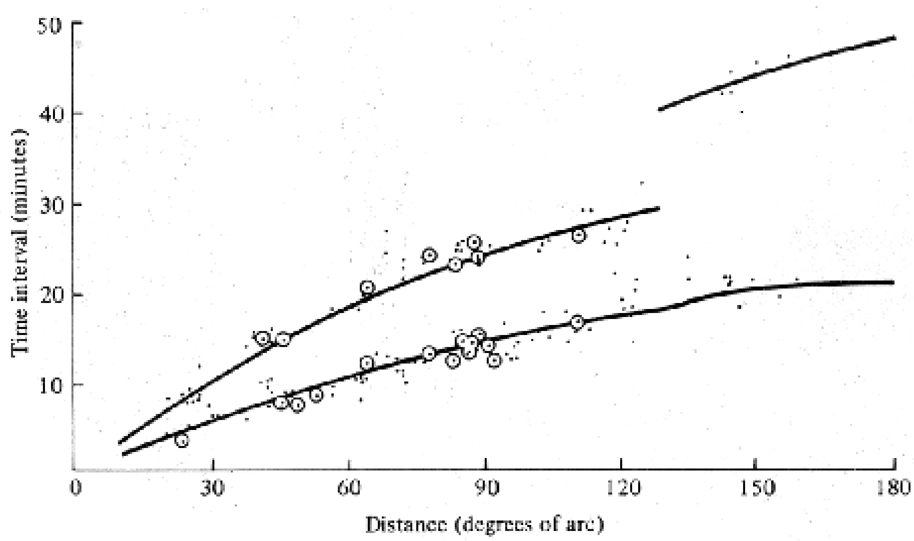
2.2 DISCOVERY OF THE THE CORE

Only three years before Mohorovic's work, an equally major discovery had been made. In 1906, Oldham presented the following data, using the system of indicating distance (delta) in degrees (°). $1° = \frac{(2\pi \mathrm{r})}{360} = 111\mathrm{km}$ He observed that P wave travel times are smooth out to ~ 150 ° but, beyond 130 degrees, the travel curve is offset and flatter. Also, S waves had a 10 minute delay at 130 °.



Paths of seismic waves through the Earth assuming a core of radius 0.4*R*, in which the speed is 3 km/sec, while the speed outside it is 6 km/sec. [From Oldham, 1906.]



Time curves of first and second phases of preliminary tremors. The marks surrounded by circles are averages. [From Oldham, 1906.]

Bolt [1982]

His interpretation was that the later portions are due to ray paths through a central core of much slower material, where P-waves slowed, and S waves were absent.

He used a simple and clever model of two unifrom shells; an outer one with velocity 6 km/sec, and an inner one with 3 km/sec. Snell's law predicts that no direct rays arrive in a "shadow zone" between about 105 ° and 142°, and a zone 142 ° - 180 ° with arrivals throught the slower core. Further study showed that P arrivals are very weak in the shadow zone, and that S waves were not clear in the shadow zone.

It is now clear that there are several errors in Oldham's indentification, but his discovery is a major one. In particular, it became clear that S waves were not passing through the core, and in 1926 Harold Jeffreys used theoretical calculations to show that the core was fluid.

INNER CORE

A further breakthrough came in 1936, when Inge Lehman explained the weak P wave arrivals that occurred in the shadow zone by proposing an *inner core* with velocities higher then the *outer core*. Because the inner core has higher *P* wave velocity than the outer core, waves refract upward and emerge in the shadow zone. These phases are known (using a nomenclature we will soon discuss) as *PKIKP*, because *P* waves in the inner core are denoted by *"I"*. In addition, waves reflect at the boundary between the inner and outer cores, giving the phase *PKiKP.*

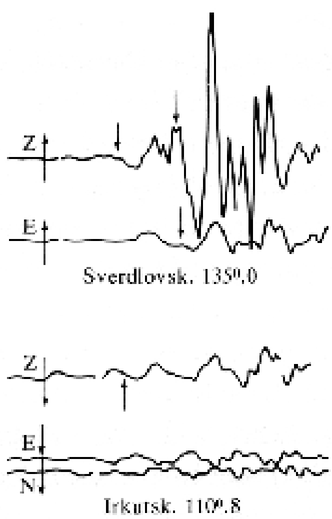
Box 1.4 The Seismological Discovery of the Earth's Inner Core

P′

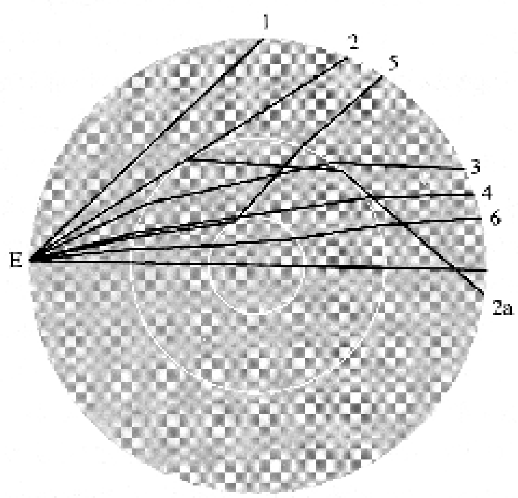
By I. Lehmann

An explanation of the P_3' wave is required, since now it can hardly be considered probable that it is due to diffraction. A hypothesis will here be suggested which seems to hold some probability, although it cannot be proved from the data at hand.

We take it that, as before, the earth consists of a core and a mantle, but that inside the core there is an inner core in which the velocity is larger than in the outer one. The radius of the inner core is taken to be $r_1 = \frac{8}{10} r_0 \text{ sine } 16° = 0.2205\, r_0$, so that the ray whose angle of incidence at the surface of the earth is 16° just touches the inner core.



June 16, 1929, P_3' records



Paths through the Earth with inner and outer cores. [From Lehmann, 1936.]

From I. Lehmann, "*P′*," Bureau Central Seismologique International, Series A, *Travaux Scientifique*, *14*, 88, 1936.