The Interior of the Earth Was Read Not from the Waves That Arrived but from the Ones That Did Not

— Taking the core radius ratio at **0.546225**, plain straight-line geometry with no refraction puts the epicentral distance of a ray grazing the core at **113.783157** degrees — the separator is whether the evidence is a presence or an absence — [Paper 688]

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— From thinking to syncing. —

Abstract

Nobody has seen the inside of the Earth. Its layers are known because it was measured that waves do not arrive over a certain range.How much information an absence carries is counted here from the geometry of a shadow.No new theorem or law is claimed. First, and this is the core. The onset of the shadow alone gives the radius of the core——straight-line geometry with no refraction, inverted from the observed 103 degrees, returns 3966.0408 km, differing from the true 3480 km by 0.139667 (Section 2). **Second, solved forwards it lands in the same range——a core radius ratio of 0.546225 puts the grazing ray at 113.783157 degrees, alongside the observed 103** (Section 2). **Third, the shadow is measured over more than a third of the Earth——the area receiving no S waves is 0.387524 of the surface** (Section 3). **Fourth, inside it lies a band with no P waves either——the band from 103 to 143 degrees covers 0.286842 of the surface, and the difference between the two widths separates a liquid core from the bending of waves within it** (Section 3). **Fifth, by volume the core is a sixth of the Earth——the radius ratio of 0.546225 gives a volume ratio of 0.162973** (Section 3). **Sixth, the separator is whether the evidence is a presence or an absence——an arriving wave reports one path; a region of non-arrival reports the position of a boundary** (Section 4). **Keywords**: seismic shadow zone, outer core, inverse problem, evidence from absence, epicentral distance, layers of the Earth.

Scope of this paper (scope note): **No new theorem or law is claimed——the P and S shadow zones, the liquid outer core and its radius are all standard (Gutenberg 1913, Lay and Wallace 1995).Travel times are not computed——refraction within a sphere is not treated. Only one line of straight-ray geometry is used, and its coarseness is stated as the number 0.139667.The inner core is not treated——detecting the solid inner core, identifying discontinuities and any finer division into layers are not the subject.Composition is not discussed——the material, temperature and density profile of the interior are not treated; densities appear only as representative values for comparison.Records are not treated——individual earthquakes, network geometry and hypocentre determination are not treated, and the 103 and 143 degrees are customary representative values.Relation to earlier papers**: **Paper 99 treated the inverse problem of reading an interior from values on its boundary——there the data present on the boundary fixed the interior; here the absence of data on the boundary does. The same inverse problem, with the information carried the other way round.**What is added is **inverting the shadow onset to a core radius and putting the discrepancy at 0.139667**, **setting it beside the forward value of 113.783157 degrees**, **counting the shadow as a fraction of the Earth's surface**, **separating the S and P shadows at 0.387524 and 0.286842**, and **placing the separator on presence against absence**.

1. Notation and the Question

Setting: **inside a sphere of radius R sits a core of radius R_c. A straight ray from the source grazing the core cuts the surface at two points; the angle they subtend at the centre is the epicentral distance.**

$$\Delta_{\text{graze}} = 2\arccos\frac{R_c}{R}, \qquad R_c = R\cos\frac{\Delta}{2}, \qquad A(\Delta) = \frac{1-\cos\Delta}{2}$$

$A(\Delta)$ is the fraction of the surface within an angular distance Δ of the epicentre; it was checked to give $A(180^\circ) = 1$ and $A(90^\circ) = 0.5$.

Question: **how much information does the fact that waves do not arrive carry?**

2. The Onset of the Shadow Fixes the Core

Computation 2.1: **with a core radius of 3480 km and an Earth radius of 6371 km the ratio is 0.546225, and the grazing ray subtends 113.783157 degrees.**

Computation 2.2: **inverted, the observed onset at 103 degrees returns a core radius of 3966.0408 km, a ratio of 0.622515, differing from the true value by 0.139667.**

> **Observation 2.3**
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> **this is the core: one line of geometry with no refraction gives the radius of the core to fourteen per cent.The only information used is that beyond some angle no wave arrives——however precisely the travel time of an arriving wave is measured, that is information about a path; the position of the boundary is reported by the edge of the shadow.**

> **Observation 2.4**
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> **the sign of the discrepancy means something too.The straight-ray estimate makes the core too large. Rays bend downward in the mantle, where speed increases with depth, so the real shadow begins nearer than straight rays predict——the residual 0.139667 is exactly the price of leaving refraction out.**

3. How Wide the Shadow Is

Computation 3.1: **the fractions of surface area were derived.**

region	fraction of the Earth's surface
beyond **103** degrees (S shadow)	**0.387524**
the band **103** to **143** degrees (P shadow)	**0.286842**
within **90** degrees (hemisphere; check)	**0.500000**
within **180** degrees (whole sphere; check)	**1.000000**

> **Observation 3.2**
>
> **the difference between the two widths separates two properties of the core.S waves are absent everywhere beyond 103 degrees, while P waves reappear beyond 143, having been bent around——one core both refuses shear waves and refracts compressional ones, and the shape of the shadow carries both facts at once.**

Computation 3.3: **from the radius ratio 0.546225 the core is 0.162973 of the Earth by volume; with representative densities of 10900 and 4500 kg/m³ that is 0.320475 by mass.**

Observation 3.4

half by radius is a sixth by volume.“The core is half the size of the Earth” is a statement about radius; by volume it is 0.162973——without naming the quantity every time, a factor of more than three goes astray.

4. The Separator

Observation 4.1

the separator is whether the evidence is a presence or an absence.An arriving wave reports one path; a region over which nothing arrives reports the position of the boundary that casts it——the first is information about a point, the second about an area.

Observation 4.2

beside Paper 99.Paper 99 treated the inverse problem of reading an interior from values on its boundary ——there data present on the boundary fixed the interior; here the absence of data does. An inverse problem can take an absence of values as its input.

Observation 4.3

what is not said.Travel times, refraction, the inner core and composition are not treated, and the shadow angles are representative——what is shown is that one absence fixes the radius of the core to fourteen per cent.

5. Roll Call and Closing

1. **radius ratio 0.546225** (Computation 2.1): **3480/6371.**
2. **grazing at 113.783157 degrees** (Computation 2.1): **solved forwards.**
3. **inverted to 3966.0408 km** (Computation 2.2): **from the onset alone.**
4. **discrepancy 0.139667** (Computation 2.2): **the core; fourteen per cent.**
5. **S shadow 0.387524** (Computation 3.1): **over a third of the surface.**

6. **P shadow 0.286842** (Computation 3.1): **the band 103 to 143.**
7. **0.500000 and 1.000000** (Computation 3.1): **the formula checked.**
8. **core is 0.162973 by volume** (Computation 3.3): **though half by radius.**
9. **0.320475 by mass** (Computation 3.3): **with representative densities.**
10. **presence or absence** (Observation 4.1): **the separator; Paper 99.**

Closing: **The interior of the Earth was read not from the waves that arrived but from the ones that did not.Inverting the observed shadow onset of 103 degrees through straight-line geometry with no refraction returns a core radius of 3966.0408 km, differing from the true 3480 km by 0.139667——the only information used is that beyond some angle no wave arrives.Solved forwards, a radius ratio of 0.546225 gives 113.783157 degrees, in the same range.The shadow is not narrow——0.387524 of the surface receives no S waves, and a band covering 0.286842 receives no P waves either; the difference between the two widths carries at once that the core refuses shear waves and refracts compressional ones.By radius the core is nearly half the Earth, by volume 0.162973——the quantity must be named every time.The separator is whether the evidence is a presence or an absence.Placed among the earlier papers——in Paper 99 data present on the boundary fixed the interior; here the absence of data does.To be honest——travel times, refraction and the inner core are not treated, and the shadow angles are representative.**

References

1. Gutenberg, B. (1913). Uber die Konstitution des Erdinnern, erschlossen aus Erdbebenbeobachtungen. *Physikalische Zeitschrift*.
2. Lay, T., & Wallace, T. C. (1995). *Modern Global Seismology*. Academic Press.
3. Yamagishi, Y. (2026). *Reading the Interior from the Boundary* [Paper 99]. Zenodo. 10.5281/zenodo.21758790

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