Signals Below Ground

Use wave speeds and magnetic evidence to investigate Earth's layers.

ESS.2A.2 "Analyze and interpret data to explain and communicate the differentiation of Earth's physical divisions (e.g., lithosphere and asthenosphere) using data from seismic waves and Earth's magnetic field."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline two wave-speed changes in the table, then number the passage sentences that help you interpret each change. Circle one sentence that explains what magnetic evidence can tell you.

Clues from an Ocean Basin

(1) Earthquake waves let scientists probe rock they cannot reach. P waves travel through solids and liquids, but S waves travel only through solids. The table lists wave speeds estimated at four depths beneath one ocean basin. Each speed describes conditions at that depth, not an average for an entire layer. Compare both wave types before drawing a boundary.

ESTIMATED WAVE SPEEDS BENEATH ONE OCEAN BASIN

Depth (km)	P-wave speed (km/s)	S-wave speed (km/s)
60	8.1	4.5
160	7.7	4.2
300	8.5	4.7
3,000	8.2	No S-wave travel

(2) Earth's lithosphere is the rigid crust and uppermost mantle. Below it, the asthenosphere is solid mantle that can flow slowly over geologic time. Hotter, less rigid rock may slow seismic waves without becoming liquid. A speed change can suggest a transition, but measurements at widely spaced depths cannot locate a boundary exactly.

(3) Deep inside Earth, a liquid outer core surrounds a solid inner core. Moving, electrically conducting iron alloy in the outer core generates most of Earth's magnetic field. A magnetic field supports the presence of moving conductive material, but it does not show the depth of a boundary by itself. Combine magnetic evidence with seismic data when describing Earth's interior.

2 ANSWER WITH EVIDENCE

Use the passage

1. Compare both wave speeds at 60 km and 160 km. What division might this change suggest, and why?

2. Both waves travel at 160 km and 300 km, but their speeds differ. What does this evidence suggest about the material at those depths?

3. How does the difference in S-wave travel at 300 km and 3,000 km support a division inside Earth?

4. What does Earth's magnetic field add to the seismic evidence at 3,000 km, and what can it not tell you?

3 YOUR TURN

Your own words

At a second ocean site, estimated P- and S-wave speeds are 8.1 and 4.5 km/s at 40 km, then 7.7 and 4.2 km/s at 80 km. Write a short field report comparing this site with the table's site. Explain what division the new data suggest, one limit of the depth measurements, and whether magnetic evidence could settle that limit.

Signals Below Ground

PART 1 · READ AND MARK

Underline two wave-speed changes in the table, then number the passage sentences that help you interpret each change. Circle one sentence that explains what magnetic evidence can tell you. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Compare both wave speeds at 60 km and 160 km. What division might this change suggest, and why?	**Both waves slow at 160 km. This suggests a transition from rigid lithosphere toward less rigid asthenosphere, though the data do not locate the boundary exactly.**
2	Both waves travel at 160 km and 300 km, but their speeds differ. What does this evidence suggest about the material at those depths?	**The material at both depths is solid because S waves travel through it. The lower speeds at 160 km suggest less rigid rock than at 300 km.**
3	How does the difference in S-wave travel at 300 km and 3,000 km support a division inside Earth?	**S waves travel at 300 km but not at 3,000 km. This supports a division between solid mantle and the liquid outer core.**
4	What does Earth's magnetic field add to the seismic evidence at 3,000 km, and what can it not tell you?	**The field supports the presence of moving, electrically conducting material in the outer core. It cannot locate the core boundary by itself.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

At the second site, both waves slow between 40 and 80 km, suggesting a transition from rigid lithosphere toward less rigid asthenosphere. The table shows a similar slowdown between 60 and 160 km, so the transition may be shallower at the second site. Neither set of measurements locates an exact boundary because the sampled depths are far apart. Earth's magnetic field cannot settle this question because it does not show lithosphere thickness.

Accept a supported comparison that describes a possibly shallower transition without claiming an exact boundary. Students should distinguish magnetic evidence for the outer core from seismic evidence about the lithosphere and asthenosphere.