RLP-ESA · RLP Earth Science A — The Universe, Deep Time and a Changing Surface

Unit 3: Plate Tectonics from the Middle of a Plate: Missouri and the New Madrid Seismic Zone

Practice Workbook. The same problems, in the same order, as the Practice sections of the online lessons.

Name _____ Period _____

Lesson 3.1 — A Missouri Earthquake and the Moving Plates

FLUENCY

1. A magnetic stripe boundary 2.0 million years old lies 60 km from a ridge axis. What is the spreading rate on that side, in cm per year?

2. Sea floor 900 km from a ridge moved away at 2.5 cm/yr. How old is it?

3. GPS station MACC in St. Francois County, Missouri, moves 14.5 mm/yr toward the west, measured against Earth as a whole. How far does it move in 25 years?

APPLICATION

4. The Atlantic is about 5,000 km wide and widens at about 2.5 cm/yr (full rate). About how long ago did it start to open, assuming a steady rate?

5. Explain why the oldest ocean floor is about 180 million years old while continental rocks reach 4 billion years.

6. A volcanic island 480 km from a hotspot is 5.0 million years old (illustrative values). How fast has the plate moved over the hotspot?

CHALLENGE

7. If a 10,000 km-wide ocean plate moves toward a trench at 5.5 cm/yr, how long does it take for crust formed at the ridge to reach the trench? Compare with the age of the oldest ocean floor.

REVIEW

8. A wood sample has 12.5% of the carbon-14 of living wood. Using a half-life of 5,730 years, estimate its age.

9. A wood sample has 35% of the carbon-14 of living wood. Using a half-life of 5,730 years, estimate its age.

Lesson 3.2 — Seismic Waves and Earth's Layered Interior

FLUENCY

1. A sound in air (speed 343 m/s) has wavelength 1.56 m. What is its frequency?
2. An S-P lag of 6.0 s is recorded. Using d = 8.4 × lag, how far away is the earthquake?
3. An S-P lag of 15 s: how far?
4. An earthquake is 84 km from a station. What S-P lag would the station record?

APPLICATION

5. Earth's mass is 5.972×10^{24} kg and its radius 6,371 km. Find its average density in g/cm^3 and compare with granite (2.7). What does the difference imply?

6. The core-mantle boundary is at 2,890 km depth. What fraction of Earth's radius and of Earth's volume does the core occupy?

7. Three stations record S-P lags of 5.0 s, 8.0 s and 12.0 s. Find the three distances and explain how they locate the epicenter.

CHALLENGE

8. Derive the S-P factor: if P waves travel 6.0 km/s and S waves 3.5 km/s, show that d = 8.4 × lag. Then find the factor for deeper rock where P = 7.0 km/s and S = 4.0 km/s.

REVIEW

9. Review (Unit 2): a mineral has 1 daughter atom per 1 parent atom. How many half-lives have passed?

Lesson 3.3 — How Fast Is the New Madrid Seismic Zone Loading?

FLUENCY

1. Compare a magnitude 6.0 earthquake with a magnitude 5.5 earthquake. About how many times larger is the ground-motion amplitude, and about how many times more energy is released?

2. Compare a magnitude 7.0 earthquake with a magnitude 6.0 earthquake. About how many times larger is the ground-motion amplitude, and about how many times more energy is released?

3. Compare a magnitude 5.5 earthquake with a magnitude 5.0 earthquake. About how many times larger is the ground-motion amplitude, and about how many times more energy is released?

4. A fence across a fault is offset 16 m over 500 years of steady creep. What is the creep rate in mm/yr?

APPLICATION

5. The Reelfoot scarp records about 13.7 m of fault slip. At 6.0 mm/yr, how long did that slip take to accumulate?

6. Use $\log_{10}N = 5.52 - 1.19M$ (25-year counts, USGS New Madrid box) to predict the number of $M \geq 3.5$ earthquakes, and compare with the observed 26.

7. The USGS catalog lists 1,420 earthquakes of M ≥ 2.0 in the New Madrid box over 25 years. What is the average number per year and per week?

CHALLENGE

8. How many M4.0 earthquakes release the same energy as one M7.5, like the December 1811 shock? Compare with the 6 events of M ≥ 4.0 recorded in the New Madrid box in 25 years, and explain what this means for the claim that small earthquakes 'relieve the pressure'.

REVIEW

9. A wood sample has 35% of the carbon-14 of living wood. Using a half-life of 5,730 years, estimate its age.

10. Review (Unit 1): a satellite at a = 4 AU from the Sun has what period?

Lesson 3.4 — How Missouri's Crust Was Assembled

FLUENCY

1. At 6 mm/yr, the Reelfoot fault's average rate over the last 2,300 years, how far would it slip in 1 million years?

2. A range rises 5 mm/yr and erodes 2 mm/yr (illustrative). How much does it gain in 1 million years?

3. A 9 m slip in one earthquake happens in about 30 seconds. What is the average slip speed in m/s?

APPLICATION

4. Missouri moves about 14.5 mm/yr toward the west with the North American plate (GPS, measured against Earth as a whole). How far does it travel in 1 million years, and how far in the 565 million years since the Reelfoot Rift opened, if the motion were steady?

5. In the sand-box model the wall moved 8 cm in a minute. If a real fault slips 6 mm/yr, how long would 8 km of shortening take?

6. Name the rock body or landform produced by each stage: volcanism and magma about 1.48-1.45 billion years ago, the breakup of Rodinia, the assembly of Pangea, and today's squeeze on the old rift.

CHALLENGE

7. The Reelfoot fault averaged about 6 mm/yr over the last 2,300 years. If it had slipped that fast ever since the rift's faults were reactivated about 290 million years ago, how much slip would that be? What does the nearly flat Bootheel tell you about how long the fault has been this active?

REVIEW

8. An isotope has a half-life of 4 days. How long until only 1/16 of the original sample remains?

9. Review (Unit 2): charcoal has 25% of the carbon-14 of living wood. How old is it?

Unit 3 checkpoint

1. Where is the youngest ocean floor?
   A. At subduction zones
   B. At mid-ocean ridges
   C. Next to continents
   D. Under Antarctica
2. True or false: Magnetic stripes on the sea floor are symmetric on both sides of mid-ocean ridges.
3. An S-P lag of 20 s means the earthquake is about _____ km away (d = 8.4 × lag).
4. What evidence shows that the outer core is liquid?
   A. P waves speed up in it
   B. S waves cannot pass through it, creating a shadow zone
   C. It is very hot
   D. Meteorites are made of iron
5. True or false: The mantle is liquid rock, which is why it convects.
6. An M6.0 compared with an M4.0 releases about how many times more energy?
   A. 2
   B. 100
   C. 1,000
   D. 10,000
7. The Reelfoot scarp's 13.7 m of slip in about 2,300 years gives a slip rate of about _____ mm/yr.
8. The b-value of about 1.2 in the USGS New Madrid counts means:
   A. Each magnitude step has about 1.2 earthquakes
   B. Each magnitude step up has roughly one-fifteenth as many earthquakes
   C. Large earthquakes are more common than small ones
   D. Earthquakes happen 1.2 times a year
9. What formed the granite of the St. Francois Mountains?
   A. Lava flows at the surface
   B. Magma that cooled slowly underground about 1.48-1.45 billion years ago
   C. Sand cemented on a beach
   D. The New Madrid earthquakes of 1811-1812
10. True or false: The Reelfoot Rift, which the New Madrid Seismic Zone follows, opened when the supercontinent Rodinia began to break apart.

Sejal Learning Systems · Royal Legacy Preparatory School · Generated from the course's practice files; generated problems are checked by computer, authored problems by their author.