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Can Plate Tectonics Help Us Get Rid of Nuclear Waste?

INTRODUCTION

What would you do if you had to get rid of thousands of tons (1 metric ton = 1000 kg = 2200 lbs.) of used nuclear fuel, called high level radioactive waste? Where could you find a safe place to put it, a place where it could never hurt anyone?

This is not an easy question to answer. The nuclear waste *could not* explode, but it is highly radioactive, and will remain dangerous because of that for hundreds of thousands of years. In a million years or so, the waste will be no more radioactive than the ore it was originally mined from. That doesn't mean it's safe — you wouldn't want dust contaminated with uranium ore in the air you breathe!

Many engineers and scientists all over the world have been trying to figure out a safe way of storing or disposing of this waste for a long time. Listed below are five of the ideas that scientists have come up with to get rid of radioactive waste.

1. Put it in rockets and shoot it into the sun.
2. Drop it into the mud in the middle of ocean basins.
3. Store it in deep mines (especially salt mines) or caves.
4. Place cans of the material on Antarctica, and let the atomic heat melt its way down into the ice.
5. Dump it into deep ocean trenches.

Each of these ideas has both good and bad points. In this activity we are going to consider dumping the radioactive waste into ocean trenches to see if that would work out well or not.

OBJECTIVES

After you have completed this activity, you should be able to:

1. Plot the movement of a descending ocean floor plate on a graph, and discuss that movement.
2. Explain why it would be good or bad to dump radioactive waste into ocean trenches.
3. Explain some of the effects that subducting plates have on the edges of continents.
4. Tell the reasons why disposing of radioactive waste material is not an easy problem to solve.

PROCEDURE

First, read about subduction (section 2.5, p.44–48) and accretionary wedges (p. 276) in your book.

An **ocean trench** is a long, narrow depression with steep sides, located on the deep-sea floor. Ocean trenches are located where the edge of an ocean plate is going down under a continent. The scientists who suggest that radioactive waste be dumped into ocean trenches say that it will sink into the sediment at the bottom of the trench and will be carried down and away forever by plate motions.

Let's see what would happen if this plan were carried out in the Japan Trench. The descending ocean floor plate in the Japan Trench is **subducting,** or moving down, at a rate of 8 cm/yr. This rate is faster than most plates are moving. It doesn't actually move straight down, but at more of a slant or slope. Japan is located along the edge of the Eurasian continental plate, and the descending ocean floor plate slopes underneath this continental plate.

The worksheet (last page) is a cross-section of Japan and the Japan Trench. The Pacific Ocean is to the right and Asia to the left. Therefore, if radioactive waste material were dropped in the bottom of the

trench at the place marked X, it should move down to the left with the descending plate. It has been figured out that in 3 million years the part of the ocean floor plate now under the trench would move to a position 200 km to the west and 200 km down. *Put an X on your graph to show where the radioactive waste would be then.* Label that X, "3 million years."

In the next 3 million years, it would move another 200 km westward and another 200 km downward. Put another X at that spot, and label it "6 million years." In the same way, put an X on your graph to show where the waste would be in 9 million years and in 12 million years if it kept moving at the same rate. *Draw a line* through all these spots (including the X at the bottom of the trench), connecting them all together.

We are not too worried about what will happen to the radioactive waste 12 million years from now. Most of the waste will have **decayed** before then. When an element decays, it loses some energy and forms another stable element. This new element will be fairly harmless.

1. But what about one-half (0.5) million years from now? From your graph, estimate where the radioactive waste will be then, and put an X on that spot. Label it "½ million years."

2. In one-half million years, will the radioactive material have moved away from or toward Japan?

3. About how deep below the bottom of the trench will it be then (measured vertically)?

4. Some of the sediment on the subducting plate may be scraped off and added to the edge of the continent, forming an accretionary wedge. If the radioactive waste was also scraped off, and added to the accretionary wedge, what might happen to the radioactive waste?

5. The subducting plates are the cause of molten rock that pours out of volcanoes on the land behind the trenches (review subduction in your book). What might happen to radioactive waste that was in or on those plates?

6. What is your opinion of this idea for getting rid of radioactive material by dumping it into oceanic trenches? Is it a good idea or a bad idea?

SUMMARY and REVIEW QUESTIONS

7. What happens to the sediment that is on subducting ocean floor plates? List at least two possibilities.

8. Explain how and why subducting oceanic plates are associated with volcanoes (a continental arc) near the coast. (You might want to look up "Volcanism at Convergent Plate Boundaries", p. 151–152 in your book.)

(Don't forget #9 on the next page!)

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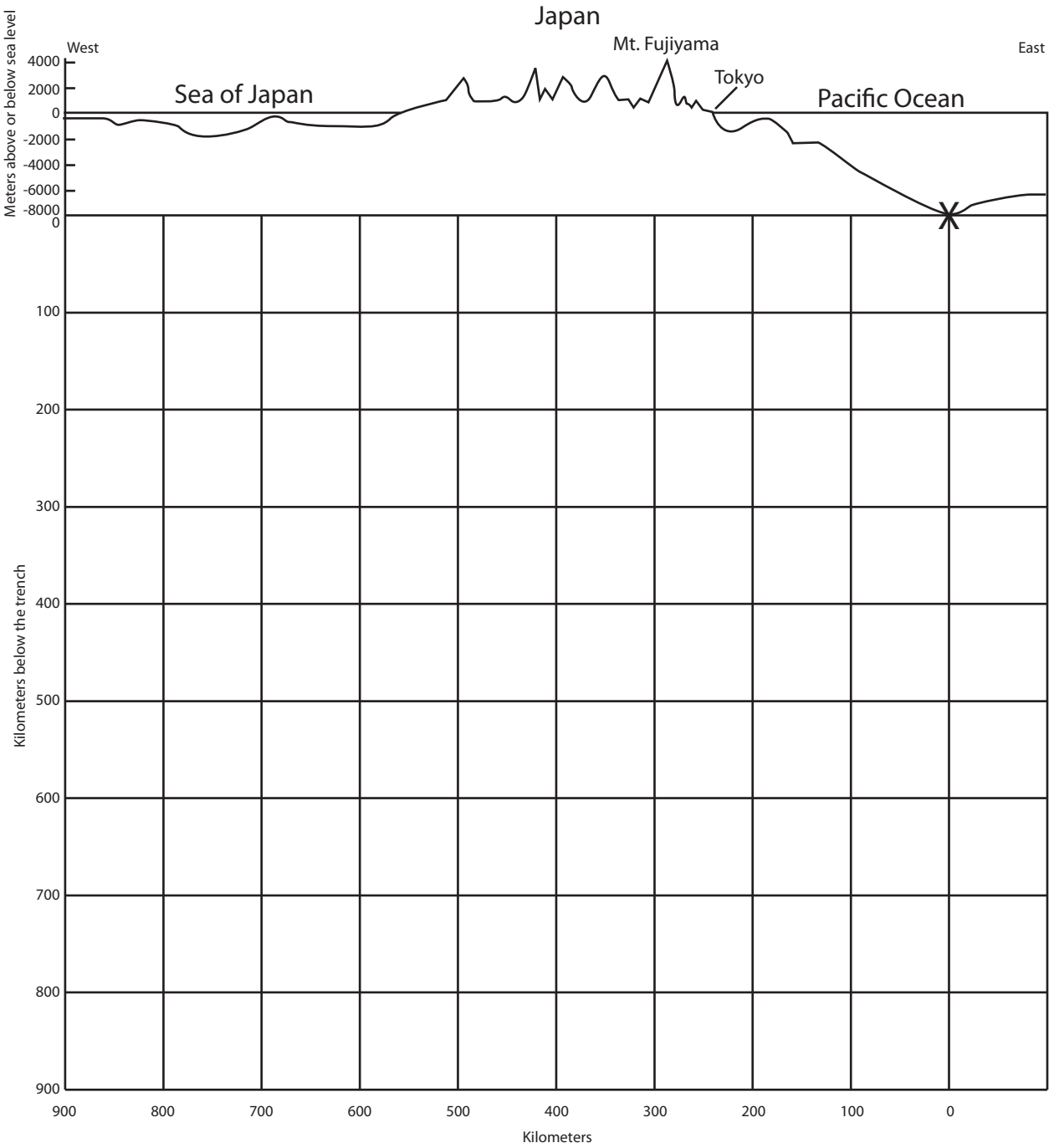
9. Imagine a hypothetical city on a coast next to an oceanic trench. Describe how the descending ocean plate is moving with respect to the city.



Note: The graph is worth one point. Read the procedure to learn how to make the graph.

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