PART III

Reading 4 "Four Stages of Planetary Development"

Planetary Development

P1 ➔ The planet Earth has passed through four-stages of planetary development. All terrestrial planets pass through these same stages to some degree, but some planets evolved further or were affected in different ways.

The Four Stages

P2 The first stage of planetary evolution is *differentiation*, the separation of material according to density. Earth now has a dense core and a lower-density crust, and that structure must have originated very early in its history. Differentiation would have occurred easily if Earth were molten when it was young. Two sources of energy could have heated Earth. First, heat of formation was released by in-falling material. A meteorite hitting Earth at high velocity converts most of its energy of motion into heat, and the impacts of a large number of meteorites would have released tremendous heat. If Earth formed rapidly, this heat would have accumulated much more rapidly than it could leak away, and Earth was probably molten when it formed. A second source of heat requires more time to develop. The decay of radioactive elements trapped in the Earth releases heat gradually; but, as soon as Earth formed, that heat began to accumulate and helped melt Earth. That would have helped the planet differentiate.

P3 While Earth was still in a molten state, meteorites could leave no trace, but in the second stage in planetary evolution, *cratering*, the young Earth was battered by meteorites that pulverized the newly forming crust. The largest meteorites blasted out crater basins hundreds of kilometers in diameter. As the solar nebula cleared, the amount of debris decreased, and after the late heavy bombardment, the level of cratering fell to its present low level. Although meteorites still occasionally strike Earth and dig craters, cratering is no longer the dominant influence on Earth's geology. As you compare other worlds with Earth, you will discover traces of this intense period of cratering, on every old surface in the solar system.

P4 ➔ The third stage, *flooding*, no doubt began while cratering was still intense. The fracturing of the crust and the heating produced by radioactive decay allowed molten rock just below the crust to well up through fissures and flood the deeper basins. You will find such flooded basins with solidified lava flows on other worlds, such as the moon, but all traces of this early lava flooding have been destroyed by later geological activity in Earth's crust. On Earth, flooding continued as the atmosphere cooled and water fell as rain, filling the deepest basins to produce the first oceans. A Notice that on Earth flooding involves both lava and water, a circumstance that we will not find on most worlds. B

P5 The fourth stage, *slow surface evolution*, has continued for the last 3.5 billion years or more. C Earth's surface is constantly changing as sections of crust slide over each other, push up mountains, and shift continents. D Almost all traces of the first billion years of Earth's geology have been destroyed by the active crust and erosion.

Earth as a Planet

P6 All terrestrial planets pass through these four stages, but some have emphasized one stage over another, and some planets have failed to progress fully through the four stages. Earth is a good standard for comparative planetology because every major process on any rocky world in our solar system is represented in some form on Earth.

P7 Nevertheless, Earth is peculiar in two ways. First, it has large amounts of liquid water on its surface. Fully 75 percent of its surface is covered by this liquid; no other planet in our solar system is known to have such extensive liquid water on its surface. Water not only fills the oceans but also evaporates into the atmosphere, forms clouds, and then falls as rain. Water falling on the continents flows downhill to form rivers that flow back to the sea, and in so doing, the water produces intense erosion. You will not see such intense erosion on most worlds. Liquid water is, in fact, a rare material on most planets. Your home planet is special in a second way. Some of the matter on the surface of this world is alive, and a small part of that living matter is aware. No one is sure how the presence of living matter has affected the evolution of Earth, but this process seems to be totally missing from other worlds in our solar system. Furthermore, the thinking part of life on Earth, humankind, is actively altering our planet.

Glossary

meteorite: a mass that falls to the surface of a planet from space
planetology: the study of planets

40. Why does the author mention the "Earth" in paragraph 1?

Ⓐ To explain the stages in planetary development for the Earth in detail
Ⓑ To contrast the evolution of the Earth with that of other planets
Ⓒ To demonstrate that the Earth passed through similar stages to those of most planets
Ⓓ To give an example of exploration of the terrestrial planets

Paragraph 1 is marked with an arrow [➔].

41. The word its in the passage refers to

Ⓐ meteorite
Ⓑ Earth
Ⓒ velocity
Ⓓ motion

42. Which of the sentences below best expresses the information in the highlighted statement in the passage? The other choices change the meaning or leave out important information.

Ⓐ The Earth may have been liquid because the heat collected faster than it dissipated if the formation took place quickly.
Ⓑ Because of the rapid formation of the Earth, the crust took a long time to cool before it became a solid.
Ⓒ The liquid core of the Earth was created when the planet first formed because the heat was so high and there was little cooling.
Ⓓ The cooling caused the Earth to form much more quickly as it met with the intense heat of the new planet.

43. The word pulverized in the passage is closest in meaning to

Ⓐ melted into liquid
Ⓑ broken into small parts
Ⓒ frozen very hard
Ⓓ washed very clean

44. The word dominant in the passage is closest in meaning to

Ⓐ most limited
Ⓑ most likely
Ⓒ most rapid
Ⓓ most important

45. What can be inferred about radioactive matter?

Ⓐ It is revealed by later activity.
Ⓑ It generates intense heat.
Ⓒ It is an important stage.
Ⓓ It floods the planet's crust.

46. According to paragraph 4, how were the oceans formed?

Ⓐ Ice gouged out depressions in the Earth.
Ⓑ Rain filled the craters made by meteorites.
Ⓒ Earthquakes shifted the continents.
Ⓓ Molten rock and lava flooded the basins.

Paragraph 4 is marked with an arrow [➔].

47. What is the author's opinion of life on other planets?

Ⓐ She does not know whether life is present on other planets.
Ⓑ She is certain that no life exists on any planet except Earth.
Ⓒ She does not express an opinion about life on other planets.
Ⓓ She thinks that there is probably life on other planets.

48. According to the passage, which stage occurs after cratering?

Ⓐ Flooding
Ⓑ Slow surface evolution
Ⓒ Differentiation
Ⓓ Erosion

49. All of the following are reasons why the Earth is a good model of planetary development for purposes of comparison with other planets EXCEPT

Ⓐ The Earth has gone through all four stages of planetary evolution.
Ⓑ Life on Earth has affected the evolution in a number of important ways.
Ⓒ All of the fundamental processes on terrestrial planets have occurred on Earth.
Ⓓ There is evidence of extensive cratering both on Earth and on all other planets.

50. The word peculiar in the passage is closest in meaning to

Ⓐ different
Ⓑ better
Ⓒ interesting
Ⓓ new

51. Look at the four squares [■] that show where the following sentence could be inserted in the passage.

At the same time, moving air and water erode the surface and wear away geological features.

Where could the sentence best be added?

Click on a square [■] to insert the sentence in the passage.