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Supplementary Information

Sources of Natural Radiation

What's Your Exposure?

Radioactivity is a natural phenomenon. Nuclear radiation released by naturally occurring radioactive elements on Earth is a form of high-energy *ionizing radiation*. When ionizing radiation passes through matter, it strips electrons away from atoms and forms ionized particles. Ionizing radiation is thus potentially more harmful than ultraviolet, visible, or other forms of nonionizing radiation. Overexposure to ionizing radiation can permanently damage cells and tissue. It is important, therefore, to understand the amount of natural and artificial "background" radiation in our lives and to take precautions to minimize exposure to unnecessary sources of ionizing radiation. There are three main sources of background ionizing radiation:

- Nuclear radiation from the decay of radioactive elements in the ground, in the air, and in food
- X-rays released by matter that has been subjected to very high electrical discharges
- "Cosmic rays" from outer space

Natural background radiation exists wherever you live. The amount, however, varies depending on location. Uranium is probably the most well-known radioactive element. Although uranium is not very abundant in the Earth's crust, all of its isotopes are radioactive. Nuclear radiation emitted by uranium in soil and rock contributes about 10% of the average annual dose of ionizing radiation. Many of the elements produced when uranium decays are also radioactive. The most important of these is radon. Radon gas in the air we breathe (and inside our lungs) is a significant source of naturally occurring background ionizing radiation. Carbon-14 and potassium-40 also contribute substantial amounts of natural background radiation in our lives and in our bodies. Carbon-14, a radioactive isotope of carbon, is produced in the upper atmosphere when nitrogen is bombarded with cosmic rays. This radioactive form of carbon is then incorporated into all living things. The percent of carbon-14 among all carbon atoms is extremely low, but there are a lot of carbon atoms in our bodies and in the food we eat! A similar argument may be made for potassium-40, a naturally occurring radioactive isotope of potassium.

Cosmic radiation consists of high-energy particles that originate in outer space. Most cosmic "rays" are the nuclei of atoms, but they may also consist of high energy subatomic particles that have been accelerated to very high speeds. Exposure to cosmic rays on Earth depends on elevation. People who live in mountain regions, for example, are exposed to almost twice the annual amount of cosmic radiation as people who live on the coasts. Traveling by airplane also increases exposure to cosmic radiation.

Technology has created additional sources of background radiation. "Nuclear medicine," for example, encompasses not only traditional X-rays, but also radiation therapy and many newer forms of diagnosis, such as CAT scans, PET scans, stress tests with radioactive imaging, etc. Diagnostic imaging procedures in which a radioactive "tracer" is injected into the body have led to major improvements in health care, but they also contribute significantly to the average annual radiation exposure for many individuals. Even televisions and computer monitors emit low energy X-rays due to the electrons that are accelerated to create pictures on a screen. (Video terminals are just modern versions of the cathode ray tube that led to the discovery of X-rays.)

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Part II. Divergence and Rift Valley Formation Observations/Drawings

Questions (Use a separate sheet of paper to answer the following questions.)

1. Based on your observations for Part II, describe what happens as continental plates diverge.
2. List an example of where the type of movement seen in Part II (divergence) occurs.
3. Label possible weak points in your final drawing for Part II. How is the formation of these weak points different from those seen in Part I?

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