1. What is a mineral and how does it differ from a rock?

A mineral is a naturally occurring, homogeneous solid with a definite chemical composition and an ordered atomic arrangement that is formed by inorganic processes. It differs from a rock in that a rock is a physically coherent aggregate of different mineral grains which is not homogeneous, lacks a defined chemical composition and a defined crystal structure.

2. What are protons, neutrons, electrons, isotopes and elements and how are they formed?

A proton is a fundamental atomic particle with a rest mass of $1.67 \times 10^{-24}$ g and an electric charge of $+1$. A neutron is a fundamental atomic particle with a rest mass of $1.67 \times 10^{-24}$ g and an electric charge of $0$. A proton is a fundamental atomic particle with a rest mass of $9.1 \times 10^{-28}$ g and an electric charge of $-1$. Protons, neutrons and electrons were formed in the Big Bang. Isotopes and elements are aggregates on these fundamental particles. Isotopes of a given element differ from each other in the number of neutrons. The two lightest elements, H and He, were formed in the Big Bang, whereas the heavier elements were formed by nuclear fusion reactions in stars.

3. What is igneous fractionation and how does it account for the differences between mantle, oceanic crust and continental crust?

Igneous fractionation is the process of deriving a magma of a different chemical composition from a rock of a definite composition, by partial melting and fractional crystallization. A typical mantle rock is a peridotite, whereas the magma extracted by 10% partial melt will be basaltic (mafic) in composition. Hence a 10% partial melt of the mantle gives basalts at the mid-ocean ridge. If this basalt is then remelted, a 10 to 20% partial melt will be andesitic in composition. If the andesite undergoes partial melting, a 10 percent partial melt can be granitic in composition. The first partial melt from the mantle give basaltic ocean crust which is thin, dense, and young relative to the continents. Subsequent partial melting events can derive a thick, light, silica-rich residuum which accumulates as the continents.

4. What is the scientific method and how is it used to draw conclusions about the origin and age of the Earth?

The scientific method consists of four basic steps by which we can learn about our physical environment. The steps are: Observation, hypothesis, testing, and theory. First, a set of observations or measurements are made about a particular phenomenon, say the origin of the Earth. Second, one or more testable hypotheses are advanced to explain or link the observations. Third, the various hypotheses are tested against further observations. Finally the surviving hypothesis becomes the theory that explains the
original and subsequent observations. In the case of the origin and age of the Earth, the observations are the many rocks of different radiometric ages and stratigraphic positions. The hypothesis is that it was formed 4.5 billion years ago and has evolved by processes observable today. Alternate hypotheses include formation at about 40 million years ago or as young as 7000 years ago by supernatural processes. The consistently very old ages of meteorites and lunar samples as well as most terrestrial igneous rocks are only consistent with the first hypothesis.

5. What are the two major energy sources that drive Earth processes and which processes does each primarily control?

The two major energy sources are the internal source that is powered by the decay of naturally radioactive elements, principally U, Th and K, and the external source that is powered by thermonuclear fusion in the Sun. The internal source powers mantle convection, plate tectonics, earthquakes, and volcanism, whereas the external source powers weather, climate, atmosphere and ocean circulation, weathering, erosion, and sediment transport and deposition.

6. What is igneous fractionation? How can it account for the difference between continents and oceans?

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7. How do the weathering rates of the different minerals in granite give rise to the different grain sizes of the weathering products?

Quartz in granite is resistant to chemical weathering and weathers very slowly. The mineral quartz (SiO2) dominates the sand-size fraction of the weathering products. Feldspars and micas weather quickly to clays that very fine grain sizes < 0.002 mm).
8. How does the transport of sediments (weathering products) by wind and water result in the different sedimentary rocks having different compositions?

Wind and water transport the weathering products of igneous rocks and sort them by grain size to put the different size fractions in different places. Unweathered material is deposited close to the source. Sand-sized grains are deposited in rivers, deserts, and beaches. Clay-sized grains are deposited when the water stops moving. Carbonates are deposited biogenically in tropical reefs. When the water evaporates, the deposit sequence is calcite, gypsum, halite, sylvite.