

Homework #6: Mineral Evolution

Your last homework addresses pre-reading assigned for the November 27th class on “Mineral Evolution”. For Part A below, you will need to read the paper by Hazen & Ferry (2010) “Mineral Evolution: Mineralogy in the Fourth Dimension” published in *Elements* (v. 6, p. 9-12), and for Part B, you will need to refer to the IUGS International Chronostratigraphic Chart (a calibrated, updated geological time scale) to answer the following questions in preparation for class. Both of these resources are posted along with the lecture slides in the Week 13 directory in CONNECT.

Part A: Mineral Evolution

- 1) The majority of minerals known on Earth appeared . . .
 - A. Immediately after the accretionary event that formed Earth
 - B. Immediately before the onset interactions between the Earth’s lithospheric plates
 - C. Immediately after the onset interactions between the Earth’s lithospheric plates
 - D. After the appearance of life on Earth**
 - E. After the appearance of macroscopic life on Earth

- 2) The formation of minerals enriched in rare elements is thought to have required which of the following?
 - A. Selective uptake by microscopic organisms
 - B. Impact events with anomalous extraterrestrial bodies
 - C. Oxidation of rare elements in sea water
 - D. Oxidation of rare elements in the atmosphere
 - E. Concentration of rare elements by repeated episodes of partial melting**

- 3) Put the following stages in the appropriate chronological order from oldest to youngest:
Anoxic Biological World
Snowball Earth
Phanerozoic Era of Biological Mineralization
Igneous Rock Evolution
Primary Chondrite Minerals

- 4) Using Table 1, determine which *post-accretionary* stage showed the greatest rate of mineral diversification. To do this, divide the approximate number of new mineral species in each stage (from stage 3 through stage 10) by the number of years represented by these stages.

STAGE 7- Great Oxidation Event

- 5) Which of the following have substantially increased the diversity of minerals on Earth? Check all that apply.
 - **Separation and concentration of elements by tectonic processes**
 - **Diversification in the types of environments where mineralization occurs**
 - **Mediation of mineralization by living organisms**
 - Appearance of new elements
 - Changes in the bulk composition of the Earth as a whole

PART B: Geological Time Scale

To get a broader perspective on the significant events that have marked the boundaries and passages of geological time, you are encouraged to visit the University of California Museum of Paleontology's online time scale exhibit (<http://www.ucmp.berkeley.edu/help/timeform.php>)

6) The Phanerozoic _____, marked by the prevalence of large, multicellular organisms, represents roughly _____ of geological time (select the pair of words from the list below to insert in the blank spaces in the sentence):

Era, All

Eon, All

Eon, Half

Era, one-quarter

Era, one-eighth

Eon, one-eighth

Period, two-thirds

Eon, one-quarter

Eon, two-thirds

Eon, one-quarter

7) Which expanse of time is larger: the era in which "Snowball Earth" is thought to have occurred or the Archean Eon?

Archean

8) The boundary between the Cambrian Period and the Precambrian (encompassing the Archean and the Proterozoic Eons) occurred 542 million years ago and the Cambrian lasted for 54 million years. Rocks found above the upper boundary (i.e., youngest age) of the Cambrian would be designated as Ordovician.

PART C: Synthesis

9) In your own words, explain why time might be important to understanding the origin and evolution of minerals.

10) Please comment about any questions you have regarding the reading and the chart.