Geophysical Research Abstracts
Vol. 17, EGU2015-4232-1, 2015
EGU General Assembly 2015

Mass Extinctions and Biosphere-Geosphere Stability

Daniel Rothman and Samuel Bowring
MIT, Lorenz Center, Department of Earth, Atmospheric, and Planetary Sciences, Cambridge, United States (dhr@mit.edu)

Five times in the past 500 million years, mass extinctions have resulted in the loss of greater than three-fourths of living species. Each of these events is associated with significant environmental change recorded in the carbon-isotopic composition of sedimentary rocks. There are also many such environmental events in the geologic record that are not associated with mass extinctions. What makes them different? Two factors appear important: the size of the environmental perturbation, and the time scale over which it occurs. We show that the natural perturbations of Earth's carbon cycle during the past 500 million years exhibit a characteristic rate of change over two orders of magnitude in time scale. This characteristic rate is consistent with the maximum rate that limits quasistatic (i.e. near steady-state) evolution of the carbon cycle. We identify this rate with marginal stability, and show that mass extinctions occur on the fast, unstable side of the stability boundary. These results suggest that the great extinction events of the geologic past, and potentially a "sixth extinction" associated with modern environmental change, are characterized by common mechanisms of instability.