Co-evolution of planetary environments and life

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Environments of terrestrial planets around main sequence stars would change with their evolution. Because liquid water is essential for life, a warm and wet climatic condition should be maintained over billions of years for evolution of life. There is, however, a paradox: atmospheric CO2, the most common green house gas in the atmospheres of the terrestrial planets, is consumed owing to silicate weathering followed by carbonate precipitation under the warm climate with liquid water. There should be some mechanisms which supply CO2 to the atmospheres in order to maintain the warm climate. Volcanism associated with plate tectonics may be the most favorable because of its continuous activity and effective recycling of CO2 from carbonate minerals due to metamorphism. Plume-type volcanism, generally seen in the terrestrial planets, may not be continuous, and can release only a small amount of CO2. Another important factor is long-term stability of the climate. It would be required that amplitudes of climate change should be limited. Negative feedback mechanism to stabilize the climate is, therefore, necessary. Global glaciation, occurred at least three times in the Earth history, seems an example of extreme climate changes. It is however noted that epoch-making evolution of life seems to have occurred in the aftermath of global glaciations. Evolution seems to be also promoted after mass extinction events associated with environmental changes. In these respects, large environmental changes could be important for the evolution of life on Earth-like planets.