Geophysical Research Abstracts, Vol. 9, 06647, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-06647

Emerged land surface in the Archean: constraints on continental growth and mantle thermal history

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The emerged surface area on Earth depends on continental freeboard and on the volume of continental crust. As most crustal growth models consist in an increasing volume of continental crust over time, the emerged land surface is likely to have increased since the early stages of Earth's history. This emergence of continental crust plays a key role in the establishment of surface cycles, and is involved in the evolution of early life, particularly photosynthesis in shallow waters during the Archean.

To evaluate the emerged land surface in an Archean setting, a new parametrisation of continental freeboard taking continental hypsometry into account is suggested. Two other important parameters are the potential temperature of the upper mantle and the volume of the continental crust. Their effects are opposed to each other through time: continental freeboard decreases as continental crust is produced and increases as the Earth's mantle cools down.

The developed model also allows the testing of crustal growth models and mantle thermal evolution. Major crustal production events, as suspected at $\sim$ 2.7-2.4 Ga, result in a sharp decrease in continental freeboard. If the continental crust was voluminous even at an early stage in Earth's history ($\sim$ 3.8 Ga), the surface of emerged land must have been significantly reduced until $\sim$ 2 Ga. This result is consistent with the observation that flood volcanism on submerged continental platforms, if common in the Precambrian, is rare to absent throughout the Phanerozoic [N. Arndt, Precamb. Res. 97, 155-164, 1999].