Continental lithosphere, unconformities and the biogeochemical cycles

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I discuss what controls the rise and fall of continents, beginning with orogenic construction of continents where uplift rates are controlled by the interplay between magmatic/tectonic thickening and erosion, the latter which results in deep seated exhumation during the orogenic event. After orogenic forcings decline, mountain elevations decline slowly as erosion continues. Eventually, thermal subsidence, in the form of a growing thermal boundary layer, occurs. The final resting elevation of continents depends then on the terminal thickness of the thermal boundary layer and the thermal state of the Earth. The former is controlled by a pre-existing chemical boundary layer. I show that in a hot Earth, the final resting elevation of continents lies below sea level and the time for a mountain to transition into a basin is on the order of 300-500 My. This is how non-conformities are made. I also show that the Earth's mantle has cooled with time, such that around 700 My ago, the final resting elevation of continents has changed from below sea level to above sea level today. This effect has profound consequences on biogeochemical cycles and climate. Prior to 700 My ago, the Earth would be characterized by a low albedo water-world with ribbon islands of active orogeny and large areas of shallow, epicontinental seas. After 700 Ma, the Earth was characterized for the first time by large expanses of land, relegating shallow seas to oceanic margins. We predict that phosphorous concentrations in seawater to be low in water-worlds and high in terrestrial worlds, such that 700 Ma marked a rapid change in the availability of phosphorous in oceans. We also show that although global elevations changed gradually, the climatic and biogeochemical transitions would have been rapid. In particular, during the transition, climate would have been very stable, switching back and forth between low albedo and high albedo worlds.