On continent formation, unconformities and the Cambrian explosion

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It is widely believed that the reason why Earth has continents and oceans is that the felsic nature of continental crust makes continents more buoyant than oceanic crust, which is basaltic, but these differences are minor. Instead, the dominant control on elevation is crustal thickness. Continents ride high because they are underlain by thick crust, while ocean basins ride low because they are thin crust. Orogenic processes, via magmatic and tectonic thickening are the key to making continents, with felsic rocks a mere by product of magmatic differentiation in thick crust. Formed by crustal thickening, high elevations are expected during continent formation and hence significant erosion must accompany continent formation. As magmatic and tectonic forcing wane, erosion continues thinning the crust and decreasing elevation, but at much lower erosion rates. With time, thermal subsidence takes over, causing subsidence. Continents are thus born through mountain building, but these mountains eventually become basins, manifested in the rock record as a major unconformity. These processes explain why the stabilized parts of continents have anomalously low elevations for a given crustal thickness when compared to active orogenic belts. The final resting state of stabilized continents is controlled by the thickness of the cratonic mantle and the ambient temperature of the convecting mantle. In a hot mantle, stable continents ride below sea level, but as the Earth cools, continents emerge because the negative thermal buoyancy of cratonic root decreases. While much of the continental crust may have formed by the early Proterozoic, the stabilized portions of the continents would have been below sea level. With secular cooling, we show that these submerged continents would have emerged in the Neoproterozoic: the Precambrian world may have been a waterworld and the Phanerozoic a terrestrial world. This transition would have fundamentally increased the concentrations of P in the marine environment due to reworking of ancient sediments and a decrease in the efficiency of the marine P sink. During this transition, the Earth could have switched back and forth between water and terrestrial worlds, causing swings between greenhouse and icehouse climates. Key phenomena, such as the Cambrian explosion, the rise of radiogenic marine Sr, two Snowball events, the Neoproterozoic rise of oxygen, and the appearance of P – rich sediments in the Phanerozoic can all be explained.