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Geologically persistent cold climate as a mechanism to reduce erosion of a continental interior

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We show that the average elevations of the continental interiors away from plate boundaries have a strong linear relation with crustal thickness when normalized to a constant lithospheric thickness. Previous models of crustal thickness in Antarctica, based on gravity and receiver function data, place cratonic East Antarctica as a clear outlier on this global trend, with an intermediate average crustal thickness 35 - 40 km, but the highest average bedrock elevation of about 1000 m after correcting for ice mass loading. This has prompted a range of explanations including the presence of mantle plumes, hot lines, or anomalous crustal and mantle lithologies beneath East Antarctica. We present a new model for the crustal thickness of Antarctica based on a simple isostatic balance, given the observed bedrock elevation and lithospheric thickness (Priestley and McKenzie 2013), calibrated using gravity and recent studies of crustal thickness from Rayleigh wave inversions (Shen et al. 2018). The revised average crustal thickness of East Antarctica now conforms closely to the global trend, indicating that the high elevation of East Antarctica is simply due to crust which is on average 3 - 5 km thicker than the other southern continents. Prior to 100 Ma, East Antarctica formed an integral part of the Gondwana supercontinent, linked to Australia, India and Africa. What distinguishes East Antarctica is geologically persistent episodes with large ice sheets or cold and dry climates since the Palaeozoic, when it has been close to the South Pole. We argue that these conditions have effectively armored the continental core, thereby more effectively preserving crustal thickness since the last major phase of orogenesis compared to lower latitude continents. The extra 3 - 5 km of crustal thickness in East Antarctica would require a reduction of 0.006 to 0.01 mm/yr in time-averaged and regional erosion rates over the last 500 Myrs compared to those in the other continents.

Reference

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