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Late Neoproterozoic rise and fall of the northern Arabian-Nubian Shield: The role of lithospheric mantle delamination and subsequent thermal subsidence

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Review of the Late Neoproterozoic history of the northern Arabian-Nubian Shield (ANS) reveals that rapid and extensive erosional denudation, widespread late-orogenic calc-alkaline and alkaline igneous activity and intramontane basin formation affected this terrane at 630-590 Ma. To account for this coupling it is suggested, that the mantle lithosphere was removed /delaminated from below the northern ANS subsequently to significant crust-mantle thickening in the course of Late Neoproterozoic orogeny. Because the physical properties of the delamination process are not clear, we use it as a conceptual term accounting for the replacement of mantle lithosphere by an asthenosphere. Removal of the thickened lithospheric mantle roots potentially caused instantaneous uplift of the northern ANS to elevations of more than 3 km, thus triggering exceptionally-rapid erosional unroofing and lateral extension. Delamination and erosional decompression potentially caused partial melting of ANS upper mantle and lower crust to produce the widespread post-orogenic magmas. In the present work we emphasis that removal of the lithospheric mantle also played a key role in lowering ANS topography to sea level. Our data show that lowering ANS down to sea level was significantly accelerated by post-delamination cooling and thermal subsidence. Unlike erosional denudation which is followed by isostatic uplift, thermal contraction causes net surface lowering. We show that thermal subsidence plays a critical role in lowering mountain belts, particularly in the latest stages of down wear, when the topography reaches a threshold of ~1.0 km and erosion slows down. Then, surface lowering by thermal subsidence is 5 folds faster (more efficient) than erosion. Post-delamination thermal subsidence can cause 1.3 km of net surface lowering within 100 m.y. regardless of the state of relief and elevation. Therefore, orogenic belts that experienced removal or delamination of their mantle lithosphere (hot orogens) would rapidly rise, but would relatively (!) rapidly fall too.