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Changes in the continental thickness through time and supercontinent cycles

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Supercontinents are a hallmark of plate tectonics activity. Nonetheless, the timing of the supercontinent cycles that shaped the Earth through crustal evolution changes is not fully understood due to the incomplete nature of the geological record. U-Pb, Lu-Hf and Oxygen analyses of magmatic and detrital zircons have been exhaustively used to probe the ancient geological record and to derive crustal evolution models. Inherently, supercontinents have higher proportions of continent-continental collisions than supercontinent-absent periods and, therefore, represent temporal points in the geological record where the continental crust was comparatively thicker.

A substantial number of analyses are now available, and yet the link between geochemical and tectonic changes through time remains to be established, and current proxies for crustal thickness models require further refinement. We explore the variations of measured radiogenic and stable isotopes in zircon and highlight periods of inverse correlations between them in the global zircon database. Such inversions are taken to depict thickening of the crust and increase in reworking rates during continental collision and amalgamation. Plate tectonics further resulted in the accretion and break-up of landmasses and cratonic blocks, at least over the last 3 billion years. The generation of zircon-bearing magmas and zircon recrystallisation took place over a range of thickness that underwent cyclic variation over time. Independent statistical analyses suggest major breaking points in the global dataset at c. 3.0, 1.8 and 0.7 Gyr and smaller oscillations within each supercontinent cycle. Such structural changes in the dataset mark the rising or tailing of supercontinent activity.

Zircon grains mark periods of crustal thickness augmentation controlled by pressure-dependent paragenesis and high supracrustal reworking rates. When linked with supercontinent cycles, the variations suggest that plate tectonics was globally operational since 3.0 Gyr, and that processes similar to subduction may have occurred only locally before that.