Did plate tectonics shut down for 200 to 300 My during the Early Proterozoic?

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Although most geologic data clearly point to an onset of modern plate tectonics, at least locally, by 3 Ga, geodynamic modeling for high mantle temperatures suggests that plate tectonics had several false starts, each followed by a return to stagnant lid tectonics. The distribution of U/Pb zircon ages in granitoids and detrital zircons suggests the last plate-tectonic shutdown may have started about 2.4 Ga and lasted the order 250 My. There is also little Nd or Hf isotope evidence to support significant juvenile additions to the continental crust during this granitoid age gap. In addition, there are no arc-type greenstones or TTG suites and only one LIP identified between about 2.45 and 2.2 Ga.

Major unconformities representing 100 to nearly 400 My occur on most cratons between 2.45 and 2.2 Ga supporting a major drop in sea level at this time. Shutdown of arcs and ocean ridges would cause a decrease in the rate of CO_2 input into the atmosphere-ocean system by volcanism, which, in turn, could lead to global cooling and to the global glaciation at 2.4-2.3 Ga.

Our results suggest that massive cooling of the mantle during subduction events at 2.7 and 2.5 Ga led to thickening and strengthening of the lithosphere, returning Earth to the stagnant lid mode of cooling for the order of 250 My. As the temperature continued to rise in the mantle due to inefficient heat loss by conduction, the lithosphere was thinned and weakened, and plate tectonic style cooling returned by no later than about 2.2 Ga.

Synthetic U-Pb 'standard' solutions for ID-TIMS geochronology

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Isotope Dilution-Thermal Ionisation Mass Spectrometry (ID-TIMS) U-Pb geochronology affords the opportunity to determine $^{206}Pb/^{238}U$ dates with unprecedented precision - often <1‰ on single analyses or weighted mean dates derived from multiple analyses. The accuracy of these dates is dominated by (1) the U/Pb tracer calibration; (2) mass-spectrometry, (3) various corrections applied (such as those for U oxide), and (4) 'constants' used in the age calculation (decay constants and the $^{235}U/^{238}U$ value of natural U). Some of these parameters can be considered as 'systematic' (i.e., decay constant uncertainties) and others either contain a random component (not accounted for by counting statistics) or are systematic but 'laboratory' specific. Quantification and consideration of these uncertainties is required for the high-resolution integration of U-Pb datasets.

At present inter-laboratory agreement and intra-laboratory long-term external reproducibility of U-Pb ID-TIMS data is assessed through analyses of natural zircon 'standards'. Though standard zircons are ideal for assessing the total system (pretreatment for Pb-loss, dissolution, purification via anion echange chemistry and mass-spectrometry), there is the possibility for real variation in the U/Pb systematics (due to either Pb-loss and/or natural age variation). We have prepared and calibrated a series of synthetic U-Pb solutions with $^{206}Pb/^{238}U$ and $^{207}Pb/^{235}U$ ratios that yield "concordant" ^{206}Pb-^{238}U and ^{207}Pb-^{235}U dates at 100 Ma, 500 Ma and 2 Ga. The solutions were prepared by iterative mixing of natural uranium (SRM 950a), ^{206}Pb (SRM 991) and ^{207}Pb (metal from Cambridge Isotopes) solutions. Determination of the ^{206}Pb-^{238}U and ^{207}Pb-^{235}U ratios is being achieved via calibration against the ET535 and ET2535 tracers. These solutions are ideal for monitoring mass-spectrometer performanace. We believe these solutions will augment natural zircon standards as a means of interlaboratory comparsion and assessment of long-term external reproducibility. These solutions are intended for community use and will be made available (visit: www.earth-time.org).