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Implications of the detrital zircon record for global plate tectonic reconstructions in deep time

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Full-plate reconstructions describe the history of both past continental motions and how plate boundaries have evolved to accommodate these motions. The fluxes of material into and out of the mantle at plate boundaries is thought to deeply influence the evolution of deep Earth structure, surface environments and biological systems through deep time. Traditionally, plate tectonic reconstructions have relied on geophysical data from the oceans, which provides details of how Pangea broke apart (since ca. 200 Myr) while paleomagnetism is the primary quantitative constraint prior to Pangea formation. However, these data do not directly constrain the extent of subduction zones or other plate boundaries, so reconstructing the past plate configurations of past supercontinents must rely on alternative methods. One source of data that can resolve this problem is to use observations from detrital zircons. Previous studies have proposed classification schemes to determine tectonic settings where samples were deposited, based on the different characteristic shapes of detrital zircon age spectra found in convergent, collisional and extensional settings.

Here, we investigate the applicability of this method to test and refine global full-plate tectonic reconstructions in deep time, using a published database of zircon ages. We first use reconstructions for relatively recent times (<100 Ma), where reconstructions are reasonable well constrained, to evaluate the effectiveness of the classification method. For older times, where uncertainties in the reconstructions are far larger, we can use the results to discriminate between competing models. We analysed the proximity between reconstructed plate boundaries and zircon sample sites assigned to different tectonic classifications, and found that the classification method does well (~64□79% success depending on distance threshold used) in distinguishing convergent settings. The ability of the classification to define extensional settings such as rift basins is less clear, though samples in this class do lie preferentially further from convergent settings. Based on these insights, we apply the method to evaluate full-plate reconstructions for the Neoproterozoic as well as other competing models for the configuration of Rodinia.