Fine-grained sediments record evolving igneous systematics, not the rise of felsic crust

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The occurrence of continents on Earth is unique among planets, but their origin and evolution remain enigmatic. Many studies correlate significant, ~3–2 Ga trace-element changes in terrestrial sediments with a global upper-crustal mafic-to-felsic transition, the onset of plate tectonics, the rise of modern continents, and an increase in atmospheric oxygen. However, many of these estimates rely on a set of igneous behaviors that may not hold throughout Earth history. To understand the compositional evolution of Earth's upper crust, I first quantified secular compositional trends in crustal igneous rocks (a proxy for erodible crust) using principal components analysis (PCA) for major elements and a brute-force correlation analysis for trace elements. The PCA shows that the array of igneous rocks exposed to erosion and weathering obeyed distinct major-element trade-offs at different points in Earth history, showing that, e.g., decreases in upper crustal MgO need not have been balanced by increases in SiO_2. The brute-force correlation analysis quantifies major-element exchange vectors for numerous trace-element ratios, and shows that **i**) some trace-element ratios measured in sediments correlate with multiple major-element oxides of interest in their source rocks and **ii**) these correlations are distinct for Archean and post-Archean igneous rocks. When the igneous changes are propagated through the sedimentary data, they yield ~3.0–1.5 Ga decreases in average upper crustal MgO and FeO and increases in K_2O, Na_2O, Al_2O_3, TiO_2, and P_2O_5, but at nearly constant SiO_2 and CaO. The combined sedimentary and igneous record therefore indicates that exposed Archean upper crust was almost as siliceous as modern continental crust, even as other major and trace elements changed significantly through time. Though the observed compositional changes are compatible with the onset of a new tectonic regime in the late Archean, they also permit the existence of primordial felsic continents in the absence of modern-style plate tectonics. A major conclusion of this study is that post-Archean geochemical data should not be used to model Archean geologic processes.