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Detrital rutile thermometry indicates low temperature/pressure (subduction-related?) convergent tectonics since the Paleoarchean

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The initiation of plate tectonics and the stabilization of the first cratons are important phases of Earth's evolution; however, major questions remain over how and when plate tectonics initiated on Earth, and what pre-plate tectonic geodynamics looked like. Indicator rock assemblages that are critical for understanding the presence and style of plate tectonics include high- to ultra-high-pressure metamorphic rocks such as blueschist and eclogite. Although the role of preservation and formation biases for these rock assemblages are debated, the Archean geological record is clearly incomplete; as such, accessory minerals hosted in sedimentary rocks provide an additional archive to interrogate tectonics processes through Earth history. Rutile provides one such mineral with important attributes: (i) compositional (and age) data can be used as a proxy for source; (ii) Zr concentrations provide a proxy for temperature, and (iii) rutile stability at low temperatures is generally limited to pressures greater than 1 GPa. Here, we use detrital rutile to trace the temperature range of metamorphism from the Archean to present-day. We combine a literature-based global record with additional rutile age and compositional data from Mesoproterozoic sedimentary rocks (Espinhaço Supergroup) of the São Francisco Craton. Notably, our new detrital rutile data together with this global compilation, show low *T/P* thermobaric ratio dominated in the Paleoarchean with an increase in *T/P* ratios up to and during the formation of the first supercontinent Columbia. This record of low *T/P* ratios contrasts with global bedrock records of metamorphic pressure-temperature conditions that are generally restricted to intermediate to high T/P thermal gradients. How these observations can be interpreted with respect to modern-day style deep and steep subduction remains unclear; however, the presence of low *T/P* gradients is consistent with some form of convergent margin tectonism, and is more difficult to explain by stagnant-lid or sagduction geodynamics. As we expand our Early Earth accessory mineral archives, we hope to better constrain its much-debated geodynamic history.