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Unraveling Earth's Earliest Crust: Insights from mantle-crust interaction in the Paleoarchean, southern São Francisco Paleocontinent

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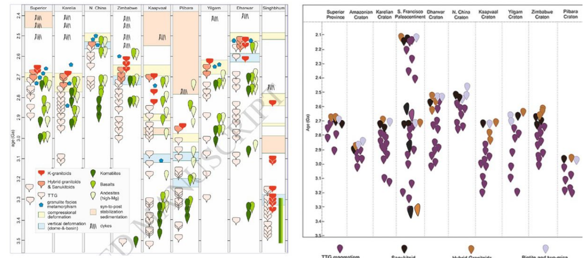
Deciphering the intricate processes underlying the formation and stabilization of continental crust during the Archean era is vital for understanding Earth's early geological history. Here, we present a comprehensive analysis integrating new geochemical, isotopic, and geochronological data from granitoid rocks within the Archean basement of the Southern São Francisco Paleocontinent, southeastern Brazil (SFP). Our study endeavors to unravel the complex evolution of continental crust in this region. We delineate a significant shift in crustal genesis mechanisms, transitioning from Archean melting of hydrous basalts to melting of enriched mantle peridotite, driven by metasomatic processes. The emplacement of sanukitoid rocks during this epoch underscores deep interactions between metasomatized mantle material and crust-derived magmas. Employing a suite of analytical techniques encompassing U-Pb dating, Lu-Hf, Sm-Nd, and Sr isotopic analyses, oxygen isotopic compositions, and Zr trace element analysis, we elucidate the temporal and compositional evolution of continental crust within the Campos Gerais Complex during the Paleoarchean era. Notably, our study identifies the oldest known sanukitoid rock, dating back to 3.3 Ga, characterized by mantle oxygen isotopic signatures and chondritic Lu-Hf and Sm-Nd isotopic compositions. Furthermore, our analyses suggest the stabilization of proto-cratonic crustal blocks during the subsequent Mesoarchean period (3.2–2.8 billion years ago), often accompanied by extensive reworking of pre-existing granitoid crust. We propose a comprehensive model for the origin of sanukitoids, implicating the opening of the mantle wedge after a period of shallow subduction, fostering interactions between metasomatized mantle material and crust-derived magmas. Our study underscores the dynamic interplay between mantle and crustal processes during the Paleoarchean era, highlighting the importance of localized geological investigations in elucidating broader geodynamic processes. Additionally, our findings shed light on the temporal relationship between subduction initiation and the establishment of modern plate tectonics, highlighting the unique nature of these processes during Earth's early history. The chronology of our results, complemented by prior data, delineates a complete orogenic cycle, featuring a 3.3 Ga sanukitoid, succeeded by High-K Granites, 2.9 Ga TTG, sanukitoid, and High-K granites.



Hawkesworth et al., (2024)

Modified from Bruno et al., (2020)