Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.38180

The role of arc volcanism on icehouse–greenhouse transitions: a comparative assessment of the Cryogenian and Late Paleozoic

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Earth's transitions between icehouse–greenhouse climates are largely influenced by the greenhouse gas composition of the atmosphere, particularly CO_2. The amount of carbon that is free to exchange between reservoirs at Earth's surface is dictated by the long-term carbon cycle whereby volcanic outgassing provides the major flux of CO_2 to the atmosphere and the weathering of Ca- and Mg-bearing silicate minerals acts as the major CO_2 sink. Accordingly, shifts between icehouses and greenhouses are hypothesized to be driven by variation in the relative efficiency of the carbon sources and sinks, which are in-turn largely tied to changes in tectonic processes. Here we present an assessment of newly-generated geochronologic and geochemical data from Neoproterozoic and upper Paleozoic sequences collected across multiple major continental terranes (e.g., northern Greenland, northern Australia, Southeast Asia, South Korea, etc.) incorporated with globally-compiled records of continental magmatism to investigate two of the most significant icehouse intervals in Earth History: the Cryogenian Snowball Earth events and the Late Paleozoic Icehouse. These newly expanded records provide enhanced temporal and spatial coverage of continental magmatism during these climatic shifts and demonstrate consistent patterns with global magmatism waning during the transition into the icehouse climates and magmatism expanding during the transitions back into the greenhouses. Notably, the Cryogenian, which encapsulates the most extensive icehouses recorded in the rock record, corresponds with the most spatially-reduced interval of magmatism of at least the past ~800 million years.