

Geochronological constraints on the emplacement of the Franklin LIP: Testing hypotheses for the onset of the Sturtian snowball Earth

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The establishment of time-correlative glacial deposits around the world, coupled with paleomagnetic data and climate modeling, has shown that ice reached equatorial latitudes at least twice during the Cryogenian Period. The cause for such catastrophic climate change remains uncertain, and explanations for the onset of the Sturtian snowball Earth have invoked chemical weathering of the Franklin large igneous province (LIP) in the preceding millions of years, or the radiative forcing from its immediate sulfur aerosol emissions. High precision geochronology has the potential to test these hypotheses with the ability to resolve geologic events on the sub-million year timescales of climate changes. A U-Pb age obtained from baddeleyite in diabase sills from the western Arctic closely linked the emplacement of the Franklin LIP to the timing of onset of the Sturtian glaciation at approximately 717 Ma; however, new high precision ages obtained from zircon in other Franklin LIP sill samples using the chemical abrasion-isotope dilution-thermal ionization mass spectrometry (CA-ID-TIMS) technique refine previously published baddeleyite ages and are older than the most precise age constraint on the onset of the Sturtian glaciation by a few million years. Here we combine the geochemistry and geochronology of intrusive and extrusive rocks associated with the Franklin LIP from Victoria Island to the Coronation Gulf to estimate eruption rates over time in this region. The new, precise geochronology data are consistent with hypotheses linking weathering of the Franklin LIP to the onset of the Sturtian snowball Earth, but it is also possible that there is no causal relationship. These data further challenge the accuracy of baddeleyite dates of LIPs on the sub-million year timescale needed for testing links between LIPs and environmental change.