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Age constraints on Paleoproterozoic glacials and oxygenation from South Africa

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Absolute age constraints are a key requirement to understand links between global tectonics, sedimentation and changing surface environments in the Neoarchean and Paleoproterozoic, such as oxygenation of the ocean-atmosphere system (the Great Oxidation Event, GOE) or increased carbon burial during the Lomagundi $\delta^{13}C$ excursion. Of particular importance is the interval ~2,420 to ~2,200 Ma, which contains evidence for increasing global oxygenation and several local or global glacial deposits, including a Snowball Earth episode [1]. Uncertain geochronology means global correlations are intensely debated [2]. Correlations allow the Snowball Earth episode to fall before, during or after the GOE. Here we present a synthesis of currently available age constraints from the Transvaal Supergroup of South Africa, which is exposed on the western (Griqualand West sub-basin) and eastern Kaapvaal craton (Transvaal sub-basin).

Paleoproterozoic BIF in the **Transvaal** sub-basin are cut by an erosive unconformity, overlain by a basal glacial diamictite and marine siliciclastics of the Duitschland Fm. An angular unconformity (mid-Duitschland unconformity) is regarded as a cryptic glacial surface [1], and mass-independent fractionation of sulfur isotopes disappears across the unconformity [3]. This is taken as a global marker for detectable oxygen levels [1]. The basal Duitschland Fm. must be younger than 2,424 Ma based on detrital zircons. Regional correlations clearly suggest that the Duitschland Fm. is equivalent to the Rooihoogte Fm., which contains the ~2,350 Ma Bushy Bend lavas near its top. As the contact to the overlying Timeball Hill Fm. (~2,316-2,250 Ma) is conformable, 2,320 Ma is a reasonable minimum age for the Duitschland Fm. The Timeball Hill Fm. contains red beds formed under an increasingly oxygenated atmosphere, and is overlain by the ~2,220 Beshoek glacial diamictite, a likely correlative of the Makganyene Fm. in the Griqualand West sub-basin.

In **Griqualand West**, siliciclastics and Fe-rich sediments of the Koegas Subgroup (~2,415 Ma) unconformably overlie major BIF [4]. An unconformity with glacially striated pavement separates the Koegas Subgroup from the overlying Makganyene diamictite, which is regarded as a Snowball Earth deposit. The age of the Makganyene Fm. is contentious, but a U-Pb date of 2,222 Ma in the conformably overlying Ongeluk volcanics should provide a reliable age constraint.

Detrital zircon dates from the Transvaal sub-basin show prominent unconformities and clear younging trends up through the succession, reflecting a progressively thicker sedimentary cover and increasing internal recycling. A prominent ~2,575-2,410 Ma zircon population occurs in samples from across the Kaapvaal craton, but has no known source terrain on the craton. It is assigned to Pilbara craton volcanics, whose equivalents were probably eroded from the Kaapvaal craton. Such a relationship would support connection between both cratons by about 2,400 Ma.

The age populations of Koegas Subgroup, Makganyene Fm., and Duitschland Fm. are remarkably similar [5]. This likely reflects important craton-wide erosion of the same source terrains, which is consistent with the major influx of siliciclastics across the craton, and with development of important unconformities around 2,400 Ma. Similar trends are observed globally around this time. The association of glacials with a tectonically active period implies however that not all glacial deposits need to be globally correlative; several could be local in origin.

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