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Solidification timescale for the Dufek Intrusion, Antarctica determined by U-Pb zircon ages

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The 8-9 km thick Dufek layered mafic intrusion of Antarctica was emplaced at approximately 182 Ma associated with the Ferrar dolerites and the breakup of the supercontinent Gondwana. It is rivaled in thickness only by the Bushveld Complex of South Africa and shows a similar progression in mineral compositions all the way to the uppermost contact with an overlying granophyre layer. This progression in mineral composition suggests that it crystallized from the bottom to the top and did not form an upper solidification front (a.k.a., Upper Border Series) typical of smaller intrusions such as the Skaergaard Intrusion. Unlike the Bushveld Complex, however, the Dufek Intrusion is exposed in only two ~1.8 km thick sections: the lowermost Dufek Massif, and the uppermost Forrestal Range, which are separated from one another by a ~50km wide snowfield. The remainder of the stratigraphy is inferred from geophysics, evolution of mineral compositions, and projection of the dip of the layering through the snowfield.

We obtained precise CA-ID-TIMS U-Pb zircon ages from samples from the Dufek Massif and Forrestal Range in order to determine the timescale of solidification of a large layered mafic intrusion. What we found is surprising - zircons from the bottom of the intrusion record younger ages than those from the top of the intrusion. Two samples from the Dufek Massif have zircon U-Pb ages of 182.441±0.048 Ma and 182.496±0.057 Ma; whereas three samples from the Forrestal Range have zircon U-Pb ages of 182.601±0.064 Ma, 182.660±0.10 Ma, 182.78±0.21 Ma. Thus, the lower section of the Dufek Intrusion solidified approximately 160,000 years after the upper. We explore two possibilities for this reverse-age stratigraphy, (1) that the ages reflect the solidification of interstitial melt in a single magma chamber cooling from the top down, or (2) that the Dufek Massif and Forrestal Range are two separate magma chambers that are not connected at depth. Our results have implications for the stratigraphic thickness estimates of the Dufek Intrusion as well as the duration of magmatism associated with continental breakup.