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Supplemental Material

Table S1. U-Pb zircon data.

Table S2. Ar-Ar data table detrital grains.

Figure S1. YAR1 R-2 of the Patuxent Formation (bedrock) from the Pensacola Mountain adjacent to Foundation Ice Stream.

Figure S2. WAW R-9 represents local bedrock from the southern margin of the Recovery Ice Stream.

Figure S3. STB R-8 represents local bedrock from the northern margin of the Recovery Ice Stream.

Figure S4. YAR4B SS R-7 is sandstone erratic from the Foundation Ice Stream.

Figure S5. YAR4C SS R-4 is a sandstone erratic from the Foundation Ice Stream.

Figure S6. POR R-5 is a porphyry from the Foundation Ice Stream.

Figure S7. LIC SS qtz R-3 is a sandstone erratic from the Academy Glacier.

Figure S8. LIC SS red R-10 is a sandstone erratic from the Academy Glacier.

Figure S9. GR R-1 is a granitic erratic from Academy Glacier.

Figure S10. BRZ R-6 is a sandstone bedrock sample from Brazitis Nunatak along the Foundation Ice Stream upstream of the Thomas Hills.

Figure S11. MOU-SEL is a conglomerate erratic from the MOU moraine site along the Foundation Ice Stream. Rock hammer for scale. Zircons were separated from the from matrix for analysis.

Figure S12. Multidimensional-scaling (MDS, Vermeesch, 2013) analysis of zircon U-Pb geochronological age spectra from ice stream moraine tills: A. All sample locations; B. A more restricted sample set, including the Foundation Ice Stream, Academy Glacier, and south Recovery Glacier data. MDS takes a matrix of pairwise dissimilarities between age distributions as input and produces a map on which similar samples cluster closely together and dissimilar samples plot far apart. The MDS analysis was made using the software package Provenance within the R statistical programming environment (Vermeesch, 2016).

Notes on common, exotic, and bedrock cobble/pebbles chosen for U-Pb analysis

Of the 10 pebble/cobble samples, 3 represent the local bedrock that the Foundation Ice Stream, Academy Glacier, and Recovery Glacier transport. Gray fine-medium grained metasedimentary pebbles (YAR1 R-2) of the Patuxent Formation represent the local component in the Foundation Ice Stream and Academy Glacier (Fig. S1). Since the Recovery Glacier has contrasting bedrock geology on both sides, pebbles from the tills inferred as bedrock based on angularity, abundance, and like composition to bedrock described in literature were taken. WAW R-9, a gray/brown fine-medium grained sandstone, represents the local component near the Whichaway Nunataks and has similar composition to the outcropping Whichaway Formation of the Beacon Supergroup described in Stephenson and Blundell (1966) (Fig. S2). STB R-8 represents the other side of the ice stream near Stephenson Bastion and is a greenschist, or metamorphosed sedimentary rock with chlorite crystals from low-grade metamorphism (Fig. S3). STB R-8 has a similar composition to the Turnpike Bluff Group, composed of greenschists and described as the bedrock of Stephenson Bastion in Faure and Mensing (2010).

YAR4B SS R-7 and YAR4C SS R-4 are common rocks found in the pebble fraction of Foundation Ice Stream till deposits, which suggests a nearby source. YAR4B SS R-7 is a white fine-medium quartzose sandstone with portions of iron staining (Fig. S4), while YAR4C SS R-4 is a white-brown quartzose sandstone without iron staining (Fig. S5). These rocks were chosen to represent common detritus the Foundation Ice Stream is carrying. POR R-5 is a porphyry, or an igneous cobble consisting of coarse-grained crystals in a fine-grained matrix, found in till deposits along the Foundation Ice Stream (Fig. S6). This uncommon lithology can offer insight into more distal source units.

LIC SS qtz R-3 and LIC SS red R-10 are common rocks found in the pebble fraction of Academy Glacier till deposits, which also suggests a proximal source. LIC SS qtz R-3 is a white-brown medium grained quartzose sandstone (Fig. S7), while LIC SS red R-10 is a red medium-grained quartzose sandstone (Fig. S8). Since they are ubiquitous in the pebble fraction, and the till has a reddish tint to it as well, they were chosen to represent common detritus the Academy Glacier is carrying. GR R-1, a granitic cobble, is an uncommon lithology found in this ice stream's till deposits that can also offer insights into source units that may not be in close proximity (Fig. S9). Sample BRZ R-6 is a coarse-grained quartzose sandstone taken from bedrock of the Devonian Sandstone farther upstream (Fig. S10). This cobble's lithology is common in the pebble fraction of Foundation Ice Stream and Academy Glacier tills, thus it was chosen to compare to till age populations.

MOU SEL is a conglomerate collected from the MOU moraine along the margin of the Foundation Ice Stream (Fig. S11). A total of 299 clasts >2 mm were identified from the conglomerate. Just over 61% of the clasts were metasedimentary, 13.4% were quartz pebbles, and 13% were sedimentary grains. The majority of the grains were rounded or sub-rounded with only ~15% angular or sub-angular. Most of the grains, 72%, were a distinctive greenish gray with varying intensity. XRD analysis on a few of these colored grains showed the presence of microcline, chlorite, biotite and muscovite. The matrix of the sample was white to light gray in color, well sorted, and moderately well rounded.

Sites that are geographically close, such as the sites within the Foundation and the Institute Ice Stream areas, plot close together in MDS similarity space. Data from the Slessor Ice Stream and northern Recovery Glacier (Stephenson Bastion) plot far from the other sites, as expected from the dominance of ages older than 1500 Ma at Slessor and Recovery and their

rarity at the other sites. Sites from the Academy Glacier and the south side of the Recovery Glacier (Whichaway Nunataks) plot close to the Foundation Ice Stream Sites, indicating that the hinterland of all these sites is geochronologically similar, but they are different enough to be statistically distinguishable from each other. The Foundation Ice Stream sites are all similar to each other. It is notable that the old and young till (YAR-2 and YAR-4C) from Mt Yarborough also plot close together, indicating that there was a similar source for these tills despite the different ice sheet thickness at the times they were deposited.

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*The blue ruler shows the scale in inches.

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MDS plot using U-Pb zircon data

Figure S12. Multidimensional-scaling (MDS, Vermeesch, 2013) analysis of zircon U-Pb geochronological age spectra from ice stream moraine tills: A. All sample locations; B. A more restricted sample set, including the Foundation Ice Stream, Academy Glacier, and south Recovery Glacier data. MDS takes a matrix of pairwise dissimilarities between age distributions as input and produces a map on which similar samples cluster closely together and dissimilar samples plot far apart. The MDS analysis was made using the software package Provenance within the R statistical programming environment (Vermeesch, 2016).