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Radar polarimetry at Crary Ice Rise, Antarctica, reveals details of ice-flow reorganization over the last millennium

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Ice rises are locally grounded areas in floating ice shelves. It has been suggested that they form during deglaciation, as the surrounding grounded ice begins to float, but at Crary Ice Rise there is evidence of the opposite, that its formation is a consequence of local grounding of floating ice in the Ross Ice Shelf. Here we use ground-based polarimetric radar measurements using a phase-sensitive system (ApRES) to extract information about englacial crystalline textures at Crary Ice Rise. These textures are flow-induced and contain a record of the dynamics of the area. We observe a sharp transition in the direction of alignment of the crystalline texture that, across our measurement sites, varies in depth but is consistent in direction. Our interpretation is that ice was floating and fast-flowing along the direction of drainage of Whillans Ice Stream and then it grounded: 1000 +/- 200 yr ago in the east ridge and 500 +/- 100 yr ago in the west ridge. After grounding, the ice flow changed direction by nearly 90 degrees, across the local ridges, establishing the present ice-rise flow. Since the time of grounding, the ice has thickened by about 30 m on the east ridge, and by up to 100 m on the west ridge. Our study raises questions about a progressive retreat of the grounding line from the last glacial maximum, and demonstrates a method using polarimetric radar data that can be applied to infer recent changes in ice-flow direction at other sites.