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Antarctic Ice Shelf Aquifers:Characteristics and Potential Contributions to Ice Shelf Loss

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Water-saturated firn layers, or firn aquifers, have recently been identified from satellite microwave image time-series data in some western Antarctic Peninsula ice shelves. Subsequent field work on the Wilkins Ice Shelf (this work) and Mu□ller Ice Shelf (MacDonell et al., 2021) has proven the existence of these perennial ice shelf firn aquifers. Most of the aquifer areas are maintained by seasonal meltwater recharge. Brine aquifers have been known for many decades in certain slow-moving ice shelves with shorter or absent melt seasons (e.g., McMurdo Ice Shelf). We present both satellite evidence of meltwater firn aquifers in several areas of the Antarctic Peninsula, and radar profile evidence consistent with extensive brine infiltration in the Abbott, Nickerson, and Shackleton Ice Shelves. These latter ice shelves had been previously identified as likely sites of widespread brine infiltration (Cook et al., 2018).

The hydrofracture-driven disintegration of the Wilkins Ice Shelf in February-March of 2008, and subsequent rapid calving events extending into the winter season, justify a closer look at the relative potential for fresh-water aquifers, brine aquifers, and surface melt ponds for inducing hydrofracture in ice shelves. The destructive impact of surface or near-surface meltwater on floating ice is now well-established and is implicated in the loss of the Larsen A and Larsen B ice shelves, and rapid late-stage disintegrations of several tabular icebergs. Brine-aquifer-induced disintegration was suspected for the Wilkins breakup (Scambos et al., 2009), but now appears to be related to the effects of a freshwater system. A question remains regarding the vulnerability of ice shelves with significant brine infiltration in an aquifer.

We will present field measurements from the Wilkins Ice Shelf and discuss the relative hydrofracturing potential of fresh water and brines under various scenarios pertinent to ice shelf stability. The potential for future expansion of fresh-water aquifers under warming coastal conditions, and the characteristics of a hypothetical transitioning from a cold brine aquifer to a

fresh-water aquifer will be discussed.

Cook, S., Galton-Fenzi, B.K., Ligtenberg, S.R. and Coleman, R., 2018. Brief communication: widespread potential for seawater infiltration on Antarctic ice shelves. *The Cryosphere*, *12*(12), 3853-3859, doi: 10.5194/tc-12-3853-2018.

MacDonell, S., Fernandoy, F., Villar, P. and Hammann, A., 2021. Stratigraphic analysis of firn cores from an antarctic ice shelf firn aquifer. Water, 13(5), 731, doi:10.3390/w13050731.

Scambos, T., Fricker, H.A., Liu, C.C., Bohlander, J., Fastook, J., Sargent, A., Massom, R. and Wu, A.M., 2009. Ice shelf disintegration by plate bending and hydro-fracture: Satellite observations and model results of the 2008 Wilkins ice shelf break-ups. Earth and Planetary Science Letters, 280(1-4), 51-60, doi:10.1016/j.epsl.2008.12.027.