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Subglacial hydrology beneath the Antarctic Ice Sheet

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Liquid water at the base of a glacier exerts profound influences on its flow, thereby its interactions with climate, yet our understanding of subglacial hydrology beneath the larger ice sheets, chief amongst them the 30 million km^2 Antarctic Ice Sheet, remains underdeveloped. Beneath thick ice water is generated through basal melting induced by the insulating effect of overlying ice, but detecting and observing such water, and determining where and how it flows, is fraught with practical difficulties. The advent and development of remote sensing technologies to investigate polar regions has supplied significant new hydrological insights. The most well-constrained hydrological phenomena beneath the Antarctic Ice Sheet are subglacial lakes. Widespread ice-penetrating radar surveys have revealed that the ice sheet is underlain by numerous lakes, estimated cumulatively to contain between 4000 and 12 000 km^3 of water, and these commonly correspond with ice-surface depressions or regions of unusual flatness identified by satellite altimetry. While the largest lakes have been discovered, there remain potentially hundreds of undiscovered or uncatalogued smaller lakes, and many details of lake behaviour remain unresolved. Over the last decade subglacial lakes have generated considerable scientific interest due to their potential to house unique forms of life, but to date no subglacial lake has been directly sampled, owing primarily to the difficulty of avoiding sampling-related contamination. Moreover, recent satellite altimetric observations have suggested that some lakes periodically drain and fill, and may be connected to one another, but the degree of lake interconnectivity and what controls this are unknown. Away from subglacial lakes, subglacial water, and minor, but potentially high-impact, variations in subglacial hydrology, are hard to detect beneath ice typically several km thick. Ice-penetrating radar and seismic methods offer the greatest potential, generating bed echoes whose reflection strengths

increase markedly with the presence of water. Liquid water is commonly present beneath fast-flowing ice streams, whereas slow-flowing ice divides and source regions are typically frozen at the base. A major implication is that subglacial hydrology mediates, and may even primarily control, the configuration of ice streams, which account for $\sim$80% of the grounded ice delivered to the oceans each year. Nevertheless, the distribution and variability of subglacial water, and the degree to which subglacial water relates to other parameters that influence ice flow, remain poorly constrained. There is, therefore, a need to improve our understanding of subglacial hydrology beneath the Antarctic Ice Sheet, and a plethora of projects to be undertaken during the International Polar Year (IPY) promises to do just that.