Bathymetry beneath the Abbot Ice Shelf from IceBridge gravity data: Implications for ocean-ice interactions

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Floating ice shelves surround much of the Antarctic continent and play an important role in stabilizing the Antarctic ice sheets. Some ice shelves have experienced rapid thinning attributed to interactions between the ice and warm Circumpolar Deep Water (CDW) circulating beneath. Knowledge of the bathymetry beneath ice shelves is important for assessing their vulnerability and modeling ice-seawater interactions. The Abbot Ice Shelf, located between Thurston Island and the Eights Coast of West Antarctica, shows a positive mass balance unlike nearby ice shelves in the Amundsen Sea Embayment. We inverted NASA Operation IceBridge (OIB) airborne gravity data over the Abbot Ice Shelf to obtain its underlying bathymetry. The morphology reveals a series of asymmetric fault-bounded basins to the west of 94°W. East of there, the sub-ice bathymetry is relatively shallow with no evidence of tectonic activity. South of the Abbot Ice Shelf, a rift basin is also found to the west of 99°W under the Cosgrove Ice Shelf. The shallowest constriction on our ten profiles is ~450 m and the sub-shelf basins north of 73°S appear to be interconnected. Thus, barring an uncharted blocking sill, water above that depth can circulate beneath the ice shelf.

Two CTD casts near the western ice front show the presence of warm CDW at depths below ~400 m. Temperatures are >3° above the melting point of ice at those depths, and the overlying thermocline is >1° above freezing up to depths of ~200-250 m. CDW thus has access to the cavity beneath the ice shelf. Melting by seawater that flows beneath the ice shelf will be limited by variability in the thermocline depth and by the relatively shallow ice draft, which is less than 275 meters below sea level (mbsl) throughout much of the cavity. The base of the ice is deeper along the Eights Coast east of 97°W where the grounding line depth varies from ~275 to 475 mbsl on our profiles. Those flight lines consistently show a variety of possible sills, pinning points and enclosed basins interpreted as formed by the uplifted footwall rims of south-facing normal faults. However, the high observed melting rate of the Abbot ice shelf indicates that those features do not fully restrict penetration of warm seawater to the deepest ice.