

Unravelling the Dynamics of Denman Glacier, East Antarctica: Insights from MT and Integrated Geophysical Investigations

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SUMMARY

In recent years, some parts of the Antarctic ice sheet have undergone substantial mass loss due to accelerated glacier flow, primarily influenced by the warming ocean, bed topography and basal melting. Despite advancements in mapping bed topography and subglacial hydrology, critical sectors of Antarctica still remain poorly understood.

Denman Glacier in East Antarctica flows through what has been modelled as the deepest trough on Earth, approximately 3.5 km below sea level. Models of the bed topography reveal high instability of the glacier with a potential 1.5m sea level rise (Morlighem *et al.*, 2020). Concerns about its stability are exacerbated by the retreat of the grounding line by over 5 km since 1996, and by suggestions that the bed topography may be channelling subglacial water and amplifying basal melts (Pelle *et al.*, 2023). However, the full extent of the glacier's trough has never been directly imaged, and the impact of localised melt enhancement from subglacial discharge remains unknown.

In order to address these gaps and improve our understanding of the Denman Glacier dynamics, the Denman Terrestrial Campaign (DTC) was conducted during the 2023/24 summer season. A primary objective of the DTC was to obtain magnetotelluric (MT), active and passive seismic, and gravity measurements on a profile traversing the glacier. Broadband MT data were acquired with Phoenix instrumentation as part of the AuScope-funded GRIT (Geophysical Research Infrastructure for AnTartctica) pool.

MT data show a measurable contrast between the highly resistive glacial ice and less resistive underlying bedrock. This contrast is used to constrain the thickness and shape of the Denman trough, as well as imaging the sub-ice melt and interactions with deeper groundwater systems in the ice-bedrock interface zone. Furthermore, by integrating conductivity models with co-located seismic and gravity data along the transect, we leverage the complementary information to constrain the trough shape more accurately and model the subglacial basin and dynamics. The results of this work provide the first geophysical measurements of the thickness of the Denman Glacier and the underlying hydrology, allowing more accurate glaciological models of future sea level rise.

Keywords: magnetotellurics, sea level rise, glacier dynamics, integrated geophysics, Antarctica

REFERENCES

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