Antarctic Science International Bursary Project Report: Quantifying sediment flux through central East Antarctica

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Brief report on the research visit, in September 2018, to collaborate with Professor Robin Bell at Lamont-Doherty Earth Observatory, Columbia University, New York, U.S.A., to examine englacial sediments in ice penetrating radar transects of central East Antarctica. Travel and accommodation were funded by the Antarctic Science International Bursary and Northumbria University.

Project rationale
Sediment can alter frictional stress at the glacial bed and modify ice flow[1], change ice flow direction through long-term erosive processes[2] and transfer essential nutrients and bio-available iron from continental sources to the ocean[3,4]. It is therefore critical to constrain how sediments are entrained and transported within ice sheets. The extended research project, funded by the Antarctic Science International Bursary, was designed to spatially extend research on englacial sediments in West Antarctica[5,6], to central East Antarctica.

Study area
As Principal Investigator of Antarctica's Gamburtsev Province (AGAP) project, Professor Robin Bell has access to over 120,000 line-km of ice penetrating radar data from the central East Antarctic Ice Sheet (EAIS)[7]; extending across the Gamburtsev Subglacial Mountains, and into the southernmost margin of the eastern branch of the Lambert rift system (Figure 1). For the extended research project, I visited Professor Bell in New York to collect and discuss AGAP ice penetrating radar data and associated GPS measurements, with the aim of detecting, tracing and quantifying sediment flux through central East Antarctica.

Preliminary research findings
During a week-long visit to Lamont-Doherty Earth Observatory we explored the full suite of AGAP data, whilst concentrating our efforts on ice penetrating radar data that were known to contain fingers, inclusions, sheets and folds[7,8] (Figure 2) where debris can be entrained through shear instabilities, as well as uplift and folding in response to converging flow associated with subglacial topography. Englacial reflectors, exhibiting similar characteristics to sediment reflectors discovered in West Antarctica[5,6], were identified in several ice penetrating radar transects (e.g. Figure 3). Some of these reflectors can be traced through successive radar transects. Work is still underway to determine if the reflectors we identified are indeed englacial sediments. As the reflectors do not extend to the surface, (like they do in our previous study in West Antarctica) it is difficult to ascertain this without direct measurements (i.e. ice cores). However, an inventory of possible sediment inclusions has been compiled.

Personal reflection
Discussions with Professor Bell and colleagues at Lamont-Doherty Earth Observatory were fundamental to my improved understanding of radar-detected englacial structures. By attending a

follow-on conference in New York, I was also able to meet several other researchers who introduced me to more quantitative methods to explore sediment reflectors (principally Mie scattering analysis). This work enabled me to develop new skills and create a more robust field plan for a subsequently funded research project to examine glacial sediments in Dronning Maud Land, East Antarctica (funded by Fonds Baillet Latour in 2018). I am therefore thankful for all the assistance and discussions I had with Professor Bell, and the team at Lamont-Doherty Earth Observatory, as well as the wider cryospheric community. These discussions were facilitated by my travel to New York, which was generously supported by the Antarctic International Bursary, for which I am incredibly grateful.

Research dissemination and outreach

Our inventory of possible sediment inclusions in central East Antarctica will be presented at several research talks and seminars in the U.K., and at international conferences organised by the International Glaciological Society so that we can continue to explore and discuss englacial sediments, and radar reflectors within the glaciological community. To support my research-led teaching activities at Northumbria University, I have also shared AGAP ice penetrating radar transects with undergraduate and postgraduate students who are interested in exploring the vast subsurface of Antarctica.

References

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Figures

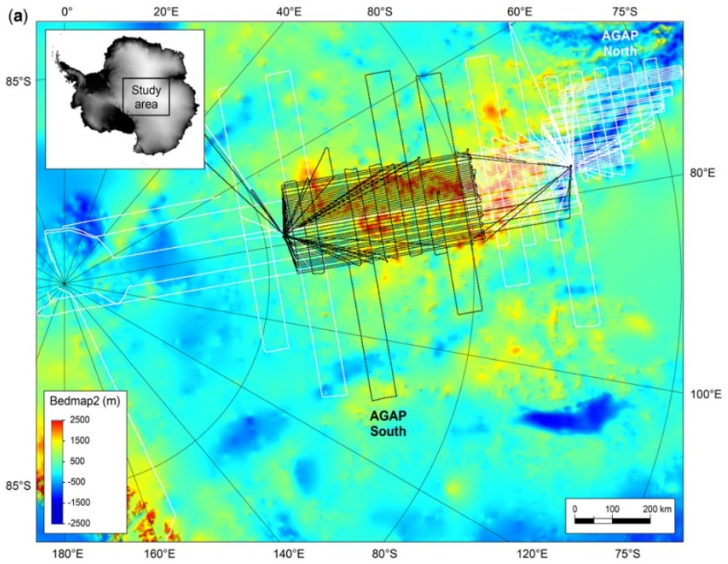

Figure 1. AGAP airborne geophysical tracks (black lines)[7] examined in the extended research project were traversed over the Gamburtsev Subglacial Mountains (coloured red on Bedmap2[9] background imagery). Adjacent geophysical surveys of East Antarctica are recorded as white lines.

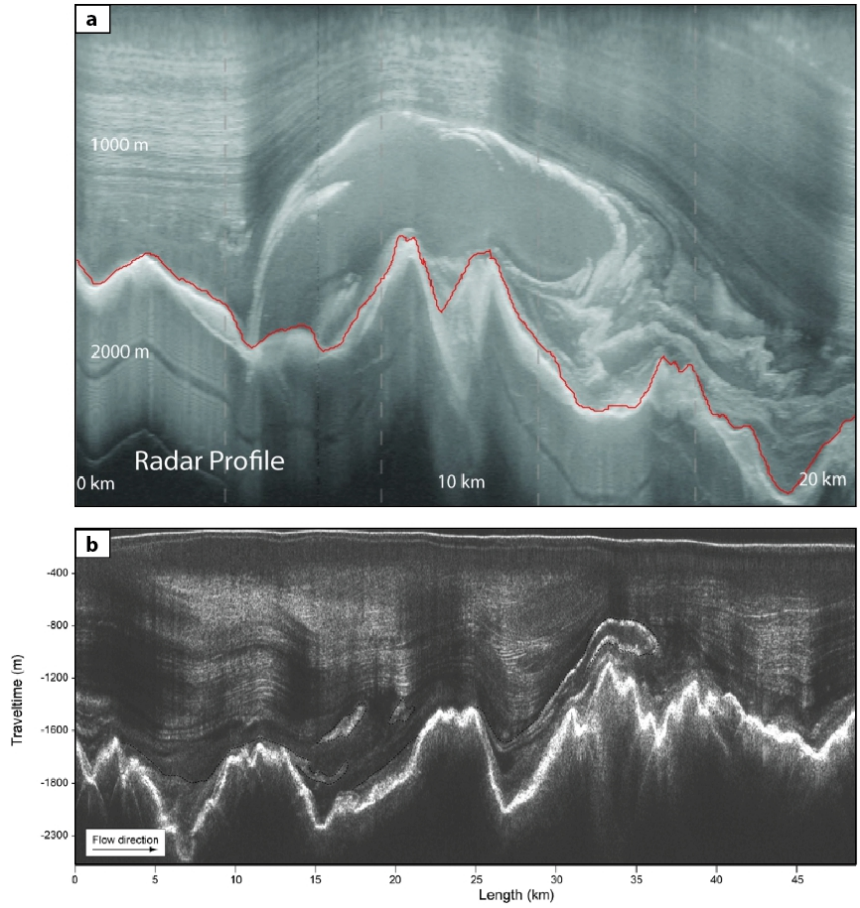

Figure 2. Radargrams from the AGAP survey reveal folds, inclusions, fingers and sheets above the Gamburtsev Subglacial Mountains[7], where debris could be entrained through shear instabilities, as well as uplift and folding in response to converging flow, associated with subglacial topography.

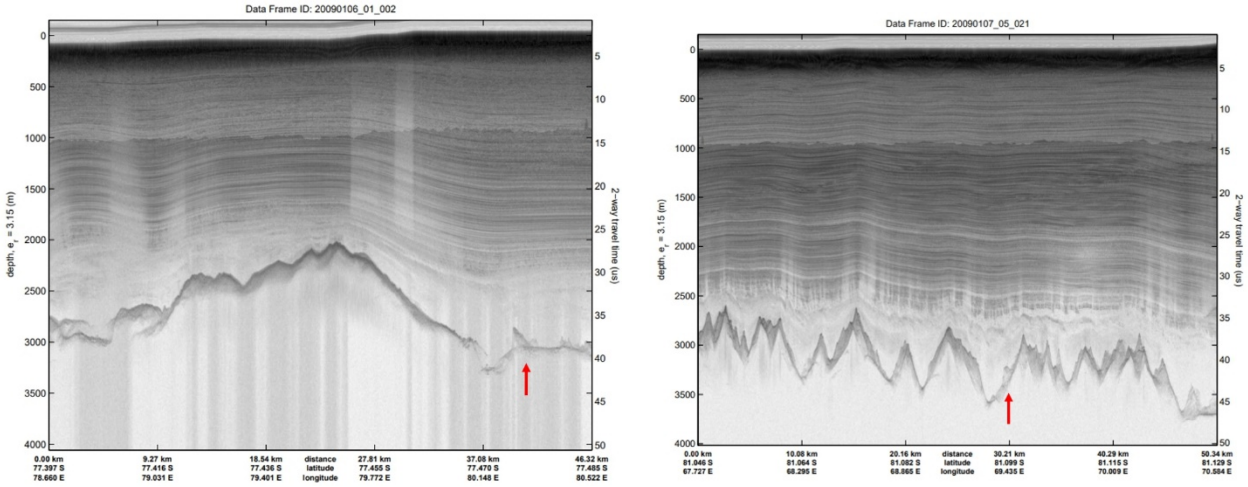

Figure 3. Analysis of AGAP ice penetrating radar transects reveal that there are several englacial reflectors close to the subglacial bed. These features (noted here by red arrows) are visible in a variety of radargrams, where they are found at various orientations and distances from the valley side walls, and not a constant proportion of ice thickness. These are the key identifying features that suggest these reflectors could evidence englacial sediment inclusions in central East Antarctica.