New aerogeophysical views of bedrock topography, subglacial geology and englacial layers in the South Pole sector of the East Antarctic Ice Sheet

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Abstract

Despite extensive international airborne geophysical research efforts in Antarctica, the South Pole region stands out as one of the largest "poles of ignorance" in the whole continent, as very little data have been acquired here since reconnaissance surveys performed in the 1970's. Of particular significance for investigating past East Antarctic Ice Sheet (EAIS) dynamics and long-term stability is the presence of a deep subglacial basin that was first identified by these early surveys and called the Pensacola-Pole Basin. The South Pole area is also receiving heighted attention in the paleoclimate and paleo ice sheets communities in light of some subglacial highlands located between South Pole and the Gamburtsev Subglacial Mountains being identified as potential candidate sites to recover > 1.2 Ma old ice via ice core drilling, while also drilling into the bedrock to help constrain subglacial geology.

During the 2015-2016 Antarctic field season we flew an extensive aerogeophysical campaign to explore the South Pole Frontier, as part the PolarGAP project funded by the European Space Agency, which was designed mainly to help fill in the void in GOCE (Gravity Field and Steady-State Ocean Circulation Explorer) satellite gravity data coverage south of ca 83.3°S. As part of this project we collected ca 30,000 line km of new radio echo sounding, laser altimetry, airborne gravity and aeromagnetic data over the South Pole region.

Here we present the new ice thickness, bedrock topography, and gravity and magnetic anomaly views of the South Pole region derived from PolarGAP. The airborne gravity and radar data reveal the form, extent and depth of the Pensacola-Pole Subglacial Basin, which stretches for over 900 km from the Weddell Sea to South Pole. Linear free-air gravity lows image several distinct glacially overdeepened graben systems, flanked by fault-bounded horst-like mountain ranges. These grabens are interpreted here to have formed in association with the Jurassic Transantarctic rift system and to have been subjected to significant glacial erosion and overdeepening by the EAIS in Oligocene to Neogene(?) times. These deep tectonic basins constrain the modern flow of the Foundation, Academy and Support Force catchments, and are likely to have persistently controlled flow patterns of the EAIS into the Weddell Sea Embayment throughout its history. The newly imaged englacial layers provide glimpses into past enhanced glacial flow deep in the interior of the EAIS, thereby providing new constraints to help plan future more detailed site surveys and ice sheet and bedrock drilling efforts at South Pole.

Keywords: Aerogeophysical survey, deep basins, South Pole