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Influence of the Transantarctic Mountains on the evolution of the East Antarctic Ice Sheet; insights from landscape analysis

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Presently, the East Antarctic Ice Sheet (EAIS) is impounded by the Transantarctic Mountains that dam most of the eastern margin of the ice sheet. In the past, the EAIS has thickened to the point that it overtopped the >4000 m mountain range, significantly modifying the landscape of the mountain front. Analysis of this glaciated landscape can provide key data to understanding the evolution of the EAIS and paleoclimate inferences.

Digital data sets and GIS methodologies provide quantitative tools to identify key aspects of glaciated landscape morphology. Here we present the results of analysis of RAMP 500 m grid DEMs along the length of the Transantarctic Mountains. We recognize three distinct morphologies that can be directly related to evolution of the EAIS and past climate. These morphologies are recognized by distinct patterns in the aspect distribution, i.e., the predominant facing directions.

Morphology I is characterized by a bi-directional aspect distribution, that captures the predominance of valley walls along small fjords. Morphology II is characterized by a uni-directional aspect distribution reflecting a lack of fjords, and the preservation of seaward facing escarpements associated with Tertiary development of the mountain range. Morphology III, which is restricted to the northern stretches of the mountain range, is characterized by a non-directional aspect distribution reflecting fluvial drainage patterns that have not been significantly modified by structural or glacial

processes.

The preservation of Tertiary features and the lack of fjords in morphology II regions indicate that these regions have not been significantly affected by large-scale glacial processes. In contrast, the strong pattern of fjords and the small signal from Tertiary features in Morphology I regions indicate large-scale glacial modification of the landscape. Thus, we recognize regions along the TAM where the EAIS thickened until it overtopped the mountains and flowed to the Ross Sea, erasing the Tertiary signal and forming fjords. In contrast, in other regions the EAIS did not thicken enough to overtop the mountain range, and the Tertiary signal is preserved and no small fjords formed.

Analysis of the sub-ice landscape displays a direct correlation between the regions that were not modified by the EAIS and glacial troughs that cut through the mountain range. Currently these through going troughs drain large portions of the EAIS. Preliminary analysis indicates that these troughs formed during uplift of the TAM, prior to onset of glaciation.

These results indicate that these through-going troughs have always efficiently drained the East Antarctic Ice sheet. Thus, during the growth and evolution of the EAIS the TAM was leaky, and prevented significant over-thickening of the ice sheet across broad regions. Thus, the paleo-thickness of the EAIS would have been modulated by the TAM, with the leakiness of the mountain range preventing extreme thickening.