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East Antarctic Ice Stream underlain by major sedimentary basin

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Ice sheets were traditionally considered to consist of slow-moving inland regions, which are drained by faster moving outlet glaciers and ice streams, and these are separated from each other by distinct onset regions with well defined shear margins. Recent work has shown, however, that this is not the case, and instead, there is a network of enhanced flow tributaries, which penetrate hundreds of kilometres inland from the margins. This complexity has significant implications for understanding ice sheet flow and stability, which is important for determining present-day and possible future changes in behaviour.

An airborne radio echo-sounding campaign carried out in the upper reaches of Bailey Ice Stream and Slessor Glacier, in Coats Land, East Antarctica, in the austral summer of 2001/02, has revealed that tributaries of enhanced flow lie within well-defined basal troughs, and are separated from each other by basal topographic highs. These new data indicate significant differences in ice thickness, compared with those estimated in the BEDMAP database. A numerical modelling study revealed that driving stresses are high enough to account for flow by ice deformation alone in inter-tributary areas and, in two of the three enhanced flow tributaries of Slessor Glacier. The trough in which the third tributary lies is sufficiently deep that it could have been below sea level at some time in the past. Analysis of airborne magnetic data (collected at the same time as the echo sounding) indicates the presence of a thick sedimentary basin beneath this tributary. It is not possible to date the sediment or to unequivocally identify its origin but its thickness, magnetic signature and preservation suggest that it is likely of marine origin. It lies some 540 km inland from the current grounding line and a similar

distance from the nearest coastline suggesting that some time in the past this part of East Antarctica was submerged. Using model estimates for subglacial erosion rates for the tributary region of Ice Stream C, West Antarctica, we deduce that either this part of East Antarctica was likely deglaciated or has undergone a substantial change in flow regime during the Neogene. In addition, we believe that the existence of the sedimentary basin is the likely cause of the higher estimated basal sliding velocities for this tributary compared with the other two. The former inference has important implications for the glacial history of the continent, while the latter has implications for how ice dynamics in East Antarctica are modelled.