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SPECIAL ISSUE IN HONOUR OF THE LONG-STANDING CONTRIBUTIONS OF PROFESSOR DAVID E. SUGDEN TO ANTARCTIC GEOSCIENCE

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Guest Editorial

Standing on the shoulders of giants

Almost twenty years has passed since David Sugden and colleagues published a seminal paper in *Nature* presenting geomorphic evidence for the long-term stability of the East Antarctic Ice Sheet (EAIS). This laid a cornerstone for our understanding of Antarctic ice sheet history that has had major ramifications for the role of the EAIS in past and, indeed in future sea level rise estimates. Yet, despite two decades of research, the stability of the EAIS in a warmer world remains enigmatic. The debate this work precipitated created a relative academic storm, and would lead David to write a key paper debating the interpretation of the evidence presented; provocatively entitled '*The East Antarctic Ice Sheet: unstable ice or unstable ideas?'*

The quest for an answer has precipitated some of the most influential science projects undertaken in Antarctica. This includes the Cape Roberts Drilling Project, and the highly successful ANDRILL programme, which has provided multiple new insights into global climate and Antarctic ice sheet history. However, key questions still remain over the relative stability of the EAIS during periods of elevated CO_2 and warming oceans. We are currently unsure whether the EAIS has a 'tipping point' in response to future climate change, and its resulting sea level contribution is fiercely debated.

In the past decade projects such as ICECAP and emerging satellite remote sensing studies from GRACE to ICESat have provided unique insights on the EAIS and, critically, the sub-glacial environment that, as David hypothesized, would be the key to understanding its evolution and therefore its stability. New data, and new technologies, have provided the updated BEDMAP compilation, which provides critical constraints for future work,

Alongside these advances are important new records from both the ice sheet and the surrounding ocean. From the successful Aurora Basin ice-core drilling project to the ongoing Integrated Ocean Drilling Program focused in the oceans surrounding the EAIS, new records of climate are providing critical pieces to complete this challenging puzzle. Alongside these is an improved understanding of the dynamics of the Southern Ocean, which together with advances in our understanding of the sensitivity of marine-terminating ice sheets to ocean forcing, suggest that circulation changes in the Southern Ocean could induce accelerated mass loss from marine-based sectors of the EAIS contributing to global sea level rise.

However, the final piece of the jigsaw that will resolve this long-standing debate is still missing. This is probably because the answer does not actually lie in either the stability or instability camps, but rather in a combination with distinct sectors of ice sheet responding dynamically and regionally to relatively small changes in climate. An ever-increasing number of studies suggest this, including ice sheet modelling, palaeoceanography and contemporary glaciological studies. However, on the question of Pliocene and indeed Pleistocene East Antarctic Ice Sheet stability, the jury is still out.

So what, or perhaps more importantly who, will be able to resolve this important debate? Certainly it will take techniques and individuals capable of bridging each of these disciplines, and David's work has demonstrated a remarkable capacity for encouraging cross-fertilization between separate disciplines. Indeed today, the field that we call "glaciology" is well placed to address this question, being vibrant and widely interdisciplinary, with considerable cross-representation from field scientists, remote sensors, oceanographers, climate modelers, geomorphologists and a community of cryospheric numerical modelers. However, given the scale of Antarctica and the fragmentary nature of the evidence, answering this question will take scientists who, as David's undergraduate tutor at Oxford once said, *"understand that ideas are as respectable as facts and that they exist to be questioned."*

Chris Fogwill, Robert Bingham, Andrew Mackintosh, David Marchant

The guest editors wish to express thanks to all of the authors involved in the manuscripts submitted to this special volume of *Antarctic Science,* celebrating the award of The Seligman Crystal to Professor David Sugden from the International Glaciological Society. The response from the international Antarctic geoscience community to our request for submissions was overwhelming. Each of the papers contained within this volume provides valuable new insights into key questions within Antarctic geoscience and glaciology, reflecting the enthusiastic, longstanding and on-going influence that David has had on the fields of Antarctic glaciology and geomorphology. In addition, by covering subjects as diverse as modern ice shelf and ice sheet processes, to Antarctic and Martian geomorphology, ice sheet modelling to ice sheet climate forcing this special volume is truly multidisciplinary, reflecting David's interests and the scope of *Antarctic Science*. Finally, the guest editors wish to extend a special thanks to Prof David Walton, Sharon Cooke and the Antarctic Science Editorial team, for their support, guidance and patience throughout the development of this volume.

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