Records from greenhouse periods in the geological past are a critical guide for realistic projections of future climate change. A robust interpretation of these records requires the integration of fragmentary geological data from outcrops and drill holes, both rare in Antarctica, with the best available ice-sheet and climate models[10]. We must now add the best possible reconstruction of Antarctic topography to the list of requirements.

Estimating palaeoelevations for the Antarctic region outside of West Antarctica (the area covered by Wilson and Luyendyk) will pose a much bigger challenge. The landscape beneath the ice is among the most inaccessible places on Earth. The pioneering radar-sounding of the 1970s (ref. 11) has been supplemented with new and better technology and compilations. But only recently have efforts begun to gather high-resolution geophysical data to understand the initial growth of the East Antarctic ice sheet and reconstruct the landscape of its likely birthplace — the Gamburtsev Subglacial Mountains[12]. Reconstructing the landscape deep in the interior of Antarctica, based on very sparse data, will require predictions from ice-sheet models coupled with fluvial and glacial erosion models[13].

Recognizing the importance of palaeotopography for ice-sheet and climate models, no matter how crude they will be at first, the Antarctic Earth Science community has recently embarked on a 'mission impossible' to develop a series of palaeotopographic base maps of Antarctica covering the past 100 Myr as boundary conditions for these models[14]. Modelling based on the new maps will not only provide improved estimates of past ice-sheet volumes, but also of sea-ice extent, which drives ocean bottom water generation.

Wilson and Luyendyk's reconstruction of the West Antarctic topography[7] is a crucial step forward towards understanding the behaviour of the ocean–climate–ice-sheet system in the greenhouse world more than 34 Myr ago. Understanding these ancient climate conditions is increasingly of interest: they could be the climate system of Earth by 2100. ❐

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PALAEOCLIMATE

Potomac paradise

The Amazon River is at present winding through lush tropical forests, thick with green leaves and vines. Meanwhile in the mid-Atlantic coastal plain of the US, leaves are falling from the trees and grass is turning brown, ready for the first dusting of snow. At first glance, it would seem that the two systems have little in common. Yet, 55.5 million years ago, the mid-Atlantic shelf may have looked far more like Amazonia than any modern environment in North America.

During the Palaeocene–Eocene Thermal Maximum — a period of abrupt warming that began about 55.5 million years ago and lasted for around 100,000 years — temperatures rose by 5 to 9 °C. This warming came on top of temperatures that were already higher than today. This climate event is marked by a thick (2- to 15-m) layer of clay that was deposited in the Salisbury embayment, which stretches along the North American coast from Virginia to New Jersey. To the naked eye, the clay layer can be an attractive red colour. But the more exciting characteristics, at least for this line of research, are found by looking more closely: the clay is filled with an unusually high concentration of tiny single-domain magnetite grains. Based on an analysis of the magnetite grains, and their organic carbon-rich matrix, Robert Kopp of Princeton University and colleagues concluded that these grains were deposited on a hot and humid river-dominated shelf, not unlike a present-day tropical setting (*Paleoceanography* doi:10.1029/2009PA001783; in the press).

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The grains in question were formed primarily by bacteria that secrete nanometre-size magnetite crystals to orient themselves in the water column. Kopp and colleagues concluded that to trigger a bloom of these bacteria, and preserve their remains, the suboxic zone of the seafloor sediments must have expanded from pre-Palaeocene–Eocene Thermal Maximum levels. Furthermore, in part owing to altered cycling of iron in the expanded suboxic zone, more reactive iron must have been available to the magnetotactic bacteria.

These conditions are surprisingly similar to those found on the modern Amazon shelf: soil and rock weathering in the hot and humid conditions brings abundant iron to the sediments, and high organic-matter deposition promotes up to 2 m of suboxic conditions in the underlying sediments. The Amazon-like conditions in the mid-Atlantic could have been supported by ancient precursors to either the Susquehanna or Potomac rivers, as both were in existence during the Palaeocene and Eocene epochs.

The temperature drop at the end of the Palaeocene–Eocene Thermal Maximum marked the end of the deposition of magnetofossil-rich clays, and the termination of the Amazon-like conditions.

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