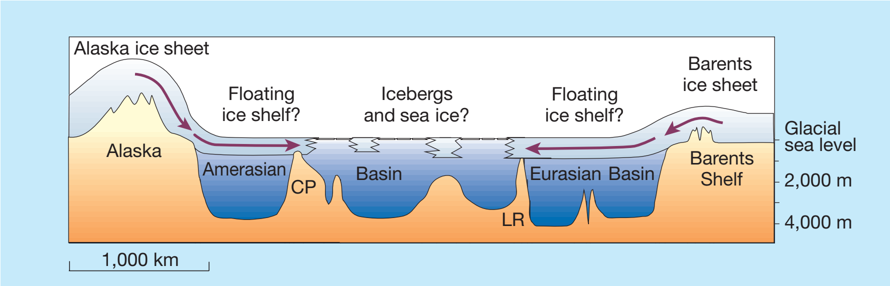

Figure 2 **Profile across the Arctic Ocean, as indicated by the red line in Fig. 1. The graphic indicates the topography of the ocean basin, and its subdivisions, and shows the possible extent of floating ice shelves inferred by Polyak *et al.*[1]. These ice shelves may have developed asynchronously. CP, Chukchi Plateau; LR, Lomonosov Ridge.**

earlier phases of the last interglacial–glacial cycle, which started 115,000 years ago, or to even older ice ages[2,3].

At first sight, the results of Polyak and co-workers[1] support the Grosswald–Hughes model. But stratigraphic models for sediments of the central Arctic Ocean are still controversial, so Polyak *et al.* are cautious in assigning ages to the newly found glacial features in the deep Arctic Ocean. Further sediment analyses will be necessary to address this uncertainty.

That apart, the new findings raise several questions that will have to be tackled by the combined expertise of glaciologists, geologists, climatologists and modellers. Can large ice shelves remain stable in an open ocean basin? What could have caused the rapid expansion of floating ice shelves across the deep, wide Arctic basins? Why were the sizes and configurations of the ice sheets in the Northern Hemisphere apparently so different in different cold periods? And what were the feedback mechanisms between ice-sheet development, ocean currents and atmospheric circulation?

There are two principal requirements for the birth and growth of glacial ice sheets: low temperatures, and circumstances in which snow precipitation exceeds the rate of melting in the summer. A reduction in the amount of solar energy reaching Earth set the stage for high-latitude cooling during ice ages, but it was moisture supply that was the decisive factor in determining where and when ice sheets formed. For example, a correlation between LGM ice-sheet growth in the northwestern Barents Sea and seasonally ice-free conditions in the adjacent Norwegian Sea has been documented[8]. Such findings indicate the key role of the oceans in ice-sheet growth.

According to Polyak *et al.*[1], an earlier ice sheet in the Barents and Kara seas produced a floating ice shelf, about 1 km thick, which reached and scoured the underwater Lomonosov Ridge in the central Arctic (see Fig. 2). At the same water depth (970 m), but further south, the ridge seems to have been unaffected[9] — so the ice shelf must have been tongue-shaped and thinner there, or must have been bounded by sea ice to the east. Ice shelves, however, are unstable and are highly sensitive to variations in sea level. So the flow from the ice-supply routes of the continental shelves must have been extremely fast, which implies a much stronger moisture supply than during the LGM (when the Barents–Kara ice sheet terminated at the shelf break).

Then, as now, the most important moisture source for Eurasia was the North Atlantic. During the LGM, the North Atlantic was cold[6] — probably too cold to feed fast-flowing ice sheets. It could have been that conditions intermediate between glacials and interglacials (interstadials), when water temperatures and evaporation were higher than in full glacials, were more favourable to the growth of large ice sheets in the Eurasian Arctic. Indeed, during the interstadial of around 70,000 years ago, ice sheets reached much further to the east than at any time since then[2].

The new results from fieldwork on land and deep-sea surveys seem puzzling, but are not necessarily contradictory. The timing of pre-LGM glacial events remains poorly known, but it holds the key to understanding the behaviour and impact of ice sheets. At a time when many palaeoceanographers are investigating in great detail the influence of past ice sheets on ocean circulation and climate[10], we have good reason to reconsider events in the Arctic: climatologists and modellers have much to learn about why, when and how large ice sheets formed there. ■

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Daedalus

Computing for art

Computer optimization is a powerful art form these days. Starting from a crude approximation in parameter space, an iterative program can 'hill-climb' very rapidly to a useful optimum. Daedalus now wants to apply it to the greatest art form of all, which these days is advertising. Enormous sums of money are cheerfully spent seeking the optimum advertisement that will grip potential purchasers, and the speed and lack of conventional wisdom of the computer is bound to help.

When Standard Oil changed its name to Esso, only human decision was needed. When the latter changed further to Exxon, a computer program churned out thousands of possible names, ignorant of the limitations of the letter 'x' in English, and a human observer reacted to the outcome. So, says Daedalus, what we need is a big screen, or many little screens, all watched by potential customers wired up to headphones, electroencephalograph, heartbeat and galvanic skin-response detectors, and so on, all of which are fed back to a master computer controlling the whole thing.

The initial screen image, maybe a boot or a bicycle, will be so faint that the subjects will probably take it to be an imagining of their own, if a bit self-willed. But, far faster than any focus group, the machine will take everybody through a whole range of options until its hill-climbing optimization routine has identified that sudden frisson of delight or recognition in at least one subject. The whole languages, the gigabytes of visual data, now easily stored and accessed in modern computers, make feasible the entire ambitious concept — indeed, much of the expense of the project will lie in setting up the initial database of resources. Fortunately these can be almost continuously upgraded with more words, music and even existing advertisements, as the project proceeds.

Thereafter, the machine will improve the sound and image to a powerful democratic optimum. The project will be far more expensive than the conventional activities of advertising agencies. But it will also be far faster and far more likely to produce great and powerful ads.

For his hill-climbing project, Daedalus has settled on advertising for its dominance and financial rewards. But his machine should also be able to optimize pop music, high art, architecture, and other art forms that also fall short of what one might reasonably expect. **David Jones**