Abstractions

H. PAELIKE

FIRST AUTHOR

In August 2004, an international team of researchers extracted 400 metres of sediment core from the Arctic sea floor. It was a technical achievement that many thought impossible. The team is now using the sedimentary record to reveal past climate changes in the Arctic, which could elucidate future climate trends.

For example, the period known as the Palaeocene/Eocene thermal maximum interests climatologists because it is similar to today's warming climate. And the team has discovered that during this period, 55 million years ago, the sea surface temperature in the Arctic was as high as 25 °C.

The results have implications for our understanding of environmental change, says co-author Kathryn Moran, an oceanographer at the University of Rhode Island and one of the project's primary architects. Moran tells *Nature* about the expedition.

What technological advances made this expedition possible?

Sea ice moves constantly and can be up to three metres thick. So we worked with three icebreakers, one of which was fitted out to drill into the seafloor. The drill ship maintained a fixed location, and the other two vessels protected it by breaking up ice and pushing the pieces away. This stopped the drill ship being knocked out of position.

The technique had never been attempted before, and there were several naysayers. But it worked wonderfully, and we were able to maintain position above one drill hole for nine days. We proved the concept.

What did you miss most while on site?

We lacked very little because the Swedish Polar Research Secretariat, which organized the fleet, took care of our every need. They provided saunas, excellent food and a bar. They even threw us a party with *surströmming* — fermented Baltic herring. We had another party when we reached the North Pole: while guards with shotguns stood watch for polar bears, we walked on to the ice and celebrated.

What is your dream tool; what would make expeditions easier?

A seafloor-drilling system that stayed in place no matter what the conditions were. Money's the biggest hurdle right now. Drilling is an art, and mechanically complicated. There is one such drill in development, but it's in the very early stages of planning.

What can you say about global warming today based on your findings?

The Arctic is currently warming, but we have evidence that it used to be much warmer. We hope that our results can be used by climate modellers as 'ground truth' so that they can refine their predictions.

MAKING THE PAPER

Donna G. Blackmond

What made amino acids into lefties?

N. MILES

Many molecules are 'chiral', meaning they exist in two forms that are mirror images of each other — like left and right hands. But biology prefers playing with a single form. All the amino acids that make up animals' proteins, for example, are left-handed, or homochiral. And yet scientists think that at the dawn of life on Earth, the primordial soup included plenty of amino acids in both left- and right-handed forms. So, how did one type come to dominate the other? Donna Blackmond and her colleagues at Imperial College London have discovered one possible mechanism.

Back in 1953, Charles Frank suggested that the answer might lie in autocatalysis — reactions in which the product itself acts as a catalyst. In certain cases, he theorized, if a left-handed autocatalytic molecule also suppresses production of the other hand, a mixture that started with a slight excess of lefties would swiftly become dominated by them, explaining the chiral imbalance in the world today.

In 1995, Kenso Soai and his colleagues from the Tokyo University of Science proved the principle, with an autocatalytic reaction that led to an imbalance in just this way (K. Soai *et al.* *Nature* 378, 767–768; 1995).

According to Blackmond, a chemical engineer turned chemist, this kick-started the study of the evolution of homochirality. And eight years later, after studying the Soai reaction, her group showed that you could generate a similar imbalance when producing an aldol. But their reaction did not rely on autocatalysis; instead it used the amino acid proline. An excess of one chiral form (enantiomer) of the proline catalyst produced a higher-than-expected excess of one enantiomer of the aldol.

As the researchers examined this 'asymmetric amplification' further, they found that, no matter how much of one proline enantiomer there was, the aldol invariably came out in the ratio expected for a 50% excess. This result completely stumped the team. "The data did not fit any of the existing models for asymmetric amplification," Blackmond explains. "We had to start thinking outside the box."

In their reaction, some of the proline was dissolved in liquid and some was solid, forming a solid–liquid equilibrium. The reaction occurs only in the solution phase, and when the researchers examined the proline in solution, they found that there was always a 50% excess of one enantiomer — regardless of the ratio of enantiomers in the experiment overall.

The team researched this phenomenon meticulously, scrutinizing papers from as far back as 1899. These papers, which dealt with phase behaviour, showed that the ratio of two enantiomers in solution is a physical property of the amino acid itself — its eutectic composition. "Once we realized what was happening we tested a bunch of amino acids to find their eutectic points," says Blackmond.

It turns out that serine has an unusually high eutectic point. On page 621 of this issue, Blackmond's group reports that a sample of serine with a tiny excess of left enantiomers becomes practically all left-handed in a solution at solid–liquid equilibrium. Blackmond says this means you can create a model for the evolution of homochirality that, unlike Frank's, doesn't invoke autocatalysts. And that's an advantage, because autocatalysis requires a less likely far-from-equilibrium scenario.

"The answer was there all along," she adds, "but no one had put together the pieces." ■

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A numerical perspective on *Nature*.

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