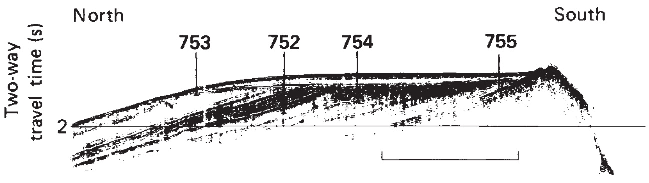

Fig. 2 Seismic line RC2708–20 across Broken Ridge with the positions of the Leg 121 drill sites indicated. (Scale bar, 10 km.)

occurred at the K/T boundary, but is instead an indication of abnormally low levels of planktonic productivity following an ecological crisis at the end of the Cretaceous. The recovery process for calcareous microplankton evidently took longer at the (then) high-latitude location of Broken Ridge than is generally found in low-latitude K/T boundary sections[8].

Another surprise in the section at Broken Ridge is the large amount of volcanic ash in the dipping and truncated sequence. These basaltic ashes are similar in composition to Kerguelen–Heard Plateau and Ninetyeast Ridge lavas, and we interpret them as recording eruptions at the hotspot to the south-west of Broken Ridge. The amount of ash seems to have decreased from the early Turonian (90 Myr) to the middle Eocene, reflecting either a true waning of volcanism or migration of the volcanic centre away from Broken Ridge. These ashes preserve a clear magnetic-reversal stratigraphy for 75–55 Myr (Chron 33N to 23R).

We sampled the basaltic basement at three widely separated sites along Ninetyeast Ridge (756–758). Basalts from site 756, and also probably from site 757, were erupted above sea level, as found at previous sites on Ninetyeast Ridge[5,6]. But the lavas recovered at the northernmost site (758) are submarine pillows and sheet flows. Dating of the overlying sediment suggests that the drilled basalts are more than 38, 58 and 80 Myr old at sites 756, 757 and 758. The northward increase in basement age is consistent with Ninetyeast Ridge being the trace on the Indian plate of the Kerguelen/Ninetyeast hotspot[9].

The basaltic rocks are not primary magmas derived from the mantle, but moderately evolved tholeiites. Although there are important intra- and inter-site variations in magma composition, ratios of incompatible elements show that Ninetyeast Ridge basalts are similar to those found on oceanic plateaux, such as Kerguelen–Heard[10]. Furthermore, trace-element abundance ratios fall between those of mid-oceanic-ridge and Kerguelen Island basalts (Fig. 3), perhaps indicative of mantle-source mixing before eruption. Such mixing relationships might hold for other trace elements and isotope ratios. Also inter-site compositional variations could reflect long-term changes in the composition of the mantle source.

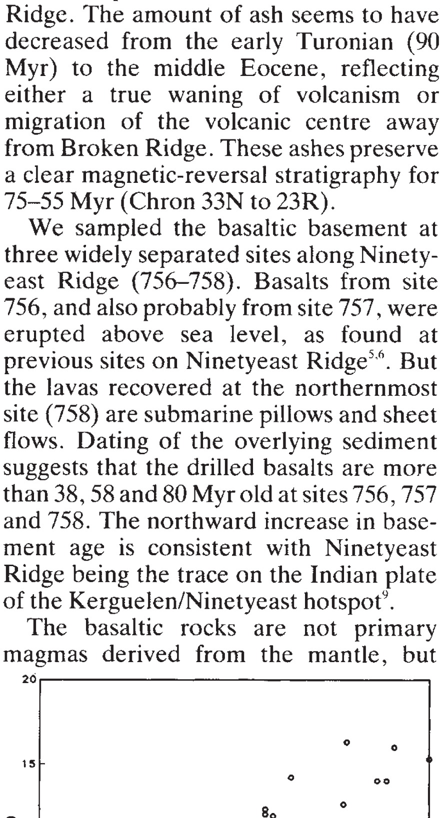

Fig. 3 Zr/Nb-ratio versus Y/Nb-ratio for basalts from Kerguelen Island (□), Ninetyeast Ridge (★) from Leg 121, refs 10–12 and M. Storey and A.D. Saunders (personal communication), and mid-oceanic-ridge basalts (○).

Microfossils recovered along Ninetyeast Ridge represent a latitudinal transect across different climate zones: temperate, subtropical and tropical. Thus assemblages at site 756, the southernmost site, progress from temperate to subtropical from the Eocene to the middle Miocene (14 Myr), while at site 757, 1,200 km further north, the same progression occurred significantly earlier — upper Palaeocene (55 Myr) to mid-Oligocene (32 Myr). The record at site 758 is temperate in the Campanian (83 Myr) becoming tropical in the upper Maastrichtian (73 Myr). Biostratigraphic timescales, usually based on microfossils from a single climatic zone, are difficult to correlate with those from other zones. The new data will allow interzonal relationships to be determined.

The upper 100 m of sediment at Site 758 includes a terrigenous clay component, probably of Himalayan origin, appearing first in the upper Miocene and becoming more abundant later on. This fraction preserves an excellent magnetic-reversal stratigraphy for the past 7 Myr (Bruhnes to Chron 6), during which time volcanic ash layers become increasingly abundant. These record eruptions in the Indonesian volcanic arc. Subtle changes in clay content and colour in the topmost sediments reflect relative changes of biogenic and terrigenous input, presumably determined by climatic variations in reponse to fluctuations in the Earth's orbit. □

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Daedalus

Advanced woolgathering

WOOL must be the most inefficiently produced of all agricultural products. Grass takes up a little of the solar energy which hits a field; sheep cropping the grass take up a small fraction of that, and put a still smaller fraction of it into their wool. The energetic efficiency of the whole process can hardly exceed about 10 parts per million. Daedalus is now improving matters by cutting out the middle man. He plans to grow wool directly in a field, much like grass itself.

The biochemistry of the project is simple and elegant, at least in principle. Plants use solar energy to photosynthesize glucose and amino acids, which are the basic raw materials of animal metabolism. And some photosynthetic microorganisms, like microalgae and cyanobacteria, actually release such metabolites into their environment. They can be immobilized in polymeric foam or calcium alginate gel, where they generate these products quite rapidly.

So DREADCO's biochemists are maintaining a section of living sheepskin on a heart-and-lung machine, to discover what nutrients it actually takes up from the blood of the sheep. Glucose is the most obvious and simplest, with various lipids and structural amino acids not far behind. The team will devise a mixed community of microalgae and nitrogen-fixing cyanobacteria, immobilized on a suitable fabric, to supply these biochemicals. The living sheepskin and the artificial photosynthetic surface will then be put together back to back.

The result will be a direct plant-to-wool conversion membrane, DREADCO's Woolfield®. With luck, an element of sheepskin on this nutrient surface will not only flourish and grow wool; it will slowly extend sideways over the fabric, like skin growing to cover a wound. A big sheet of photosynthetic fabric could then be 'seeded' with a distribution of small sheepskin sections, which would gradually enlarge to cover it completely.

Woolfield will simply be laid out to grow, algal side up, wool side underneath. Or it may be supported on trestles like the fabric of an enormous low tent. With a photosynthetic efficiency approaching 1 per cent, a square metre of Woolfield will be as productive as 1,000 square metres of sheep farm, and much less trouble. Thus it could be dyed by spraying colour precursors over it in a suitable pattern, and sheared by simply watering it with a hormonal antagonist to keratin synthesis, to detach the growing wool fibres. Woolfield may even become a useful fabric in its own right, a warm and self-renewing woolly blanket material for tents, roofing and outdoor clothing.

David Jones