

## MATTERS ARISING

## Pyroclastic sulphur

FRANCIS *ET AL.*<sup>1</sup> recently commented on the apparent rarity of pyroclastic sulphur in terrestrial eruptions. They described sulphur-rich ejecta from Poás volcano, Costa Rica, and mentioned the presence of myriads of small, sulphur spheres. Similar spheres have been reported in tephra erupted from Ruapehu<sup>2-4</sup>, New Zealand, and may well be common at many volcanoes where an active vent is occupied by a crater lake.

The Ruapehu spheres range from 50  $\mu\text{m}$  to 1 mm, but most are 125–750  $\mu\text{m}$  in diameter. They have a lustrous, granular surface, and comprise solid, black, orthorhombic sulphur with disseminated silicate, and iron sulphide dust, a few small vacuoles and rare, yellow sulphur crystals. Some are globular, some are fused double-spheres, but most are almost perfectly round 'rough' spheres'. They were ejected in abundance by phreatomagmatic eruptions in 1971, and one fine ash collected 15 km downwind comprised 12% by volume of spheres<sup>2</sup>. Sulphur also occurs in Ruapehu tephra as uncommon, angular, yellow fragments, and sulphur drip on ejected blocks. Rafts of spongy sulphur float on the lake in quiet or eruptive periods.

Vent morphology and activity of Ruapehu<sup>6</sup> and Poás appear similar, and a subaqueous liquid sulphur lake has been postulated for both volcanoes<sup>7,8</sup>. I agree with Francis *et al.*<sup>1</sup> that this is unlikely. Much consolidated, volcanoclastic/chemogenic sediment has been erupted from Ruapehu, and in some siltstones ejected in 1971, sulphur occurs as globules in cavities, and veins crossing the bedding. This I believe is evidence that sulphur is 'sweated' out of sulphurous sediment, whence it may enter superheated steam fumaroles and be discharged violently into muddy lake water to form black droplets. The lack of coarse, clastic or scoriaceous sulphur suggests that there were no large accumulations of liquid sulphur present when the lake bed was fragmented during phreatomagmatic eruptions of Ruapehu.

C. P. WOOD

New Zealand Geological Survey,  
PO Box 30368,  
Lower Hutt,  
New Zealand

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FRANCIS REPLIES—We were not aware of the existence of small sulphur spherules in the material ejected by the Ruapehu eruption of 1971, and are grateful to Wood for bringing it to our attention. We agree that such spheres may well be common in active volcanoes with crater lakes, and would welcome any further observations of these and related phenomena.

P. W. FRANCIS

Department of Earth Sciences,  
The Open University,  
Walton Hall,  
Milton Keynes MK7 6AA, UK

## Recombination intermediates

IN the summary of their elegant demonstration of adenovirus recombination intermediates, Wolgemuth and Hsu<sup>1</sup> state: "To the best of our knowledge, this is the first visualization of *in vivo* recombination intermediates of discrete DNA molecules isolated from eukaryotic cells". They appear to have overlooked the paper published last year by Bell and Byers<sup>2</sup> which presented an equally clear demonstration of Holliday-type recombination intermediates involving the 2- $\mu\text{m}$  plasmids of *Saccharomyces cerevisiae*. Although this earlier case might be held to be atypical of recombination in general, in that it involved inverted repeats within the same molecule rather than homologous regions of different molecules, it was, in another respect, more relevant to meiotic recombination, because the Holliday structures were found specifically in cells at the prophase stage of meiosis.

J. R. S. FINCHAM

Department of Genetics,  
University of Edinburgh,  
Edinburgh EH9 3JN, UK

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WOLGEMUTH AND HSU REPLY—As stated in the text of our paper, our study does indeed represent the first example, to the best of our knowledge, of visualization of *in vivo* recombination intermediates in animal cells and we are sorry that the word eukaryotic in the summary was misleading. We would like to emphasize

Fincham's point that our observations are more typical of recombination in that they are inter- rather than intramolecular. Our failure to cite the paper by Beck and Byers in our discussion was totally inadvertent and we had contacted them previously in this regard.

DEBRA J. WOLGEMUTH  
MING-TA HSU

The Rockefeller University,  
1230 York Avenue,  
New York, New York 10021

## Common ancestry for birds and crocodiles?

A PSEUDOSUCHIAN origin for birds and crocodiles, independent of dinosaurs, has been proposed by Whetstone and Martin<sup>1</sup>. They described two 'derived' characters of the otic region of the skull, a fenestra pseudorotunda and periotic sinuses, which were claimed to be unique to crocodiles and birds and thus evidence for their common ancestry. It is well known that crocodiles and birds possess a similar otic morphology<sup>2,3</sup>. Any hypothesis of their common ancestry independent of dinosaurs therefore depends critically on the assertion that dinosaurs do not have similar shared features, or that if they do, the features are not homologous. In this respect, we think that Whetstone and Martin's evidence is equivocal and should be treated with caution.

Whetstone and Martin note that in primitive reptiles the perilymphatic duct exits from the cranium through the vagus foramen (fissura metotica), accompanied by certain cranial nerves. In crocodiles and birds, however, the perilymphatic duct has a separate exit, and terminates in a small membrane that closes the fenestra rotunda, or, more correctly, the fenestra pseudorotunda<sup>2</sup>. The fenestra pseudorotunda lies very close to the fenestra ovalis.

Based on their interpretations of casts of the inner ear structure, Whetstone and Martin concluded that dinosaurs did not have a fenestra pseudorotunda. Casts of four of the seven genera studied were illustrated: the sauropod *Brachiosaurus*, the hadrosaur *Lophorothon*, the ankylosaur *Ankylosaurus* and the theropod *Allosaurus* (see ref. 1, Fig. 2 a–d, respectively). We question how the authors can be certain that the single trunk identified in *Lophorothon* and *Ankylosaurus* does in fact represent both the perilymphatic duct and certain cranial nerves. Why should it not represent the perilymphatic duct alone? In *Lophorothon*, for example, could not the first trunk (labelled perilymphatic duct plus nerves X–XI) represent the perilymphatic duct exiting alone, and