silicate mantle. At such low oxygen fugacity, the volatiles present will be mostly the reduced species, methane and hydrogen, with minor amounts of water and virtually no carbon dioxide[1]. Methane, so far as we know, does not react with mantle silicates, nor is it very soluble in melts (unlike CO_2), so the transition zone may be a reservoir where a fluid phase is indeed stable, as O'Neill *et al.* suggest. Under these conditions, 'redox melting' becomes a real possibility[1,2]: where methane- and H_2-rich fluids infiltrate an overlying, gradually more oxidized silicate mantle, they will gradually become enriched in water and carbon dioxide until the H_2O and CO_2 activities are high enough for partial melting of the mantle to occur. Such redox fronts may explain the presence of a low-velocity zone[10] within the peridotitic mantle, and a more focused fluid flow may initiate buoyant plumes in the overlying peridotitic mantle and ultimately cause intra-plate volcanism[1].

Recycling revisited

And finally, we may need to reconsider the effect of crustal recycling on the redox stratigraphy and isotope geochemistry of the upper mantle. For instance, it has been suggested that oxidized crust recycled into the convecting mantle may cause long-term oxidation of the mantle[11]; that some basalts owe their oxidized nature to a crustally derived component that re-emerges in the course of large-scale mantle stirring[12]; and that the crustal input can be quantified on the basis of oxygen isotopes in basalts[13]. But if O'Neill and colleagues are right, any material recycled into the deeper mantle must pass through the transition zone and suffer reduction; moreover, its oxygen isotope signature would be swamped beyond recognition on encountering the methane-rich fluid phase. How realistic are any of our favoured models? □

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PHOTOTRANSDUCTION

The invertebrate enigma

Roger C. Hardie

IT is now almost ten years since excised patches of light-sensitive channels from vertebrate retinal rods were shown to be activated by cyclic GMP, effectively settling years of controversy over whether Ca^{2+} or cGMP was the final messenger of excitation[1]. But how does the rest of the animal kingdom transduce light? This is one of the outstanding questions in sensory physiology, and was the topic for debate at a meeting last month*. Ironically, Ca^{2+} and cGMP are now two of the main candidates for the role of final messenger in invertebrate photoreceptors, but the underlying transduction machinery appears to be quite distinct from that operating in vertebrates.

Abundant evidence now implicates the phosphoinositide cascade in invertebrate phototransduction[2,3]. This ubiquitous signalling system, characterized by production of inositol 1,4,5-trisphosphate ($InsP_3$), release of Ca^{2+} from intracellular stores and Ca^{2+} influx, is found in all manner of hormonally and neurotransmitter-stimulated cells.

The simplest current hypothesis — that Ca^{2+} released from $InsP_3$-sensitive stores activates the light-sensitive channels — now appears to be insufficient. Careful measurements using Ca^{2+} indicator dyes in both *Limulus* ventral photoreceptors (H. Stieve, RWTH, Aachen; R. Payne, University of Maryland) and the drone bee (B. Walz, University of Regensburg), showed that the electrical response precedes the first detectable rise in Ca^{2+} by several milliseconds. As Payne wryly commented, this is not encouraging for a hypothesis that suggests that the rise in Ca^{2+} is causal for the light response. Furthermore, depletion of intracellular stores with a Ca^{2+} ionophore abolishes the light-induced rise in Ca^{2+} but leaves a large electrical response intact.

These experiments must be viewed in the context of extensive molecular, biochemical and pharmacological evidence for the direct role of both $InsP_3$ production and Ca^{2+} in excitation[2,3]. One resolution to this paradox is suggested by evidence for the existence of as many as three parallel transduction pathways in *Limulus*: the phosphoinositide pathway, and others involving cyclic nucleotide metabolism (K. Nagy, RWTH, Aachen). Despite a conspicuous lack of evidence for the requisite biochemical machinery, this hypothesis has its roots in work showing that cGMP can activate channels in *Limulus*, even in excised patches[4]. A further indication of multiple pathways was provided by the ability of $InsP_3$, Ca^{2+} and cGMP to activate channels in excised patches of molluscan microvillar membrane (E. Nasi, Boston University). But the conclusion that all, or indeed

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Bread and water

I. Reid

"FOR in the wilderness shall waters break out, and streams in the desert." When Isaiah spoke of the joys that awaited Zion, he didn't anticipate the fate of the occupants of this bread lorry, who had to be winched to safety by helicopter. Flash floods such as this one in Israel's Negev Desert do not just temporarily foul up road communications: on page 148 I. Reid *et al.* report that desert rivers transport very much more coarse sediment than perennial rivers — mainly because they do not have the opportunity to build up the protective layer that covers the beds of their more established counterparts. If climate change causes an increase in the frequency of flash floods in dry regions, excessive sedimentation could be an additional headache for the locals. G.W.