

could span from the T-cell membrane to the membrane-proximal domains of an MHC class II molecule interacting with a T-cell receptor¹³, as shown schematically in the figure. Such a model implies an even more unusual structure for the CD8 molecule. The CD8 monomer has a single V-like domain linked to the membrane by about 40 amino acids, which would have to be in a relatively extended conformation to allow the molecule to span the 90 Å or so required; the sensitivity of CD8 to cleavage by trypsin¹⁴ suggests that this might be so.

Whatever impact solving the structure

of these two domains has on the search for inhibitors of HIV, it is clear that the structure of the CD4 V1V2 fragment provides new ways of looking at immunoglobulin superfamily proteins. With new domain structures, new interdomain interactions and a new model for the construction of ligand-binding sites, I foresee models aplenty for this ever-growing family of proteins — at least, until the next structure comes along. □

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MANTLE GEOCHEMISTRY

Reducing mantle redox options

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IT is widely accepted that volatile species in the carbon–oxygen–hydrogen system dominate the fluid-present processes in the upper mantle¹. The redox state of the mantle controls the fluid speciation and hence the types of magma produced at depth: both the percentage melting at a given pressure and temperature and the composition of the melts are strongly influenced by whether, for example, oxidized (H₂O–CO₂) or reduced (CH₄–H₂O) fluids have induced melting^{2,4}. Clearly, in the present Earth, there are large-scale (tectonic) and small-scale processes which could influence the oxygen fugacity of the mantle and hence the melting relations. Any demonstration of a correlation between magmatism, oxygen fugacity and tectonic processes, such as that presented on page 437 of this issue⁵ by Ballhaus *et al.*, is therefore of fundamental significance for the modelling of plate processes, interactions between the asthenosphere and lithosphere, and the evolution of the crust–mantle system.

Until only recently, arguments over the existence of f_{O_2} variations between mantle samples and melt products were hampered by a lack of agreement between the calibrations of the indirect methods, such as f_{O_2} -sensitive reactions^{6–8}, at our disposal for measuring f_{O_2} . This disagreement has stemmed partly from an absence of comprehensive experimental data in the pressure–temperature–composition– f_{O_2} ranges appropriate to the upper mantle. It is an oxygen barometer based on such experimental study that Ballhaus *et al.* now present. This study allows critical comparisons to be made between the

earlier, largely indirect methods; it shows encouraging agreement with the most recent of these calibrations⁹. As a consequence, we now have significantly greater confidence that the consistent variations in f_{O_2} monitored by upper-mantle mineral assemblages can be reliably quantified and that the implied range of three to four log units in mantle f_{O_2} is indeed real and not simply an artefact of the precision of the calibrations.

Thus the f_{O_2} populations defined by Ballhaus *et al.*, and also noted by Wood *et al.*⁹, indicate that there are significant large-scale variations in the upper-mantle redox state, and that distinct f_{O_2} regimes may be associated with specific tectonic environments. The clearest example of this is the highly oxidized condition of island arc basalts (IAB), generated at subduction zones, which may be correlated with processes that cause enrichment in the light rare-earth elements (LREE) and large-ion lithophile elements (LILE), currently thought to be important in the genesis of subduction-related magmatism. This oxidized condition contrasts with the relatively reduced states implied for primitive mid-ocean ridge basalts (MORB) and the possibly conjugate, relatively undepleted (primitive) abyssal peridotites.

There remains some disagreement as to the redox state of the processes responsible for hotspot (or ocean island) basaltic magmatism. In their analysis, Ballhaus *et al.* show that xenoliths in ocean island basalts (OIB) are relatively oxidized and hence argue that the lithospheric mantle affected by hotspot plumes is also oxidized. Wood *et al.*⁹, in contrast, have suggested

that some reduced abyssal peridotites spatially associated with plume-related basalts could imply that those mantle plumes are more reduced than 'normal asthenospheric mantle'. Those samples in which a 'plume' signature can be identified are of vital importance as they present a window through which we may be able to examine the processes of lithospheric/asthenospheric interaction commonly believed to be associated with upper-mantle geochemical enrichments. It must be recognized that such samples may well be composites including fractions derived from both the lithosphere and asthenosphere, and that decompression and possible melt extraction could lead to further modifications of the f_{O_2} signatures. Both Ballhaus *et al.* and Wood *et al.* emphasize the extreme sensitivity of reduced mineral assemblages to redox perturbation by interaction with oxidized material. As a consequence, there is considerable uncertainty inherent in the use of xenolith samples for inferring the redox state of deep-mantle plume material responsible for the geochemical enrichments.

Clearly, the present confidence in our ability to determine the f_{O_2} established by the calibrations of Ballhaus *et al.* extends only as far as the limits of the spinel stability field in the mantle. The extrapolations of low-pressure electrochemical data necessary to extend our understanding of the redox structure beneath the spinel stability field may result in calibrational uncertainties which prohibit recognition of any real redox variations at greater depths in the mantle. To reach an adequate understanding of the redox condition of the deeper levels of the upper mantle, and hence address the questions of the redox states of plumes and thickened lithospheres, it is essential that we formulate and calibrate f_{O_2} -sensitive reactions involving Fe²⁺/Fe³⁺ relations in appropriate high-pressure garnet-bearing assemblages⁷ analogous to the low-pressure spinel-bearing assemblage calibrated by Ballhaus *et al.*⁵. The prime component of such a calibration must be an experimental study covering a range in f_{O_2} conditions and within the pressure–temperature–composition field appropriate for the upper mantle. □

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