teins in the membrane skeleton will be necessary to ascertain whether they are indeed associated with the junctional complexes that form the vertices of the spectrin lattice.

Why should the molecular substructure of the junctions in the erythrocyte membrane skeleton be so complex? An attachment site for about six spectrins would need only a small actin filament containing six actin monomers, along with six molecules of protein 4.1. However, a junctional complex composed only of spectrin, protein 4.1 and actin would not be self-limiting because of the propensity of actin to polymerize into long filaments under physiological conditions.

Restriction of actin-filament length by the accessory proteins mentioned above (alone or in combination) could serve to regulate the number of spectrin molecules attached to the junctions and thus specify the surprisingly regular lattice structure of the network. Some slippage in filament length regulation could easily account for variation in numbers of spectrin molecules attached to the junctions[5-7].

An apparent paradox is that although the stoichiometry of spectrin–protein 4.1 binding to actin filaments *in vitro* is equimolar, there are only about six spectrin molecules attached to any one of the 13- to 15-monomer-long actin filaments[5-7]. Because tropomyosin binds in the two grooves of the actin-filament helix without restricting filament length[13], and protein 4.9 bundles actin filaments *in vitro*[15], we still have no explanation for the actin-filament length restriction that is observed *in situ*.

In addition to ensuring the correct assembly of the membrane skeleton, it is conceivable that changes in the structure of the junctional complexes mediate the calcium- and ATP-dependent discocyte–echinocyte shape transformations of erythrocytes. A calcium- and calmodulin-dependent protein kinase activity has just been identified in erythrocyte membranes which phosphorylates both protein 4.1 and an M_r 100,000 doublet of polypeptides in the membrane skeleton[16], which could well represent the M_r 97,000/103,000 calmodulin-binding dimer[14]. Protein 4.1, as well as protein 4.9 and the same(?) M_r 100,000 doublet are also phosphorylated by a recently identified protein kinase C activity in the erythrocyte[16,20]. In addition, proteins 4.1 and 4.9 are phosphorylated by a cyclic AMP-dependent kinase, but at different sites from those phosporylated by protein kinase C[20].

A recent observation by Tao and coworkers[21] provides evidence that these phosphorylations influence the organization of the membrane skeleton. The affinity of protein 4.1 binding to spectrin *in vitro* is reduced by about fivefold on phosphorylation of protein 4.1 (but not spectrin) by a purified cyclic AMP-independent kinase from red cells[21]. It is also suggestive that the cyclic AMP phosphorylation site on protein 4.1 has just been found to reside in a spectrin-binding domain of M_r 8,000 (ref. 22). Undoubtedly, these observations are only a taste of things to come, and many of the protein associations in the erythrocyte membrane skeleton may prove to be dynamically regulated in response to physiological signals *in vivo*. □

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Glaciology

Frozen news on hot events

from Claus Hammer

ICE CORES from Antarctica and Greenland provide information on the number and dates of violent volcanic eruptions and their contributions to the upper atmospheric composition of trace substances. Interpretations of the ice-core records, particularly deductions about the influence of local eruptive activity and the varying meteorological and climatological conditions during trace-substance transfer from the volcano to the ice sheets, are difficult, partly because the techniques used in various studies have not been coordinated. A recent article by R.J. Delmas *et al.* (*J. geophys. Res.* **90**, 12; 1986) concludes that the techniques used to detect volcanic signals in ice cores are all in essential agreement. Although the visible fine-ash (tephra) layers observed in antarctic ice cores must be considered separately from other data, the conclusion of Delmas *et al.*, that the sulphuric acid record in the cores reveals remote and violent eruptions, remains unchanged.

Delmas *et al.* analyse ice cores from various sites in Antarctica, both from coastal regions of high precipitation and central sites that show very low annual accumulation. They look at acidity, electrical conductivity of melted ice samples and ionic composition during the past 200 years. The lack of historic data on eruptions in the Antarctic area limits the analysis, but the authors are able to conclude that local volcanic activity in the Antarctic contributes only little to the ice-core chemistry. The fallout of fine ash is only significant close to local volcanoes (some 200 km) and the SO_2 and/or HCl from such eruptions is apparently washed out before reaching the more central parts of Antarctica, where the volcanic acid signal is particularly clear. (This conclusion does not, of course, cover violent or substantial regional activity.) Thus the major increases in sulphuric acid concentration of the central Antarctic ice is caused by remote volcanic eruptions. Transportation of the volcanic products occurred mainly via the stratosphere, although some arrived via the upper troposphere: NH_3 neutralization is virtually absent. Transfer from the site of eruption to the ice sheet during glacial times has yet to be quantitatively assessed.

The conclusions of Delmas *et al.* provide a global perspective and agree with the results obtained from the Greenland Ice Sheet (see, for example, Hammer, C.U., Clausen, H.B. & Dansgaard, W. *Nature* **288**, 230; 1980). The Antarctic ice cores provide information on past volcanic eruptions south of 20° N, whereas Greenland registers eruptions north of 20° S, so data series from the two ice sheets offer global coverage and overlapping information.

To establish a detailed and well-dated ice-eruption record; to estimate from the chemistry of the cores the influence on atmospheric composition; and to identify the geographical sites or zones of the eruptions are formidable tasks which will require not only a good deal of optimism but also new and faster techniques for analysing the details of the chemical composition of the several thousand-metre-long ice cores. More data from the smaller ice caps, for example in the Canadian arctic, are needed. □

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