

Earthquake prediction**Electromagnetic emissions before earthquakes***from Chi-Yu King*

LARGE earthquakes are frequently reported to be accompanied and preceded by some unusual phenomena, for example, deformation of the ground, changes in activity of small earthquakes, ground-water level and chemistry, and geomagnetic and electric fields, and strange behaviour of animals. These phenomena have been increasingly studied in recent years in many earthquake-prone countries, especially in China, Japan, US and USSR, with the intention of predicting future earthquakes. One such phenomenon is electromagnetic emission, some recent examples of which are reported by Gokhberg *et al.*¹ in a paper published in *Journal of Geophysical Research*.

Using a specially designed radio receiver located near Tokyo, Gokhberg *et al.* detected some anomalously high electromagnetic emissions on 31 March 1980 during a 30-min period before a magnitude 7 earthquake occurred 250 km away at a depth of 480 km. The anomalous emissions were recorded in two widely separated frequency bands (10–1,500 Hz and about 81 kHz). Similar anomalies were also recorded before two other earthquakes (magnitude 6 at a distance of 55 km and a depth of 75 km on 25 September 1980; magnitude 5 at a distance of 50 km and a depth of 60 km on 28 January 1981), as had been recorded previously in several different seismic areas of the USSR^{2,3}.

Reports of unusual electromagnetic emissions before earthquakes are also commonplace in several other countries, especially China⁴. A notable Chinese example is the magnitude 7.8 Tangshan earthquake on 28 July 1976 (focal depth 16 km). For 3 to 5 days before the earthquake, unusual interference was received by many military and civil radio-communication receivers in an area within about 250 km of Tangshan. In another case, before the Longling earthquakes (magnitudes 7.5 and 7.6) on 29 May 1976, rain-like noise was received by an ordinary household radio while 'earthquake light' was sighted⁴. The simultaneous observation of the light and the radio noise suggests that they both were caused by the same physical process, such as electrical discharge.

While some of the anomalous electromagnetic emissions, especially those reported by untrained observers, may conceivably be unreal or caused by some other geophysical or man-made processes (for example, distant lightning, meteors and arcing power lines), many such observations are well documented and the

existence of the phenomenon of earthquake-related electromagnetic emission must be seriously considered.

Several mechanisms have been proposed in the literature to explain the electromagnetic emissions, but none is considered satisfactory. One possible mechanism is charge separation and recombination produced by fractures of rock in the highly stressed focal volume of the impending earthquake. (It has been observed in the laboratory that rock specimens do generate impulsive electromagnetic emissions when being fractured^{5–7}.) However, it is not understood why the electromagnetic waves

thus produced may propagate many kilometres through the highly conductive Earth without being attenuated, especially for the deep earthquakes. Other proposed mechanisms invoke the piezoelectric effect of quartz-containing rocks^{8,9}, or streaming potentials produced by ground-water movement⁶. □

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Cell membrane skeleton**The spread of spectrin***from Anthony J. Baines*

THERE is probably a better understanding of the red cell membrane skeleton^{1,2} than of any other cytoskeletal structure and it is one of only two systems in which the interaction of actin with the membrane is understood at even a superficial level (the other being the intestinal brush border³). The red cell membrane skeleton confers stability on the lipid bilayer, which when deprived of this support, through loss of spectrin and actin, breaks up into small vesicles^{1,2}. These observations have suggested that even if the mechanical demands on the membranes of non-erythroid cells are less, they should contain structures somewhat analogous to membrane skeletons to maintain the stability of the plasma membranes and the organelles which bound subcellular organelles.

Actin has been demonstrated to be associated with the plasma membranes of many cell types. Recent attempts to identify the proteins involved in the actin-membrane interaction in non-erythroid cells have focused on a search for molecules structurally and functionally related to the structural proteins of the erythrocyte membrane — spectrin, 4.1, ankyrin and band 3. The use of anti-spectrin antibodies led to the identification of spectrin in all red cells so far examined⁴, but early results in the search for non-erythroid spectrins were not encouraging, for radioimmunoassay revealed no spectrin in several cultured cell lines⁵.

To qualify as a spectrin a protein must do more than simply react with anti-spectrin antibodies: it should have α and β subunits

with molecular weights in the region of 240,000 and 220,000 arranged in the cell as an ($\alpha\beta$)₂ tetramer; it should be able to cross-link and gel F-actin, with or without the participation of other proteins, and bind calmodulin and ankyrin; and it should be elongated and highly α -helical.

An axonally transported brain protein with subunit molecular weights 240,000 and 235,000, which had attracted interest because of its calmodulin- and actin-binding properties, was purified by several groups working independently^{6–8, 29}; other proteins of apparently identical properties were identified by their cross-reaction with spectrin in brain⁹ and chicken cardiac myocytes¹⁰. Various names^{7,9,29} have been proposed for the brain protein, but it is fodrin⁶ (from the Greek *fodros*, a lining) that has stuck, derived from the observation that, as judged by immunofluorescence microscopy, it lines the cytoplasmic face of nerve cell plasma membranes⁶.

Weber and co-workers¹¹ have purified a different protein from intestinal brush border which cross-reacts with spectrin. Its subunit molecular weights are 240,000 and 260,000 respectively, for the counterparts of the α and β chains of spectrin, and it has been dubbed TW 240/260.

Several reports have characterized fodrin and TW 240/260 in great detail and all seem in remarkable agreement that they are genuinely spectrinesque; they are both ($\alpha\beta$)₂ tetramers^{9,11,29} with morphologies similar to that of spectrin^{9,11,29} and can cross-link and gel F-actin^{9,12,13}. The salt dependence of fodrin's sedimentation