PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A | MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

Discussion

J. Sutton

Phil. Trans. R. Soc. Lond. A 1965 **258**, 107-108
doi: 10.1098/rsta.1965.0025

IX. Discussion

Professor J. Sutton (Imperial College):

Although the primary subject of the Symposium was continental drift, this is only one aspect of a larger problem. Eventually, consideration of changes in magmatic, metamorphic and tectonic activity through the history of the crust should enable us to put forward a hypothesis to account for the behaviour of the upper parts of the Earth through geological time. As had been pointed out, most geophysical methods provided information about the current state of the Earth and part of the great value of palaeomagnetic studies lay in the fact that they produced information about the past. Some information about the behaviour of possible convection cells during continental drift could be obtained from other long-term changes in the crust. The incidence of magmatic and metamorphic activity gave some indication as to the distribution of regions where there had been an unusually high accession of heat in the past. In this way, in a rather crude fashion perhaps, one could supplement current geophysical information. Now that radiometric dating has established the age of many belts of regional metamorphic rocks, it has become clear that some metamorphic belts were intermittently active over periods of several hundreds of millions of years. In some instances successive metamorphic events within individual mobile belts were confined to more or less the same region, but in other instances some migration of activity occurred. The effect of this had been to heat in succession a series of roughly parallel strips of the crust which had in succession reached temperatures high enough to lead to regional metamorphism or to the appearance of granitic rocks. In Japan, for example, a belt of regional metamorphism about 200 My old was followed about 100 My later by another approximately parallel belt displaced towards the Pacific. In Australia, Evernden and Richards have found that successive belts of granitic rocks displaced successively farther east and north had formed within the Tasman geosyncline of southeast Australia. These belts are roughly parallel and indicate that granitic activity was successively displaced some 500 km eastward towards the present continental margin during a period of about 250 My between Silurian and late Permian times. During this period it would appear that the continent of Australia had moved by very much greater amounts. The limited migration of the regions of granitic and metamorphic activity in eastern Australia suggested that there might be a coupling between the continental crust and the upper part of the mantle. It could be argued that the mobile belt which underlay eastern Australia had migrated with the continent, though the continent had lagged somewhat behind the mantle. If this was so it led to three interesting possibilities. In Silurian times the mobile belts below the continents appear to have formed a rather close network of structures whose scale was such that no point on any continent was more than 2000 km from such an active belt. In contrast, at the present day we have very much larger non-orogenic areas and a much simpler system of mobile belts. The interest of the behaviour of granitic rocks within the Tasman geosyncline lay in the fact that here we had a record of activity during the time when the 'pre-drift' network of fold belts of Silurian times was altering to give the system established in the Mesozoic and Tertiary. During this time the mobile belts below eastern Australia, and presumably therefore also the loci of the underlying converging convection currents, were displaced horizontally as Gondwanaland broke up. The migration was essentially outwards from a comparatively small pre-drift region and indicated a progressive lenthening of the active orogenic zones with time. It is therefore possible that we have a record of the migration of the downward-flowing parts of a steadily expanding convection cell. If some such expansion of individual convection cells accompanies drift it might account for the prevalence of strike-slip faults in which the movement is parallel to the length of fold belts or of oceanic tranches. Such movement might be expected if these structures are lengthening as drift continues. If this argument is valid three conclusions appear to follow:

1. Active orogenic belts may be horizontally displaced during continental drift. The apparent shortening detectable within the deformed rocks of a mountain chain may therefore be much less than the total horizontal displacement which has occurred. Much horizontal movement may be taken up by displacement *en masse* of the continent in which the orogenic belt is situated.

2. Such horizontal movements involve a progressive lengthening of the active orogenic zone with time. They might account for the prevalence of strike-slip faults parallel to the length of mountain belts.

3. The horizontal movements appear to affect both the mantle and the continental crust for the relative movement of the continent and of the migrating orogenies produced by converging convection currents within the mantle is small compared with the horizontal displacement of the continent as a whole.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES