news and views

Chinese granites and rapid seafloor spreading

THE attention of geologists and geophysicists, for a long time focused on land masses, switched to the oceans in the mid-nineteen sixties when it became clear that the movement of continents could only be understood in terms of processes occurring in ocean basins. Now that there is a fair consensus on submarine geology and geophysics, attention is switching back to continents where there are still some very difficult problems to solve but where the insights of the past ten years can help. Two new papers exemplify the questions that are being asked.

Plate tectonics is a good framework for running the geological clock backwards for the most recent 100 million years, as the magnetic record is well preserved for this period in oceanic crust. Attempts to deduce the disposition of the continents at earlier dates, however, can be less certain because much of the ocean crust formed then has been consumed at island arcs. As with Watergate, the magnetic tape recording is missing, so other sources of evidence must be sought on land. This Jahn does later in this week's *Nature* in using newly determined ages of rocks in south-east China to study a period of exceptionally vigorous seafloor spreading about 100 million years ago. Correlations which he tries to establish within the time of magnetic records may then be extended to earlier times of intensive granitisation when there is no seafloor record.

By a coincidence it is the same area which is the subject of the other paper which originated in the Department of Geology, Nanking University (*Scientia sin.*, **17**, 55-72; 1974). Better knowledge of tectonics means better knowledge of mineral deposits. The cycles of tectonic activity in south-east China have led to rich sources of ore, and it is of great importance to know which regions are richest and thus can be most easily exploited.

The Nanking group have dated the distinct tectonic zones of granites that run NE-SW in south-east China. In general the older the rocks the further inland they are. Each zone is about 100 km wide and characteristic ages are 900, 480, 200 and 100 million years, the last being called the Yenshan tectonic zone and forming the coastal belt. The authors indicate the following series of events for each cycle of tectonism: subsidence, sedimentation often with volcanism, orogenic movements, granitisation, regional uplift, subsequent crustal movement and small scale granitisation. They go on to observe "the further development of the Himalayan orogenic zone in our Taiwan province and the presence of island arcs and a submarine trench east of Taiwan indicate that the same tectonic processes have been going on at present".

Analysis of metallogenetic relations and mineralisation capacity of the granite of different zones necessarily produces complex results, but there are some very striking unifying factors. They are best seen in multiple-aged composite granite bodies where several tectonic cycles have left their mark. Ore forming elements such as beryllium, tungsten, tin and niobium are progressively concentrated in the younger bodies. Yenshan rocks contain beryllium, niobium, tantalum and scandium in workable deposits. The authors conclude that it is the recurrence of granitisation rather than its occurrence on one occasion which leads to signficant metallic deposits.

But what are these cyclic tectonic events? It is this question to which Jahn's paper contributes, as it looks at the Yenshan orogeny. Jahn is limited to samples from the offshore islands; these give ages of around 100 million years. Thus the Yenshan orogeny occurs simultaneously with a postulated time of very rapid (up to five times normal) seafloor spreading, established from marine magnetic data. What is more, many others have observed vigorous activity around this period in circum-Pacific regions. Maybe there is a correlation between rapid spreading and intensity of thermal episodes, caused perhaps by an enormous increase in viscous heating as old plate descends into the upper mantle. Jahn is cautious about such a correlation, but the evidence is certainly persuasive.

Some interesting problems are raised by these two papers. If this correlation is correct, is it generally correct to associate all previous Chinese orogenies with times of rapid seafloor spreading (for which it has been already noted there is no magnetic record)? Was rapid spreading a world-wide phenomenon, and how was it caused? Will the next pulse of rapid spreading convert the continental shelf off China into another tectonic belt? These are good questions for bright research students. D.D.

Ghost neutrinos emerge from the mathematics

IT is a remarkable fact that even after two generations, the investigation of solutions to Einstein's famous field equations of general relativity is still very much in its infancy. There are indeed very few exact solutions available, and some of those which are have very bizarre properties. One recent solution, published by Davis and Ray of Clemson University in *Physical Review D* (**9**, 331; 1974) is a distinctive mathematical novelty.

To understand the implications of this new result, first recall that the gravitational field equations of general relativity are a prescription for calculating the curvature of space–time from the mass–energy content of the Universe; that is, the equations relate the geometry of space–time to the physics of matter and energy. Thus for a given distribution of matter say, the geometry of space–time in its vicinity may in principle be deduced. In practice, the equations are prohibitively difficult to solve in all but the simplest cases. One of the earliest solutions, due to Schwarzschild, give the geometry around a spherically symmetric object such as a star. The gravitational bending of light by the Sun testifies to the curved nature of space–time in its vicinity and Schwarszchild's solution gives the correct amount of curvature. Just as the geometry is determined by the material content of space, so in turn the behaviour of mass–energy depends on the geometry. There is clearly a problem of self consistency here.

Among the more elusive of the elementary particles is the neutrino, the particle produced in, among other circumstances, the β decay of a radioactive nucleus. Neutrinos have no mass or charge, but they do carry spin, and are