GEOPHYSICS

Biscay's Opening

from a Correspondent

A SYMPOSIUM on the structural history of the Bay of Biscay jointly organized by the Institut Français du Pétrole (IFP) and the Centre Nationale pour l'Exploration des Océans (CNEXO) and held at Rueil Malmaison near Paris, from December 14 to 16, was the first to be held specifically about the bay. The excellent communications between academic geologists and geophysicists and those from commercial companies were both welcome and valuable. Of the 200 or so delegates from nine countries, about 30 per cent were from commercial companies.

Since Carey's suggestion in 1958, various subsequent fits of the Atlantic continents, and the realization of the magnetic lineations in the Bay of Biscay, it has been fairly convincingly established that Spain has rotated in an anticlockwise direction away from France, thus forming the Bay of Biscay. The chief problems considered at the symposium were: when did the rotation take place and was the movement purely rotational or was there a combination of translational movement with rotation?

The several contributions on the geology of the Aquitaine Basin presented by representatives of oil companies indicated the extent to which duplication of work takes place. Notably, however, Dr E. Winnock (Société Nationale des Pétroles d'Aquitaine), who spoke on the Aquitaine Basin, and Dr R. A. Dardel (Esso), who spoke on the Parentis Basin, showed the basins to have evolved during the Trias. Two principal periods of disturbance in the Lower Cretaceous and Lower Eocene were followed by periods of less disturbed transgressive sedimentation. East-west faulting during the Jurassic and Cretaceous, coupled with tilting of the basins, indicates a subsiding continental margin while Biscay was opening.

Work on Pyreno-Cantabrian structures by P. Feuille and P. Rat (University of Dijon) showed similar disturbances and a major palaeogeographic change at the end of the Albian. M. Mattauer and M. Seguret (University of Montpelier), from evidence of Triassic basin formation, however, concluded that opening of Biscay started in early Trias. Excellent work by G. Boillot *et al.* (University of Rennes, Rouen, CNEXO) showed that Pyrenean geology could be traced offshore along the north coast of Spain as far as Cape Ortegal.

At last petrologists working in northwest Spain and Brittany have correlated the geology of the two areas. This was very adequately shown by J. P. Bard, R. Capdevila and P. Matte (University of Montpelier), illustrating the similarities between the granites, stratigraphy and the metamorphic zones of the two areas.

Studies of the floor of the Bay of Biscay, principally from reflexion profiles, showed that Cantabria and Biscay seamounts are both blocks of seafloor uplifted during the Eocene (P. Muraour *et al.*, University of Bordeaux). J. Ewing, L. Burkle and T. Saito (Columbia University) included Gascony seamount in the similarity and identified the three as being part of a linear east-west dislocation across the Bay. J. C. Sibuet, G. Pautot, Dr X. le Pichon (CNEXO) saw dissimilarities in sedimentation between north and south of approximately this line. JOIDES drill sites Nos. 118 and 119 (Dr A. S. Laughton, National Institute of Oceanography) have produced Palaeocene sediments, the oldest so far sampled. But seismic reflexion records of several authors all showed the disturbed Lower Cretaceous strata, followed by the less disturbed sediments of the Upper Cretaceous, similar to the geology of the same period on land.

The palaeomagnetic data of Drs R. van der Voo and J. D. A. Zijderveld (State University of Utrecht) require that Biscay opened during the Late Trias to Late Cretaceous, but Dr K. W. Stauffer (American Overseas Petroleum (Spain)) and Dr D. Tarling (University of Newcastle upon Tyne) presented some new measurements which constrained the time of opening to between the Kimmeridgian and the Maestrictian. The relationship between Atlantic and Biscay magnetic lineations (Miss C. A. Williams, University of Cambridge) suggests the opening was Lower Cretaceous or earlier.

The highlight of the meeting was the last afternoon with four contributions on structural hypothesis on the formation of the Bay of Biscay. Drs J. C. Sibuet, G. Pautot and X. le Pichon (CNEXO) put forward their ideas based on rotation about a centre located near Paris. The North Pyrenean Fault and faults crossing the Armorican and Spanish continental shelves, forming in some cases major features such as the Santander Canyon, were interpreted as being sub-parallel to circles about the rotation centre. Drs M. Bacon and F. Gray (University of Cambridge), on the other hand, required rotation and east-west translation along the line of the north Spanish trough.

No meeting, however excellent, can hope to solve all the problems. A considerable amount was achieved, however, in that it is now agreed that Biscay has oceanic crust in the centre with downfaulted continental crust along the edges and there is considerable agreement on the time of opening.

Barometers detect Earthquakes

OSCILLATORY motions of the atmosphere have been attracting a good deal of attention in the past few years. Most people would trace the resurgence of interest to C. O. Hines, whose missionary work in the early sixties for the view that many oscillatory effects in the atmosphere can be attributed to what are known as internal gravity waves is at the basis of much modern work. The measured data go back much farther, however, to what might be called the prehistory of atmospheric physics and such observations as the pressure pulse following the Krakatoa eruption. Recently, some geophysicists on the seismology side have also been developing an interest in the effect of such cataclysmic events on the atmosphere as a means of studying the degree of coupling between the Earth and the atmosphere, and vice versa. A coupling between large earthquakes and the atmosphere has already been reported in *Nature* (**202**, 1095; 1964) by B. A. Bolt, who detected an effect in barogram records at Berkeley following the severe Alaskan earthquake of March 28, 1964.

A similar report dealing with the energy transfer between the atmosphere and the Earth will be published in next week's *Nature Physical Science* by G. G. Sorrells, J. A. McDonald and E. T. Herrin of the Dallas Geophysical Laboratory (**229**, 14; 1971). Their equipment is a triangular array of microbarographs in east Texas and two seismographs at the same location, one 183 m down a salt mine and the other at the surface. The use of an array of microbarographs means that the direction of arrival of the atmospheric signal can be determined in much the same way as the angle of arrival of radio waves is determined by ionosphericists using spaced receivers, and sufficient care was taken with the seismographs to ensure that they could not be triggered to any extent by pressure variations in the atmosphere. Having one seismograph down a mine helps here because the shaft acts as a filter between the instrument and the surface. Even so, on July 4, 1970, the seismographs registered a disturbance during the passage of an acoustic wave in the atmosphere, and having taken these precautions the group at Dallas believe that the seismographs were indeed recording a true motion of the Earth. They point out that the measurements agree with unpublished calculations by Sorrells of the response of the Earth to a plane pressure wave moving at an acoustic velocity. The degree of coupling is indeed very small, but the figures given by Sorrells indicate that a pressure wave moving at 330 m s^{-1} generates a displacement of the Earth's surface of 10 to 15 nanometres per microbar with periods between 20 and 100 s.