from the south-west, but no exceptional waves. To investigate changes on the sea-floor consequent on the earthquake, P. Erimesco with his assistants examined the effects in the harbour of Agadir and along the shore. In the Bay of Agadir, systematic soundings were made and samples were taken from the bottom at the place where the 10-m. depth was observed. The soundings could not detect any variation from the depths marked on the charts; and the bottom samples at the place where volcanic activity had been suspected contained living annelids in perfect condition.

Thus, contrary to local reports at the time of the earthquake, we have evidence of a most unusual occurrence, namely, an area of intense earthquake destruction practically on the shore line, and virtually no effect at sea—neither the sea bottom nor the sea waves—except perhaps the rising of a shoal of zooplankton and a cloud of mud in the sea.

P. Erimesco seeks to explain this by reference to the local geology. He states that from the geological structure of the region it can be inferred that the almost vertical Cretaceous and Tertiary strata near the coast are dipping steeply underneath the sea bed. The covering Quaternary and Recent layers are sub-horizontal or horizontal and, in their upper part, not yet compacted, and are saturated with water. Earthquake waves in the Cretaceous, or in the underlying folded Palæozoic strata, are thus propagated mainly in the solid rock, and, by total reflexion, literally channelled towards the outcrop of these strata on the coast. In the unconsolidated and water-saturated material at the bottom of the sea, the energy of the shock waves is largely dissipated in the material, and only locally can a fraction of the energy released by the earthquake reach the surface of the sea. The trawler *Rolando* might have been at just such a place.

E. TILLOTSON

SEDIMENTATION IN OROGENIC BELTS

A LITTLE more than twelve years ago, Kuenen and Migliorini set out the evidence which had led them independently to the fruitful idea that certain marine sediments may be re-deposited in deeper water, possibly many hundreds of kilometres distant from their temporary resting places, by the action of turbidity currents. The speakers at the symposium "Some Aspects of Sedimentation in Orogenic Belts", held by the Geological Society at the Royal Institution on February 8, had a wide field over which to range, but it was remarkable how much of the work described stemmed directly or indirectly from this concept.

In opening the symposium the president, Prof. S. E. Hollingworth, reminded the audience how present-day views on re-sedimentation could be traced back to the work of Bailey and O. T. Jones in the 'thirties. The principal speakers in the first session dealt with work in the Alps (Prof. R. Trümpy), the Polish Carpathians (Prof. M. Ksiazkiewicz) and the Himalayas (Prof. W. D. Gill). In the second session Prof. A. Wood spoke on the Lower Palæozoic of Wales, Prof. Scott Simpson on the Upper Palæozoic of south-west England, Prof. R. M. Shackleton on the Dalradians and Prof. Gill on a Carboniferous basin in Ireland. Discussion followed in each session. A summary account will appear in the *Proceedings of the Geological Society*, and rather than duplicate this summary I propose to consider in a more general way some of the topics which came up during the meeting.

Prof. Trümpy, who has recently provided a welcome account of alpine sedimentation[2], opened with a warning note on the use of the term 'flysch'[1,2], which, he said, describes a facies group and not a rock. Flysch, he continued, is marine, thick (> several 100 m.), and essentially composed of sandstones and shales in proportions varying from about 5 : 1 to 1 : 10. Individual beds can be followed for long distances, and flysch is in general monotonous. The shales are silty and the sandstones are often felspathic and generally micaceous. True greywackes are rare. Breccias and conglomerates, though quite subordinate, are typical of many flysch deposits. Prof. Trümpy pointed out that graded calcarenites are not called flysch in the Alps.

The structural setting in which flysch appears was discussed by several speakers. Prof. M. Ksiazkiewicz[3–9] showed how flysch was deposited in various parts of the Carpathian basin at different stages of its evolution. Thus in the outer zone folded in the Lower Miocene the flysch formed from the end of the Jurassic without interruption until the Oligocene. In the middle zone flysch did not appear until the Lower Senonian shortly before the pre-Maestrichtian orogenic stage, while in the inner zone flysch rests on rocks folded at the end of the Cretaceous. In the Alps, Prof. Trümpy suggested, flysch marked a stage when tension gave way to compression. Prof. Scott Simpson made the point that flysch is not confined to fold belts, while Prof. Gill gave a striking account of a comparatively small and shallow epicontinental basin in the Visean of County Dublin, in which slides and turbidity currents had developed in a non-orogenic setting.

The difficult question of the depth of water overlying flysch deposits was approached in several ways. Prof. Trümpy placed the fossils of the Alpine flysch in three ecological groups; an authochthonous fauna of fossils such as fucoids and helminthoids derived from soft-bodied animals indicating deep water beyond the penetration of light; a transported benthonic fauna including the larger foraminifera, calcareous algae and bryozoa, preserved in graded sandstone beds; and thirdly, pelagic microfossils such as globigerinids and radiolaria. Dr. J. F. M. de Raaf reported that foraminifera similar to or identical with recent deeper water species had been found in pelitic rocks above individual turbidites from flysch deposits in Switzerland, France, Spain, Italy and Greece. Profs. Ksiazkiewicz, Scott Simpson and Trümpy gave evidence which indicated that deep-water conditions were established before deposition of flysch began. Where shallow-water sediments were followed by flysch an intervening group of deep-water sediments was often present. In this connexion an interesting parallel emerged between a succession from south-west England in which, during the Variscan orogeny, Upper Devonian shallow water sediments were followed first by deep-water shales, cherts and limestones and then by Namurian flysch, and certain Alpine successions in which shallow-water platform deposits were covered first by shales and fine-grained limestones with a purely pelagic microfauna and then by flysch. In both regions the arrival of flysch was heralded by a phase when sedimentation did not keep pace with downwarping. In contrast, Gill attributed the lack of flysch over the greater part of the Himalayas to the building up of land masses in Middle and Upper Eocene time.

Prof. A. Wood[10-12] described some of the variations in lithology shown by the Aberystwyth grits which he employed to demonstrate the changes which could occur in turbidites as they are followed down-current. He discussed the behaviour of the associated mudstone and suggested that under certain conditions muds were stripped off and added to the turbid suspension passing overhead. Detailed work of this nature and of the kind carried out by Radomski in the Alps is beginning to establish the relationship between changes in facies and the several environments which might be expected in a single basin and seems likely to improve our understanding of the mechanism of turbidity currents.

Later in the discussion Mr. W. A. Cummins suggested that the finer-grained chloritic fraction of some greywackes might in part be a secondary feature. The apparent lack of contemporary greywackes might be explained in this way. Dr. J. G. Ramsay and Dr. J. L. Knill mentioned the difficulties which may arise in establishing the original attitudes of deformed sedimentary structures. Although, as Prof. Wood pointed out, account is usually taken of the effects of plunging structures, so far as I am aware the effects of shear folding in which the angle between a sedimentary structure and the fold axis alters during folding have not been considered. The results presented by Ramsay[16] on this question should allow observations to be made in rocks deformed in this way.

Prof. Shackleton summarized present knowledge of Dalradian current directions[13-15], and commented on the distribution of the various Dalradian sediments, some of which remain remarkably consistent from western Ireland to north-east Scotland. Dr. B. Sturt described variations within the Dalradian of Perthshire and Prof. Shackleton mentioned the recent recognition of turbidites near the base of the Torridonian succession in Colonsay and Islay.

One of the most arresting features of the symposium was the sequence of maps presented by Prof. M. Ksiazkiewicz[3-9], which illustrated the results of measurements of current directions and facies analyses in the Polish part of the Carpathian flysch zone. This work, carried out by Prof. Ksiazkiewicz and S. Dzulynski, A. Slaczka, K. Zytko, W. Sikora, L. Koszarski and A. Radomski, has resulted in an elegant demonstration of the forms of the troughs and of the whereabouts and nature of the source areas. The varying directions taken by sediments were shown, and it was demonstrated, for example, that for a considerable time the axes of two neighbouring troughs sloped in opposite directions so that a northern trough was fed from the west and a southern from the east. These important results provide one of the most detailed accounts yet established of the movement of sediment within an evolving orogenic belt. I suggested, when summing up the day's discussion at the close of the meeting, that a synoptic account of comparable observations made in the British Palæozoic might be useful in bringing out what is known on this topic and what we need to find out in the future.

J. SUTTON

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ROCK ENGRAVINGS IN NORTHERN ITALY

SOME years before the First World War, l'Institut de Paléontologie Humaine was founded by Albert I, Prince of Monaco. Its various publications, not least the series of *Archives*, are of importance to every prehistorian. *Memoire* 31, entitled *Le Grande Roche de Naquane*, has maintained the standard. Rock engravings in the Val Camonica have long been known, especially as the result of the publications of G. Marro and R. Battaglia, but the time was ripe for this detailed study by M. Anati to appear. The carvings are found on rocks, many hundreds of them, up the valley for about 30 miles from near Boario to Edolo. A line drawn on a map from Bergamo to Bolzano will pass not far from the art complex. The author has attempted to separate these stylized drawings into three series: the first dating may be as old as the late Bronze Age, a second belonging to the Iron Age, and a third, which was still being made when Rome conquered northern Italy. A glance at the illustrations—there are no less than 52 full pages—reveals that there are depicted in a pocking technique animals, mainly domestic but including stags, human beings and various weapons and signs. The author decided not to select his illustrations from various sites in the complex, but to concentrate on a single rock surface. There is thus given a complete account of at least one locality from among the 600 or so which have been identified.

The Val Camonica is a long valley running up into the Alps, and it is probable that it has always been