

## Remarks about Displacements of the Old Rift Systems in the North Sea Area

A contribution arising from discussions following two of the papers presented, including the background for questions about observed lateral displacement in the area

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The old rift valley systems of West Europe have been discussed for a long time. Some earth scientists interpret the exposed parts of the rift systems (Oslo Graben, Rhine Graben, etc.) as more or less local structures. Others interpret the grabens as elements in a large-scale framework (e.g. Mittelmeer-Mjøsen Zone), where links have been buried below thick sediment cover or even destroyed. However, the origin of the graben structures is of Variscan age, and there is no reason to believe that later tectonic disturbances in the North-West Europe region were of sufficient force to destroy parts of such large-scale structural elements.

Two of the papers presented (by Dr. Naylor (Whiteman et al.) and Dr. Ziegler, respectively) give new knowledge about rift valley fragments in the Central and Northern North Sea. In addition, these fascinating papers give us splendid illustrations on the geological developments in the North Sea area. It is, however, difficult to imagine that the whole area between the Hercynian Front (Wales-London-Ardenne platform), the Fennoscandian Border Zone, and the continental margins should not be more intensively structured by the Alpine Orogeny at different geological times. The major part of this area is composed of a rather thin granitic layer. Considering the strong disturbances and major block rotations in Southern Europe together with an undulated pattern, e.g. of the Alpine ranges, some neutralizing horizontal dislocations could sometimes be expected into the area in question. Have such extensions between the Alpine Geosyncline and the continental margin in the north and north-west been recognized in any part of the North Sea area?

In connection with our geological and geophysical interpretations along and closely south of the Fennoscandian Border Zone we have, for the best explanation of the development of the region, used a neo-tectonic model acting during the Jurassic and Lower Cretaceous. The model is closely related to that of the Recent wrench-fault tectonics in South-West California. There, the granitic layer is relatively thin, and the distances to the continental margin and to the actual orogenic disturbance are rather short. Furthermore, the structural trends and the general scale of the structures are nearly the same for the two areas. In the North Sea area, the trends of the wrench-faults are demonstrated on a small scale by displacements in many of the salt structures. On a regional scale, horizontal dislocations have moved parts of an originally continuous

Mittelmeer-Mjøsen Rift System as segments into the Central and Northern Sea. These mainly north-western movements of micro-plates seem to have terminated in the lowermost Cretaceous. They were probably activated by the initial Alpine Orogeny from the south or south-east along the Eastern European Platform, and by an initial and partial opening of the North Atlantic in the north-west and west. The model provides reasonable explanations for local problems in connection with the Fennoscandian Border Zone, geological distributions in the North Sea Basin, and paleogeographical features in common with Polish and south-west Russian areas, at least during Permian into Upper Jurassic.

During the Upper Cretaceous and the Tertiary, the Fennoscandian Border Zone was affected by a rather complicated tectonics, mainly appearing as compressional features, the northernmost of which include strong isostatic movements. Close to the Fennoscandian Border Zone, younger erosion has often removed important stratigraphical sequences. The partly tensional Cimmerian features are superimposed by the younger disturbances. Concerning the possible effect of fracture-zones (resulting from sea floor spreading) penetrating into the continental areas during the opening of the North Atlantic in Uppermost Cretaceous and Lowermost Tertiary times, it is remarkable that Cimmerian fractures in the north, along the Fennoscandian Border Zone in Denmark, have not been renewed to any appreciable extent.

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