

THE INTERNATIONAL GEODYNAMICS PROJECT:

A Suggested Contribution Towards The Danish National Programme

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Research projects at present being carried out by the Geological Central-Institute of Copenhagen University which have relevance to the International Geodynamics Projects are described. These broadly have bearing on the origin and development of the North Atlantic basin.

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This contribution is built up round the ongoing programmes of research in the Geological Institute (Copenhagen University) which, in general, are related to the origin and development of the North Atlantic Ocean. Particular emphasis is placed on the volcanic and tectonic relationships of constructive plate margins consequent upon the setting of Denmark and Greenland straddling the North Atlantic Ocean where a complete profile is found representing the history of this ocean from the early break-up event in the Lower Tertiary to the present-day formation of new ocean floor in the area of Iceland (see National Academy of Sciences, 1972). Close contact exists, and will be maintained, with the Geological Survey of Greenland (G.G.U. see: Esher & Bridgwater, 1972). Icelandic geologists, the Geological Survey of Denmark (D.G.U.) and geologists of the University of Lund, Sweden. In addition, it is hoped that collaboration with the U.S. Naval Oceanographic Office, with whom two fruitful cruises have so far been carried out, will continue and perhaps be strengthened.

Contribution 1

West Greenland in association with G.G.U.

In central West Greenland a thick sedimentary basin of Upper Mesozoic age is overlain by Lower Tertiary sediments and volcanics (Rosenkrantz &

Pulvertaft, 1969). This succession appears to have an origin closely tied up with the opening of Baffin Bay (Clarke & Upton, 1971) and is regarded as a promising area for petroleum deposits (Henderson, 1969). As such, detailed investigations, both onshore and offshore are in progress. Studies on the volcanics, which are up to 10 km in thickness and which include picritic pillow lavas and pillow breccias overlain by subaerial flows of less mafic composition and with a variety of more differentiated types in the upper part, concentrate on the detailed field relationships, petrology, geochemistry and palaeomagnetism (Munck & Noe-Nygaard, 1957; Pedersen, 1970, 1973; Hald, 1973). Some of these lavas are believed to be very primitive (Clarke, 1970) and interesting interactions with the sedimentary rocks are observed (Pedersen, 1970).

Contribution 2

East Greenland in association with G.G.U.

North of Scoresby Sund, an extensive series of coast-parallel graben-like structures were the site of continued sedimentation throughout the Mesozoic (Haller, 1971). Intense plutonic and volcanic activity took place in the early Tertiary, both here and to the south, over a distance of almost 10 degrees of latitude, and this apparently coincided with the extension of the Atlantic rift system into this area (Brooks, 1973 a). The unusual volume of magmatic rocks in this part of East Greenland doubtless records the earlier position of the present-day Icelandic hot-spot and therefore provides a valuable record of earlier discharge from this important mantle plume. An elucidation of the processes leading up to and accompanying continental break-up are being studied by mapping of the sediments and volcanics, while petrological (Fawcett, Brooks, Rucklidge, 1973) and geochemical studies, including radiometric dating, isotope studies and in future palaeomagnetism, are aimed at clarifying the processes of magma generation in the mantle and its relation to the various geodynamic environments during pre-rifting, continental break-up and ocean-floor spreading with the accompanying rise and fall of geotherms. These data will also be used in conjunction with data from Iceland and the nearby ridge to examine the effect of the hot-spot. Large areas of the province are imperfectly known and more detailed exploration will allow a better synthesis of time relations and petrographic types with the earlier phases of ocean formation and is particularly related to the stated interests of the Geodynamics Project, Working Group 4.

In contrast to most Atlantic margins, which are low-lying – presumably as a result on the contraction of the mantle as the continents become farther removed from the hot spreading centre (Vogt & Ostenso, 1967), – the

Greenland and Norwegian margins remain as positive topographic anomalies. Major epeirogenic uplift took place in East Greenland in the Tertiary (Wager, 1947) and has still not subsided. This uplift is associated with possible rift formation (Brooks, 1973b) and, among the alkalic rocks associated with it, are lamprophyre dike swarms with high pressure megacrysts and olivine nodules (Brooks & Rucklidge, 1973). The further study of the rifting and epeirogenesis are included in the fields of interest of Working Group 4 and 7. Interest in this region should be intensified owing to the possibilities of economic deposits of metals and hydrocarbons.

Studies of the impressive coast-parallel dike swarm, first described by Wager & Deer (1938) have recently been initiated.

Contribution 3

Iceland

In close collaboration with Icelandic earth scientists, a number of projects are in progress on Upper Tertiary and Holocene rocks related to this spreading centre. These include petrological and geochemical investigations of a 2 km. sequence of Tertiary Plateau basalts in the N.W. peninsula, the detailed studies of the Króksfjörður central volcanic complex (Hald, Noe-Nygaard and Pedersen, 1971) and of certain Post-glacial acid rocks in southern Iceland. Further studies of mixed lavas are planned.

Contribution 4

The Faeroe Islands

In association with D.G.U. a programme of bathymetric and geophysical work on the Faroes shelf and detailed profiling of the plateau lava sequences (Noe-Nygaard & Rasmussen, 1968; Rasmussen & Noe-Nygaard, 1969) for petrological and geochemical studies are in progress and further radiometric dating and palaeomagnetic measurements are planned. The Faroes are believed to be located above continental crust (Bott et al., 1971) and, as such, should resemble closely the East Greenland lavas which are symmetrically placed on the other side of the Mid-Ocean ridge.

Contribution 5

Southern Scandinavia

In southern Sweden (Scania) a large number of alkali basaltic plugs and vents (Norin, 1933, 1934) occur in association with a north-westerly trending series of graben and horst structures. These rocks contain inclusions of ilmenite and megacrysts which have been the subject of a detailed petro-

logical and geochemical study combined with palaeomagnetic and radiometric (Printzlau & Larsen, 1972) investigations. It is intended to extend this work to the associated tuff horizons and dike swarms. This will form a contribution to the study of continental and oceanic rifts under Working Group 4.

Microprobe studies of the glasses from the Eocene ash layers of the Moler formation of northern Jutland (Bøggild, 1918) are projected. These comprise a range of compositions from basic to acid and are believed to originate from the submerged volcano in the Skagerak located by Sharma (1970) which presumably formed as a consequence of the tensional stress field caused by continental break-up.

Contribution 6

Atlantic Ocean Floor (Ocean Study Group)

In association with the U.S. Naval Oceanographic Office, samples recovered by dredging from the Mid-Atlantic Ridge, the Charlie Fracture Zone, the Icelandic Shelf and the East and West Greenland (Johnson et al., 1972, 1973 a, 1973 b) continental slopes and shelves are being studied, at present with emphasis mainly on major and trace element geochemistry. This information will be combined with the data from the geophysical surveys and interpreted in the light of sea-floor spreading to give specific information on the processes taking place at constructive plate boundaries and at continental margins (i.e. the relation between continental and oceanic crust). This work will be extended to more detailed petrological studies and to additional trace elements, specifically the rare earths. Papers on the Charlie (Gibbs) Fracture Zone, the Icelandic Shelf and the East and West Greenland continental margins are at present almost ready for press.

A large collection of additional material is also being examined for comparative purposes from other localities: the equatorial Atlantic, the Galapagos area and the East Pacific Rise. Particular attention is being paid to correlation with the adjacent continental areas and to evaluation of the effects of the Icelandic hot-spot or mantle plume by comparison of the Icelandic basalts with those from portions of the ridge removed from the hot-spot to confirm the suggested chemical differences (Noe-Nygaard, 1966). Examination of material from the Greenland-Iceland-Faeroes aseismic ridge and adjacent on-shore areas is expected to throw light on the temporal variations (e.g. rates of discharge, etc.) in the plume flow. To this end it is hoped to be able to direct future attention to the area between Iceland and East Greenland which is relatively unknown and is further a promising area for hydrocarbon occurrences.

The geochemical and geophysical programme is now being augmented with magnetic studies, both magnetic and shipborn (first tests on a specially designed spinner magnetometer at sea were highly satisfactory), and in situ γ -ray spectrometry of the ocean floor has also been satisfactorily tested.

Dansk sammendrag

Der beskrives nogle undersøgelsesprojekter, som er under udførelse af medarbejdere ved geologisk centralinstitut i København. Projekterne har sammenhæng med det internationale Geodynamics Project og sigter mod at bidrage til løsningen af spørgsmålet om Nordatlantens opståen og senere udvikling.

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