PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

Geochronology and Continental Drift-The North Atlantic: Appendix. The Structural Unity of the Reconstructed North Atlantic Continent

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Appendix. The structural unity of the reconstructed North Atlantic continent

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The map of chelozones (figure 4), which accompanies this short note, is a first attempt to show that when the pre-Tertiary North Atlantic continent is reconstructed in the manner described by Dr Miller, it has an essential structural unity. The almost perfect 'jig-saw' fit of the fundamental geological structural provinces of the North Atlantic continental masses suggests very strongly that their geographical fit is not accidental, and that they are the disrupted fragments of one originally continuous continent.

Many workers have commented on the cyclical nature of past episodes of major structural activity in the continental basements (see, for example, the references quoted by Sutton 1963), and Canadian geologists in particular have pioneered the production of maps which delimit major structural provinces in the Precambrian shield areas. Each major structural province is an area of the continental shield which became reactivated over a certain extended period, during which it was crossed by mobile belts, involved in geosynclinal subsidence and finally became the locus of a series of major orogenic/metamorphic/magmatic events which largely reworked its rock substance. After these culminating events the province becomes once again a stable part of the continental shield, subject only to epeirogenic movements and to the injection of non-orogenic granites, alkaline complexes and tensional basic dyke swarms. Isotopic age determinations on the rocks of a major structural province generally reveal the age span of the culminating events, when much of its constituent rock material was either crystallized from a melt or recrystallized during regional metamorphism. Rarely, relict areas of older rock may be found included within structural provinces largely reactivated at some later date.

Gastil (1960), Runcorn (1962*a*, *b*), and others, have discussed the periodicity of these events in time. Sutton (1963) developed the concept of 'chelogenic cycles' during each of which a sequence of events, controlled by convection currents in the mantle, begins with widespread orogenic events, and, passing through a period of drift dispersal and re-grouping of the continental masses, ends with a quiescent interval before the inception of the succeeding cycle. In Sutton's view, the zones of the crust activated during one chelogenic cycle become the stable structural provinces of the shield areas present during later cycles, thus he derives the term 'chelogenic' (Gr. literally, shield-forming). Regardless of the mechanisms that may be suggested to explain the underlying causes and to control the development of chelogenic cycles, the presence of these major structural provinces or 'chelozones' within, and crossing, the continental crust, cannot be denied.

A re-examination of the geochronological and geological evidence in the light of the most recent published results extends and confirms the conclusions of Gastil. It suggests that at least six geochronologically distinct chelozones can be distinguished. The major orogenic period of each of these is contained within the following age limits:

major orogenic period (My)	name of chelogenic cycle	total time-span of cycle (My)
—	Alpine	250
260 to 500	Varisco-Caledonian	250 to 850
900 to 1150	Grenville	850 to 1550
1600 to 1900	Churchill	1550 to 2400
2450 to 2750	Superior	2400 to > 2900
> 2900	Kola	

The major orogenic period may be taken as the initial event in a chelogenic cycle, as it is by Sutton and by most other workers in the Precambrian, or, as I prefer to do, and as is the most common practice when discussing Phanerozoic geosynclinal–orogenic cycles,

A map to illustrate that the reconstructed North Atla

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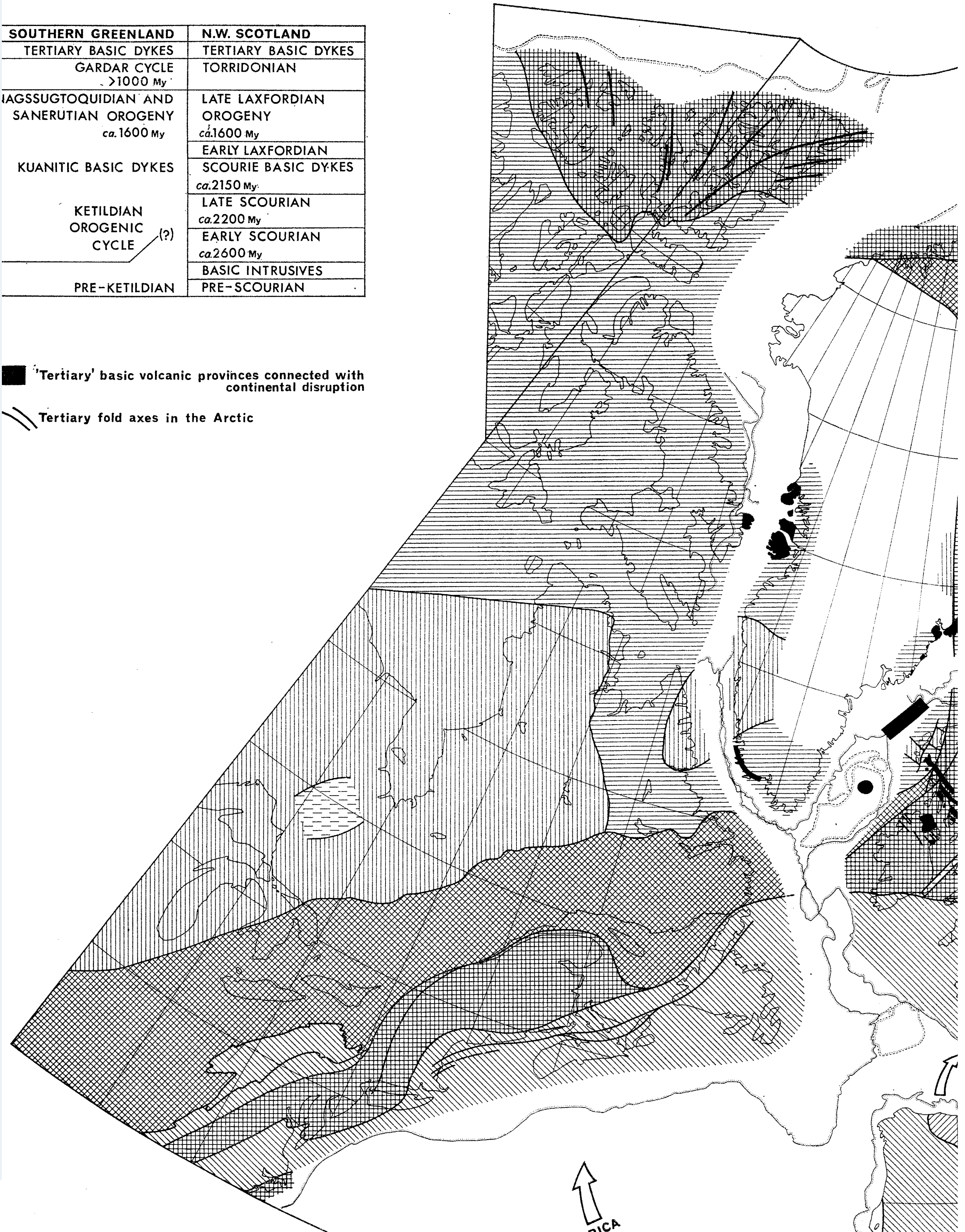
SOUTHERN GREENLAND	N.W. SCOTLAND
TERTIARY BASIC DYKES	TERTIARY BASIC DYKES
GARDAR CYCLE >1000 My	TORRIDONIAN
NAGSSUGTOQUIDIAN AND SANERUTIAN OROGENY *ca.* 1600 My	LATE LAXFORDIAN OROGENY *ca.* 1600 My
	EARLY LAXFORDIAN
KUANITIC BASIC DYKES	SCOURIE BASIC DYKES *ca.* 2150 My
KETILDIAN OROGENIC CYCLE (?)	LATE SCOURIAN *ca.* 2200 My
	EARLY SCOURIAN *ca.* 2600 My
	BASIC INTRUSIVES
PRE-KETILDIAN	PRE-SCOURIAN

'Tertiary' basic volcanic provinces connected with continental disruption

Tertiary fold axes in the Arctic



antic continent has an essential structural unity

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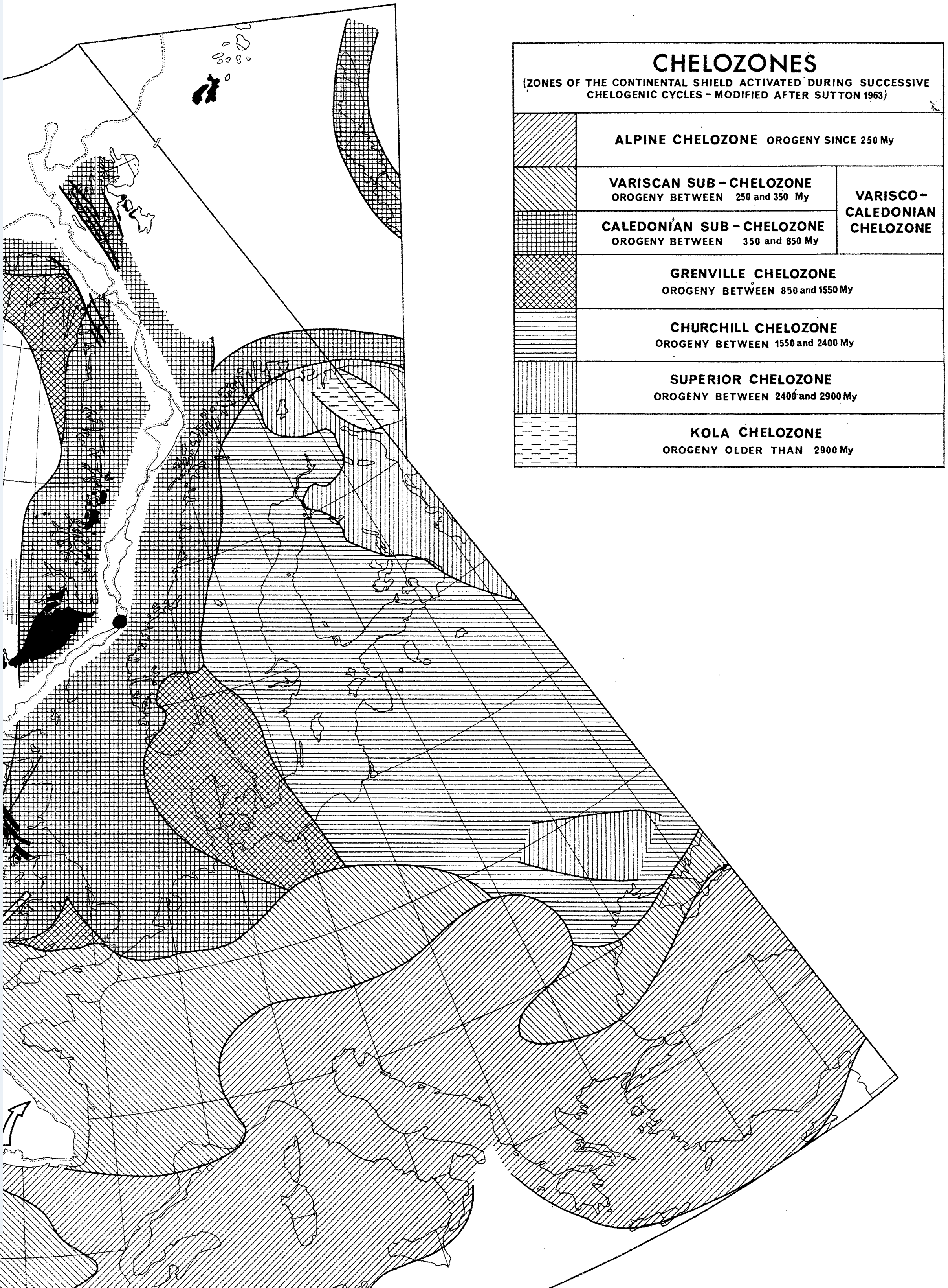

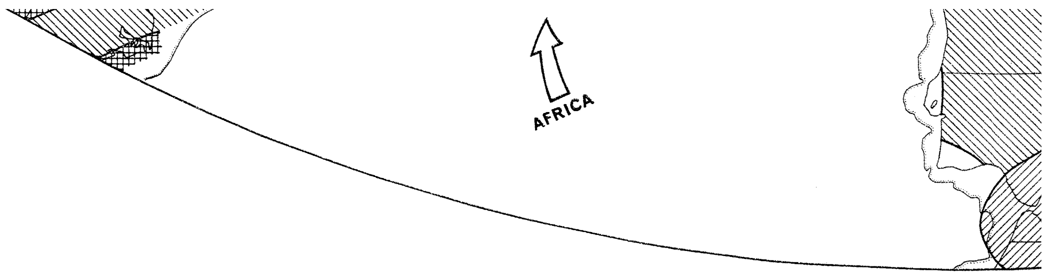

FIGURE 4

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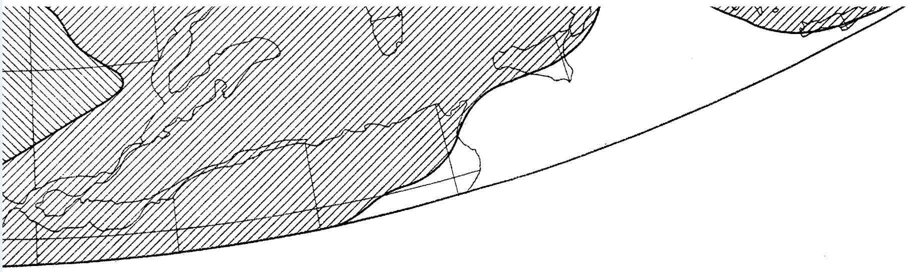

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(*Facing p.* 192)

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taken as the final culminating event of a cycle. Whichever of these two alternatives is adopted, however, it makes little difference when delimiting chelozones, as the remaining part of each chelogenic cycle is virtually non-orogenic. The greater volume of geological and isotopic data available makes it possible to subdivide the youngest of the cycles listed above into Variscan (250 to 350 My) and Caledonian (350 to 850 My) subcycles. The present (Alpine) chelogenic cycle began to develop some 250 My ago and will not come to its culmination for several hundred million years.

It will be seen from the map that continental drift disruption has split the pre-Tertiary North Atlantic continent along lines of structural weakness that very largely follow the trends of former chelozones. Tensional failure of this continental outer layer of the Earth was accompanied by the injection of basic magma and by outbursts of basic volcanism, the principal loci of which are shown on the map.

Preliminary analysis of the age data from these disruption volcanics suggest that the pre-Tertiary continent was split from the south northwards in a series of distinct episodes. The arcuate radial pattern of Tertiary folds in the Arctic borderlands of Canada, northern Greenland and Spitsbergen is thought to have evolved as a result of complimentary compression in the still continuous thin northern continental margin as the split opened in the south.

This reconstruction can be tested in a number of ways. A detailed study of the geochronology and geological structure of southeast Greenland would enable comparison to be made with the known area of northwest Scotland. Marginal effects of the Grenville chelozone should be present in the far south of Greenland as they are in the Lewsisian of northwest Scotland south of Loch Laxford. As already suggested by Wilson (1963) a study of the age relation of the Tertiary volcanics should reveal a detailed and consistent sequence of events during drift disruption. Certain geophysical tests, such as confirmation of the presence of continental crust beneath the Rockall Bank, might be applied. The reconstructed North Atlantic continent makes for greater simplicity in the palaeogeography and palaeobiology of Phanerozoic and Proterozoic times, and further work in this field and in the study of the provenance of sediments may provide confirmatory evidence.

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A map to illustrate that the reconstructed North Atlantic continent has an essential structural unity

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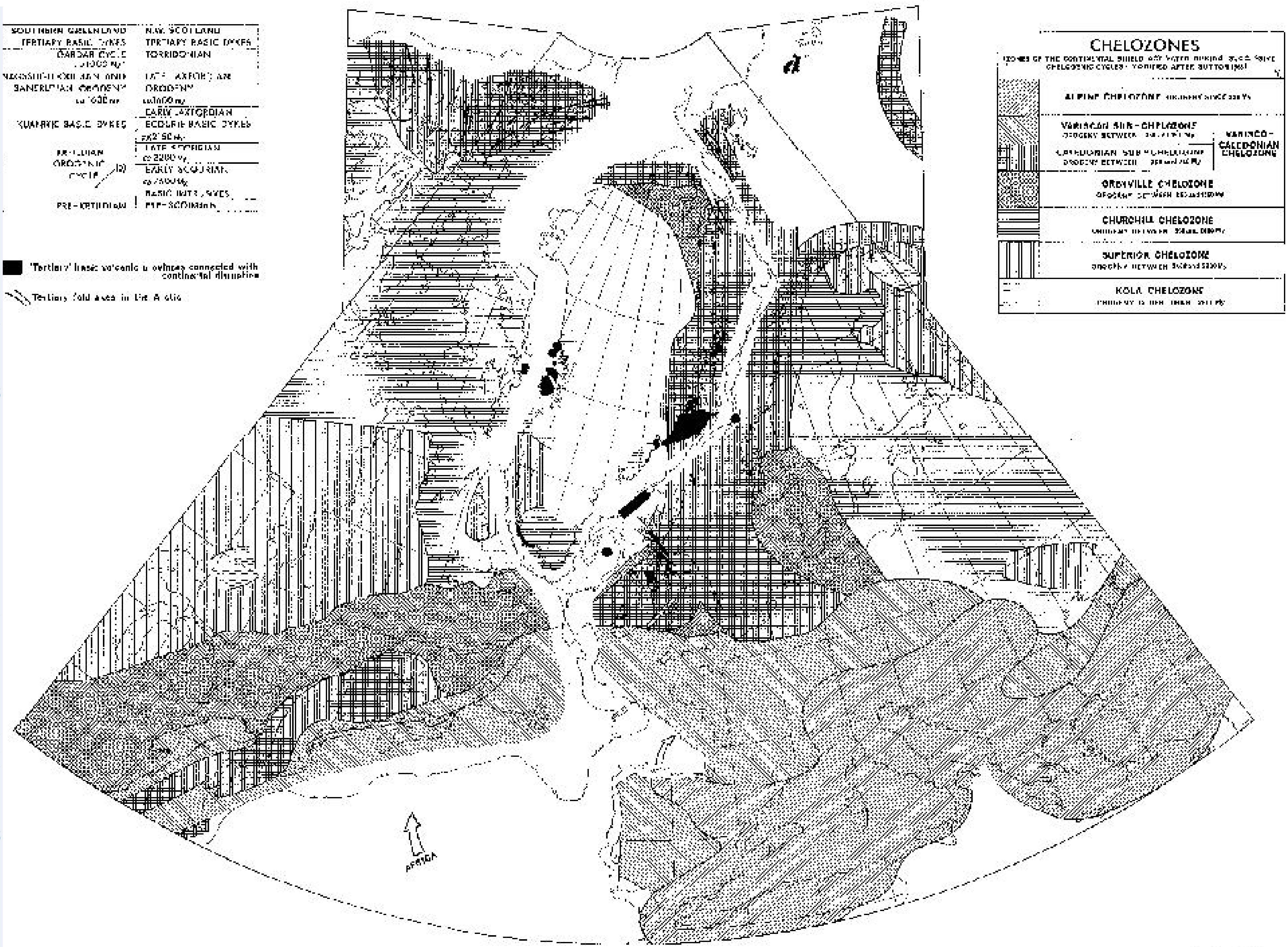

FIGURE 4

(Facing p. 187)