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LINEAMENT ANALYSIS FROM ERTS (LANDSAT) IMAGES OF THE NETHERLANDS

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ABSTRACT

A lineament map from ERTS (Landsat) images of The Netherlands is presented. The directions of these lineaments have been compared to fault patterns in the Carboniferous, the base of the Creataceous and the uppermost Tertiary and Quaternary. The known fault patterns are essentially similar to the Landsat lineament patterns.

Linear features on the surface of the earth have attracted the attention of geologists since a long time. One of the earliest descriptions of linear features in the landscape was given by H o b b s (1911) who defined them as: "significant lines in the Earth's face". Already in the late twenties R i c h (1928) mentionejoint patterns in limestones as seen from the air. After the second World War, in the fifties and sixties, numerous articles[2)] dealing with the detection and interpretation of linear patterns on aerial photographs appeared. L a t t m a n (1958) gave the following definition: "Photogeologic fracture traces and lineaments are linear trends of topographie features, soil tones, and vegetation, visible on aerial photographs. Photogeologic fracture traces are continuously discernible on a photograph for less than one mile; photogeologic lineaments are continuously expressed for at least one mile, and commonly are continuously or discontinuously expressed for many miles".

According to Lattman, the former express bedrock joints or small faults, the latter represent regional zones of scatter of faults of deep-seated origin. Lattman states further, that such lineaments (longer than one mile) are best studied and traced on controlled mosaics.

Ever since space photographs were made and data became available from the Earth's Resources Technology Satellite (ERTS, now Landsat) and from Skylab, investigators have been interested in tracing lineaments from such images. When taken under favorable atmospheric conditions, these can be considered as well controlled, small scale mosaics of good quality. As a result a considerable amount of papers[3)] on the subject has been published.

This paper deals with an analysis of lineaments from Landsat images of The Netherlands. For the interpretation, which was carried out visually, use was made of positive prints of bands 4 (0.5 – 0.6 μ), 5 (0.6 – 0.7 μ) and 7 (0.8 – 1.1 μ), on a scale of 1 : 1.000.000. Band 7 has been used specifically for the recognition of waterways and high roads. These are characterised by low reflections in the infra-red part of the spectrum and therefore exhibit dark tones on band 7 images. Combined with information from topographic maps these tonal characteristics allow the elimination of such features.

The lineament map (Figure 1) has been prepared from the Landsat images without prior knowledge of existing fault maps of The Netherlands. Later the results were compared with two maps published by H e y b r o e k (1974), which show the fault pattern in the Carboniferous and at the base of the Cretaceous; simplified versions of these maps are presented in Figure 2 and 3. Similarly Figure 4 gives a simplification of a map showing faults in the uppermost Tertiary and Quaternary of The Netherlands, which was prepared by the Geological Survey of The Netherlands. (Z a g w i j n and van S t a a l d u i n e n, eds., 1975).

In order to compare the Carboniferous-, base Cretaceous- and uppermost Tertiary and Quaternary fault patterns to the lineament map from the Landsat images four rose diagrams have been prepared (Figure 5). These show that the known fault patterns are essentially similar to the Landsat lineament pattern, only the NE trend which appears clearly in the lineaments does not show in the fault pattern maps. For testing the statistical significance of the rose diagrams a variance ratio test was carried out. This showed that at a probability level p of 0.05 there is no significant difference between the NW-trending lineaments and the NW-trending faults.

[1)] Niwars: Netherlands Interdepartemental Working Community for the Application of Remote Sensing Techniques.

[2)] Kaiser (1950), Blanchet (1957), Mollard (1962), Kupsch and Wild (1958), Lattman (1958), Haman (1961), Mollard (1962) Allum (1966), van der Meer Mohr (1967) and Norman (1969).

[3)] Houston and Short (1973), Lattman (1973), Short (1973, 1974 a and b), Hoppin et al. (1974), Tomes et al. (1974), Viljoen et al. (1975).

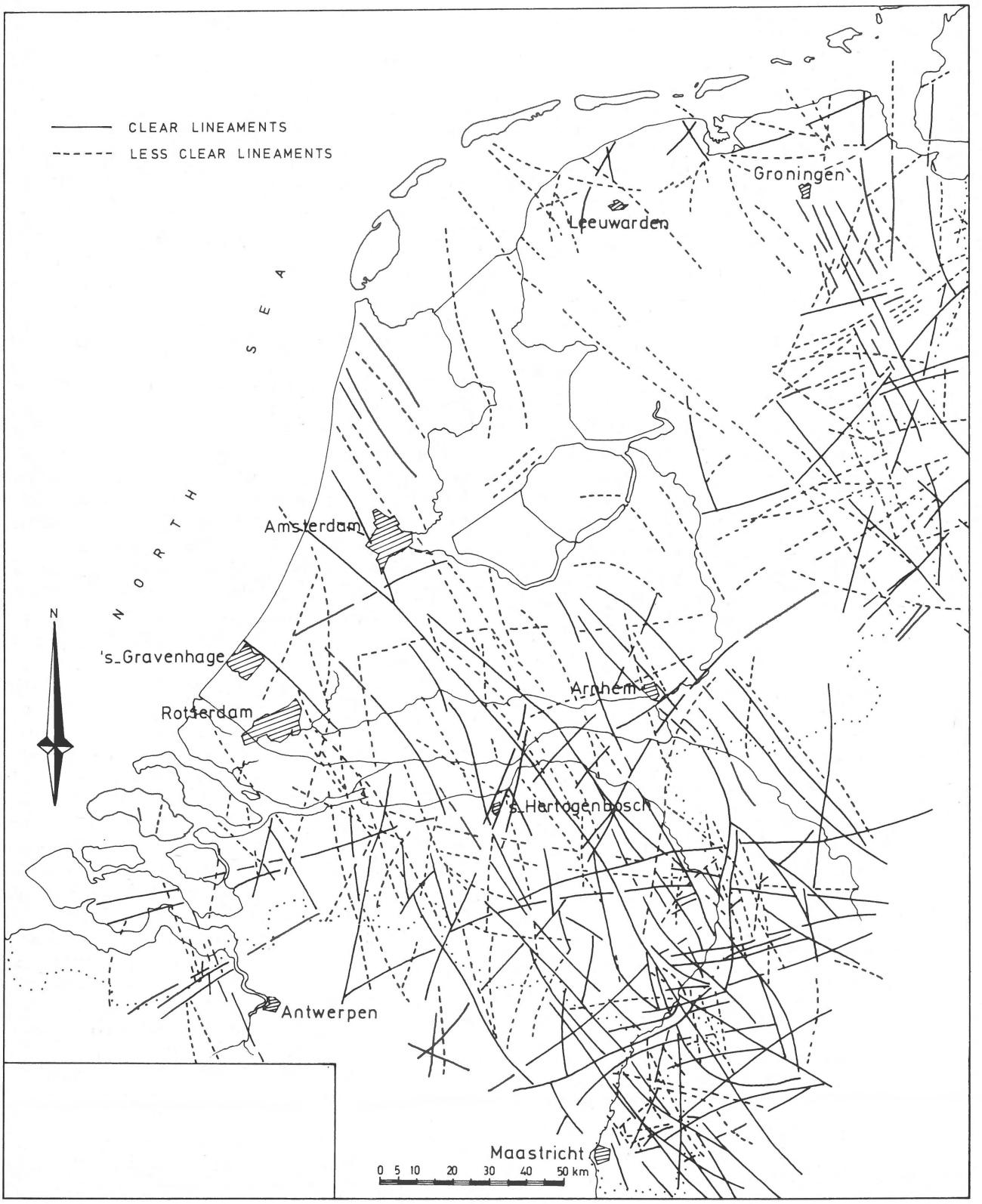

Fig. 1
Lineament Map of The Netherlands prepared from Band 4, 5 and 7 Landsat Images

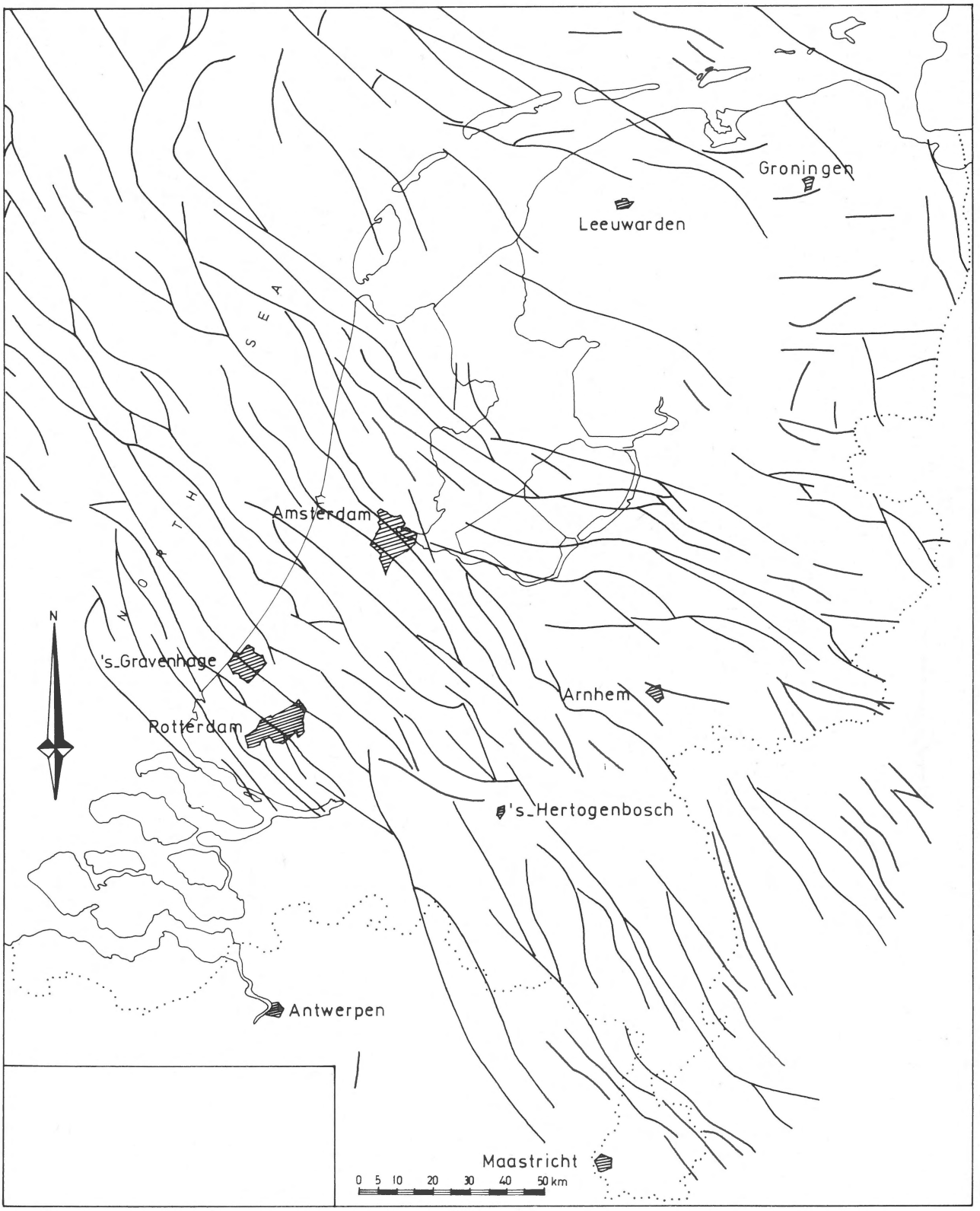

Fig. 2
Fault Pattern Top Carboniferous after Heybroek (1974)

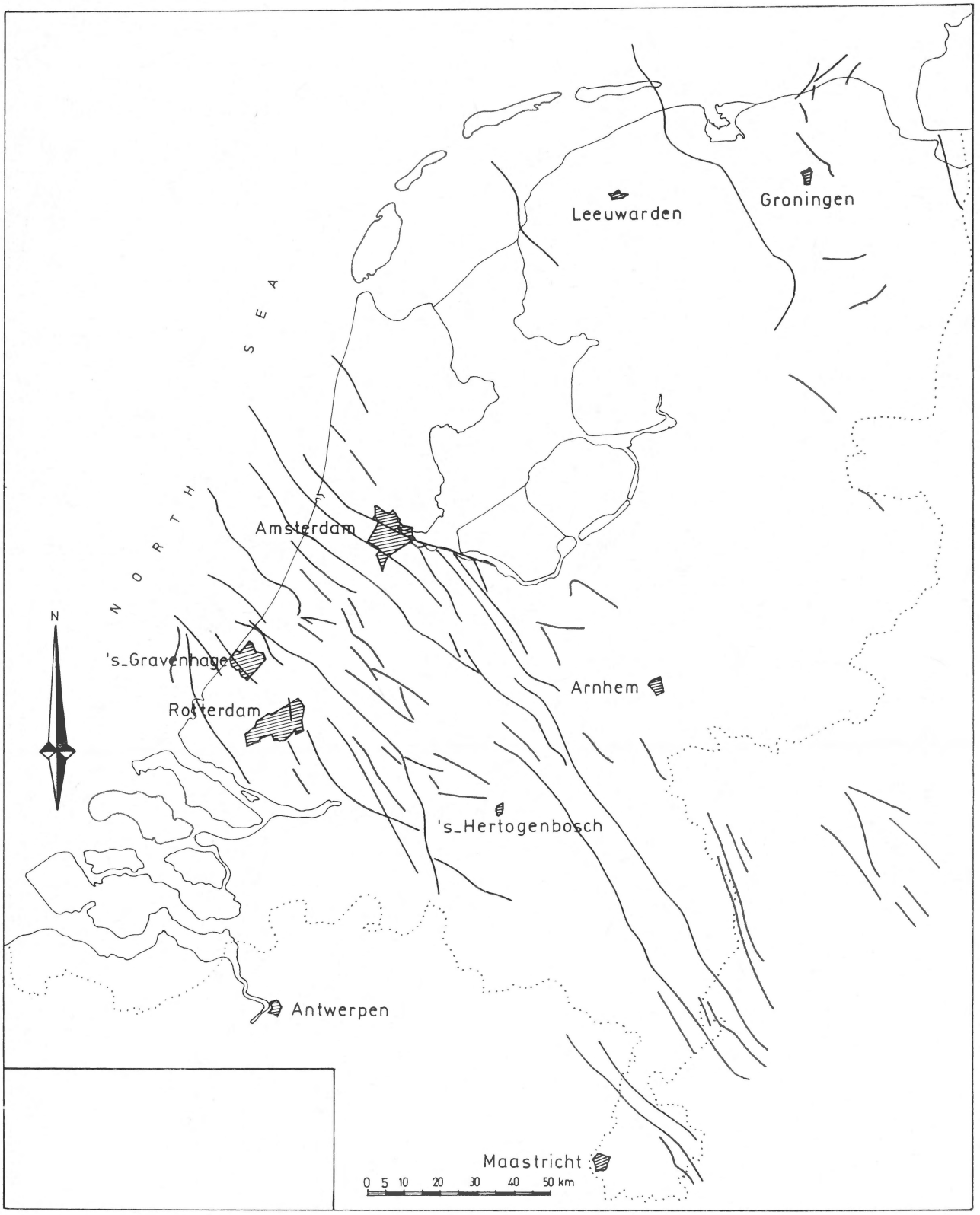

fig. 3
Fault Pattern Base Cretaceous after Heybroek (1974)

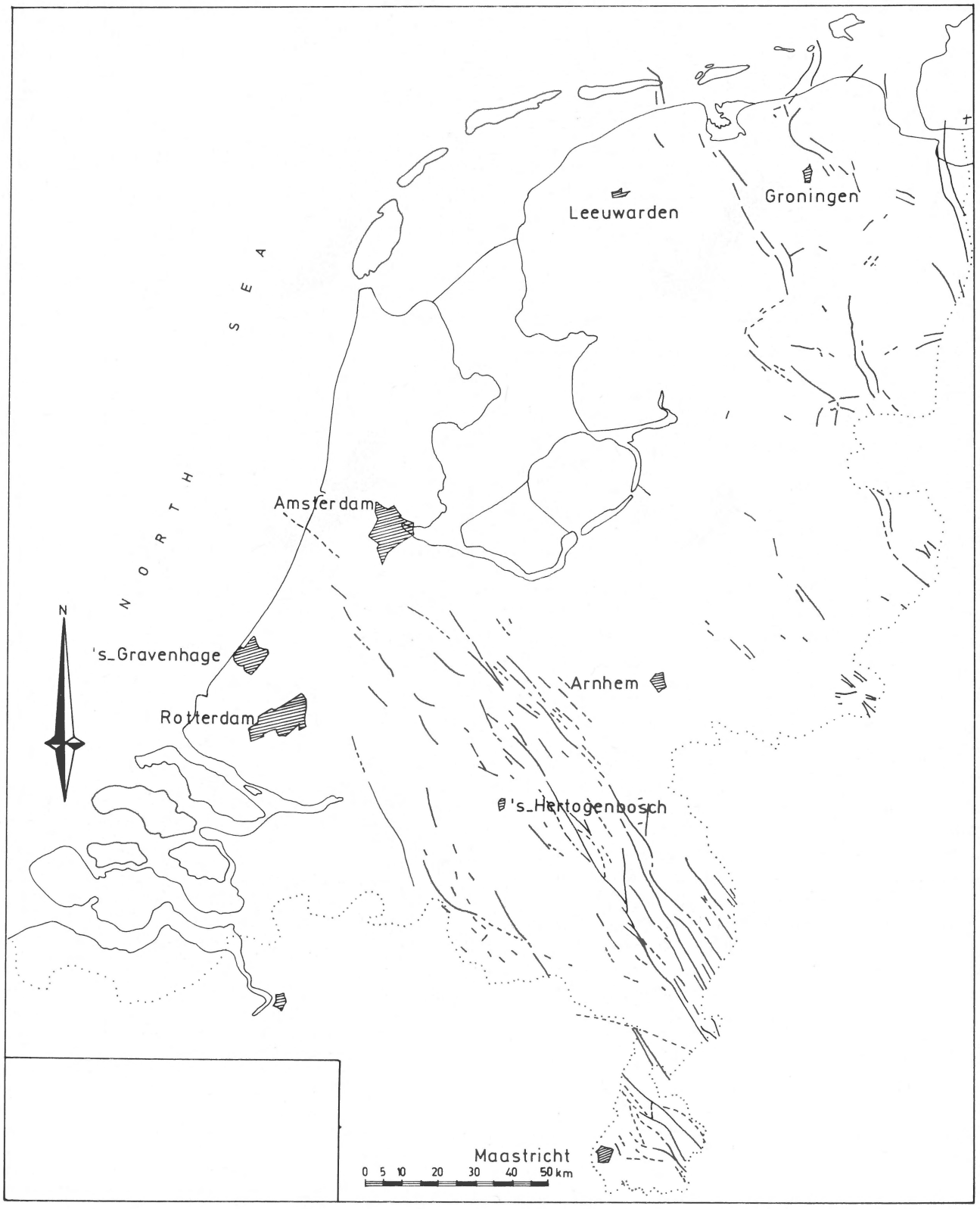

Fig. 4
Fault Pattern in uppermost Tertiary and Quaternary

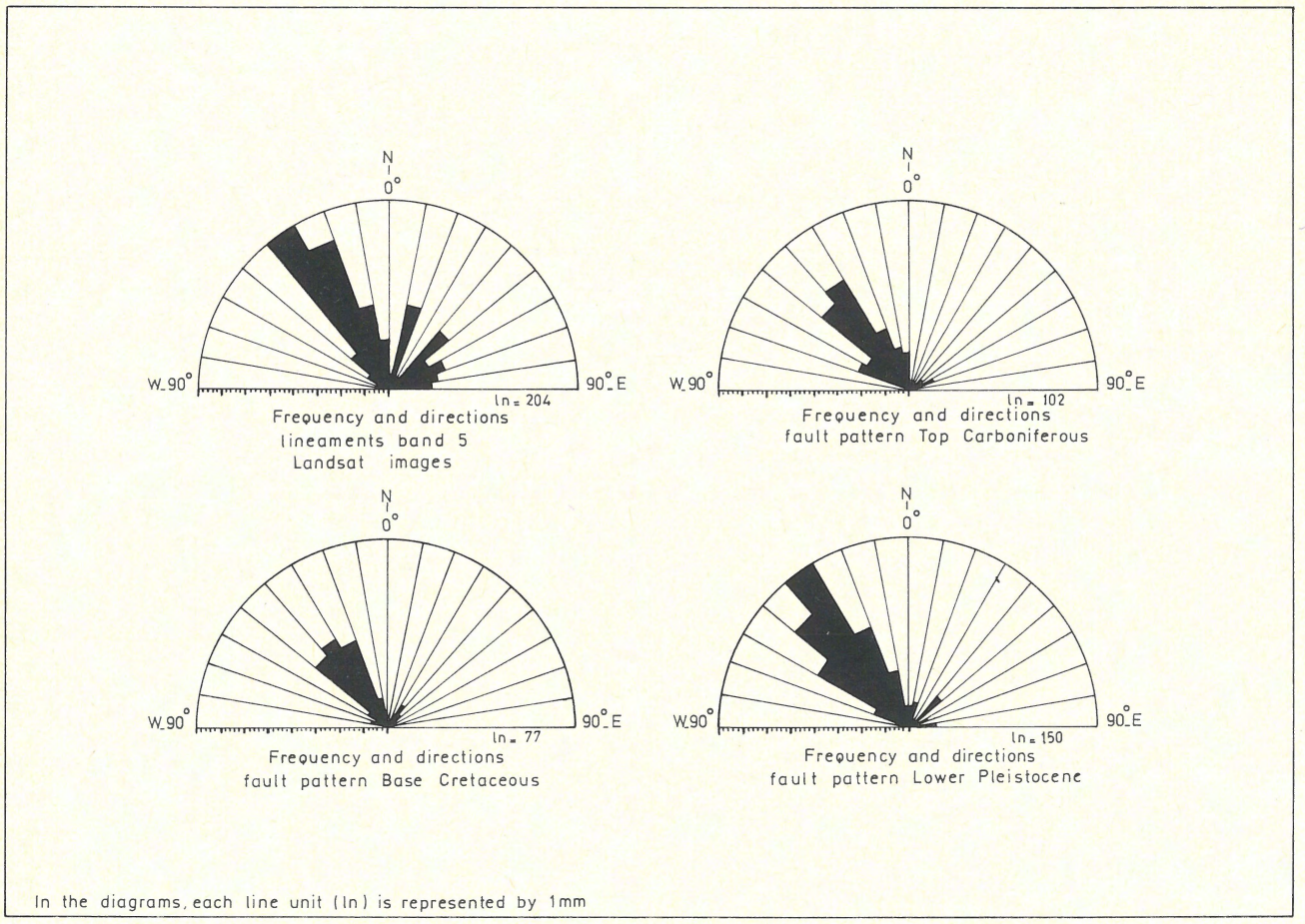

Fig. 5
Rose Diagrams of Lineaments and Faults in The Netherlands.

From the foregoing the following conclusions might be arrived at:

- Although the statistical test does not prove a causal relationship between the lineaments and the faults, it justifies the assumption that such a relationship could exist.
- The NE-trending lineaments might perhaps be regarded as the surface expression of hitherto unmapped faults.
- The surface features that produced the lineaments are probably related to changes in the topography, differences in moisture content and in the vegetation.

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